GreenpowerUSA
INSPIRING ENGINEERS

Formula Goblin Curriculum & Assembly Manual

HUNTSVILLE CITY SCHOOLS

SIEMENS

Formula Goblin Curriculum

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GreenpowerUSA

Objective

To advance education in the subjects of sustainable engineering and technology to young people. Greenpower runs engineering challenges for schools based around designing and building a single seat electric powered race car.

Alignment to Education

- Provide students and teachers with access to industry leading technology
- Support the teaching and learning of the STEM subjects
- Improve technological literacy
- Workforce preparation

Goals

- To change current views about engineering, presenting it as a fascinating, relevant, and dynamic career choice for any young person. The project strengthens college and career readiness.
- To demonstrate the importance of engineering, and associated STEM subjects, to solve the problems faced by societies today, particularly in the areas of sustainability.
- To link education, industry and community through inspirational engineering projects.
- To promote social inclusion through engaging with vulnerable and economically disadvantaged young people.

Formula Goblin (Ages 9-11)

The Formula Goblin project aims to inspire children ages 9 – 11 years old to take an interest in engineering in a fun and innovative way. The project is for children to build their very own functioning and drivable electric car. The kit comes flat packed with step by step instruction guiding the team through the build in an easy to understand manner. The build introduces children to basic mechanics, tools, and engineering concepts.

The build can be integrated in to the curriculum to highlight key areas such as friction, electricity, materials, math, and design technology – while being a fun and hands-on activity for children. The project also encourages parental participation during clubs and event days. Many schools are able to gain support from local businesses both practically and financially to help the project in their school or group.

Formula Goblin Curriculum

This curriculum is designed to introduce students to the ideas and concepts of Greenpower. It is a cross-curricular curriculum that focuses on design concepts, going green, and force and motion. Each unit incorporates hands-on STEM projects and challenges. In the Design Concepts unit, the students will understand the basics of car design concepts. They will build a race car out of upcycled materials, apply to be on the Greenpower Goblin team, learn about the history of cars and cars in their community, and create a classroom book *Student Treasures* book. In the Going Green unit, the students will learn about the effects of pollution in their environment. They will also learn about renewable and nonrenewable energy sources and how they relate to energy conservation. The students will research types of energy, electric vs. gas cars, and sources of energy for cars. They will also have the opportunity to build a wind powered car. In the Force and Motion unit, the students will learn the basics of force, motion, and friction. They will race hot wheels down ramps, explore potential and kinetic energy, and investigate how collisions affect how energy transfers. They will also test cars on different surfaces to investigate the effect of friction on speed and distance traveled. The students will also construct a balloon rocket and light a light bulb by constructing a battery out of a potato.

Greenpower Goblin Curriculum Scope and Sequence (Alabama standards)

Lesson	ALCOS Science	AL CCRS Math	AL CCRS Reading	AL CCRS Writing	AL CCRS Language/SL	ALCOS Social Studies	ALCOS Technology
Design Concepts: Recycled Racers	4.E.1	6.SP.5c					
Design Concepts: Greenpower Team Application	5.EHA.16			W.5.2	SL.5.1 SL.5.2		
Design Concepts: History of Cars			RI.5.2 RI.5.9			SS.5.13	Tech 1, 5, 7, 8, 9, 12
Design Concepts: Cars in My Community	5.EHA.16	4.G.2 5.MD.2 6.SP.1 6.SP.5 6.SP.5a	RI.5.5	W.5.3 W.5.8	L.5.3		Tech 1, 2, 9
Design Concepts: If I Built a Car	5.EHA.16		RL.5.2 RL.5.3 RI.5.6 RF.5.4	W.5.3 W.5.6	L.5.1 L.5.2		Tech 2
Going Green: Pollution and Energy	4.E.5 5.EHA.16		RI.5.1 RI.5.6 RI.5.7 RI.5.8 RI.5.9 RI.5.10	W.5.2 W.5.7 W.5.8 W.5.9			Tech 5, 8
Going Green: Renewable/ Nonrenewable Energy	4.E.5 5.EHA.16						
Going Green: Wind-Powered Car	4.E.5 5.EHA.16			W.5.1 W.5.2 W.5.4	L.5.2 L.5.3 SL.5.3		Tech 1, 2, 5, 10, 12
Going Green: Electric vs. Gas Car	4.E.5 5.EHA.16		RI.5.1 RI.5.6 RI.5.7 RI.5.8 RI.5.9 RI.5.10	W.5.2 W.5.7 W.5.8 W.5.9	SL.5.4 SL.5.5 SL.5.6		Tech 1, 2, 8, 12

Going Green: Gumdrop Structure					SL.5.1		
Going Green: Sources of Energy for Cars	4.E.5 5.EHA.16		RI.5.1 RI.5.6 RI.5.7 RI.5.8 RI.5.9 RI.5.10	W.5.2 W.5.7 W.5.8 W.5.9	SL.5.3		Tech 1, 2, 8
Going Green: Cars of the Future	5.EHA.16		RI.5.7 RI.5.9	W.5.7	SL.5.4 SL.5.5		Tech 1, 2, 5, 6, 12
Going Green: Environmental Issues	5.EHA.16		RI.5.1 RI.5.6 RI.5.7 RI.5.8 RI.5.9 RI.5.10	W.5.2 W.5.7 W.5.			
Force and Motion: Hot Wheels Ramp	4.E.1	5.NBT.7 5.MD.1		W.5.2b			Tech 1, 2
Force and Motion: Car Design	4.E.1			W.5.2b			
Force and Motion: Collision Course	4.E.3	5.MD.1		W.5.2 W.5.2d			
Force and Motion: Friction	4.E.1	5.NBT.7					Tech 2
Force and Motion: Balloon Rockets	5.MII.1 5.MS.6 5.MS.7						
Force and Motion: Potato Batteries	4.E.2 4.E.4		RI.5.2 RI.5.3 RI.5.7	W.5.7	SL.5.2		Tech 8
Force and Motion: Marble Roller Coaster	4.E.1						
Force and Motion: Impact Crater	4.E.1						

Formula Goblin Curriculum Materials List

<table>
<tr><th>Unit: Design Concepts</th><th>Unit: Going Green</th><th>Unit: Force and Motion</th></tr>
<tr><td rowspan="3">Lesson: Recycled Racers
Per Group
16 in. x 16 in. piece of corrugated cardboard (cereal box/smaller piece of cardboard)
Wheels - choose one product: 4 CDs, paper plates, or plastic coffee, yogurt, or takeout lids, or water bottle caps
Bamboo skewers
Body - 1 Paper towel roll, toilet paper rolls, empty water bottle, index cards
3 unsharpened pencils
4 metal paperclips
Coffee stirrers
scissors
scotch tape
yard stick
stopwatch
ramp (foam board, cardboard on stack of books, etc)
Student data collection sheet
Balloon (extension)
Student data sheet</td><td>Lesson: Pollution and Energy
Per Group
Two clear plastic cups (12oz-16oz)
Shaving cream
Food coloring
Black paint
Small paint brush</td><td>Lesson: Hot Wheels Ramp
Hot Wheels cars (1 for each group)
1-2 long piece of track (for each group)
3 textbooks, approx. 2 inches thick (per group)
Measuring tape (1 for each group)</td></tr>
<tr><td>Lesson: Renewable and Nonrenewable Energy
Per Group
16 pieces of popcorn (teacher will need the bag with leftover popcorn to replenish the “used resources”)
4 paper towels
Pencil</td><td>Lesson: Hot Wheels Car
Hot Wheels cars (2-4 for each group)
1-2 long piece of track (for each group)
3 textbooks, approx. 2 inches thick (per group)
Hot Wheels Design Data sheet
Scale</td></tr>
<tr><td>Lesson: Wind Powered Car
Per Group
3 straws
4 Lifesavers
1 piece of paper or index card
2 paper clips
50 centimeters of tape</td><td>Lesson: Hot Wheels Collision
Hot Wheels cars
1 long piece of track (if not available, use a measuring tape)
Textbooks
Ruler, measuring stick, or measuring tape
Collision Course Data Sheet</td></tr>
<tr><td>Lesson: Greenpower Application
5 questions on index cards related to fable
Sticky notes</td><td>Lesson: Electric vs. Gas Car
Per Group
Poster board
Art supplies</td><td>Lesson: Friction
Per class:
Aluminum foil
wax paper
cardboard</td></tr>
</table>

<table>
<tr>
<td rowspan="4">Lesson: If I Built a Car
Markers
Paper</td>
<td>Lesson: Gumdrop Challenge
Per Group
10 gumdrops
20 toothpicks
1 ruler
Disposable surface on which to work: small paper plate, or paper towels</td>
<td>carpet
sandpaper
paper towel
Per Group:
Books for incline
ruler
Tape
Stopwatch
Measuring tape
cardboard boxes
scissors
a ruler
Hot wheels Car (3 per group)
Ramp</td>
</tr>
<tr>
<td rowspan="3">Lesson: Environmental Issues
Per two student teams:
5 pieces of 11 x 17 paper
Art supplies</td>
<td>Lesson: Balloon Rockets
1 balloon (round ones will work, but the longer “airship” balloons work best)
1 long piece of kite string (about 10-15 feet long)
1 plastic straw
Tape
picture of car</td>
</tr>
<tr>
<td>Lesson: Potato Batteries
1 balloon (round ones will work, but the longer “airship” balloons work best)
1 long piece of kite string (about 10-15 feet long)
1 plastic straw
tape</td>
</tr>
<tr>
<td>Lesson: Marble Roller Coasters
Per Group:
7 hard paper plates
1 marble</td>
</tr>
<tr>
<td>Lesson: Impact Craters
Per Group:
Roasting pan
Flour
Glass marble
Measuring tape
Ruler
Per student:
Impact Crater Data Sheet</td>
</tr>
</table>

Engineering Design Process

The engineering design process is a series of steps that engineers follow to come up with a solution to a problem. Many times the solution involves designing a product) that meets certain criteria and/or accomplishes a certain task.

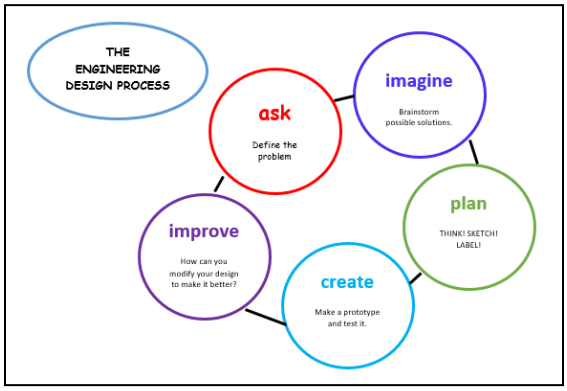
- This process is different from the Steps of the Scientific Method. If your project involves making observations and doing experiments, you should probably follow the Scientific Method. If your project involves designing, building, and testing something, you should probably follow the Engineering Design Process.

Engineers do not always follow the engineering design process steps in order, one after another. It is very common to design something, test it, find a problem, and then go back to an earlier step to make a modification or change to your design.

Design Concepts Overview

In this unit, the students will understand the basics of car design concepts. They will build a race car out of upcycled materials, apply to be on the Greenpower Goblin team, learn about the history of cars and cars in their community, and create a classroom book *Student Treasures* book.

Formula Goblin Curriculum	
Topic	Design Concepts
Lesson Title	Recycled Racers
Duration	2 hours
Lesson Focus	In this activity, teams of students learn about engineering design by constructing race cars from everyday materials that can travel in a straight line down an incline. They test their recycled racers, evaluate their results, and present to the class.
Standard(s)	• 4.E.1 Use evidence to explain the relationship of the speed of an object to the energy of that object. • 6.SP5.c Giving quantitative measures of center (median and/or mean and variability (interquartile range and/or mean absolute deviation) as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.
Lesson objective(s)	The students will: • Design and construct an upcycled race car. • Measure distance traveled. • Test and refine designs. • Communicate design process and results.
Materials	• Engineering Notebook • glue stick • *Recycled Racer Data Collection Sheet* Per Group: • 16 in. x 16 in. piece of corrugated cardboard (cereal box/smaller piece of cardboard) • Wheels - choose one product: 4 CDs, paper plates, or plastic coffee, yogurt, or takeout lids, or water bottle caps • Bamboo skewers • Body - 1 Paper towel roll, toilet paper rolls, empty water bottle, index cards • 3 unsharpened pencils • 4 metal paperclips • Coffee stirrers • scissors • scotch tape • yard stick • stopwatch • ramp (foam board, cardboard on stack of books, etc) • balloon (extension)
Vocabulary	upcycle, recycle, energy, simple machine, force, speed, transference

Procedures	**ENGAGEMENT** • **Problem/Ask:** ○ Explain that students must create an upcycled race car using everyday items. Teams will race their cars against each other. The car that goes the farthest is the winner of the challenge. **EXPLORATION** **Engineering Challenge: Recycled Racers**  • **Imagine & Plan: 30 mins** ○ Divide class into groups of 4 students. ○ Provide a set of materials to each group. ○ Students meet and develop a plan for their upcycled car without constructing the car. They agree on materials they will need and write or draw their plan in their Engineering Notebook. ○ Student teams may trade unlimited materials with other teams to develop their ideal parts list. ○ Students need to collaborate and agree upon a name for their car and write the name in their Engineering Notebooks. • **Create & Improve: 30 mins.** ○ Student groups now execute their plans. They may need to rethink their plan, request other materials, trade with other teams, or start over. This is okay, just make a new sketch and revise your materials list. ○ Next…teams will test their recycled racer on a ramp a total of three times, measuring the distance traveled each time (measure from the bottom of the ramp to the front end of the stopped car). They will hold their car at the top of the ramp and let it go – do not push the car. ○ Students record the distance on their Data Sheets and paste the sheet in their Engineering Notebooks or create a data sheet in their notebooks. ○ Between each test, the teams may need to make adjustments to their design to improve the distance it travels. • **Team Competition: 15 mins.** ○ Each team will introduce their car to the class. ○ Each team will now race their car. They will hold their car at the top of the ramp and let it go – **do not push the car**. ○ Each team will be responsible for measuring the distance their car traveled, measuring from the bottom of the ramp to the front of the stopped car. ○ The car that goes the farthest is the winner of the challenge.

	EXPLANATION
	• Pose the following questions for class discussion. Students turn and talk and share out. Teacher clarifies any misconceptions.
	  ○ What characteristics do the fast cars have in common?
	  ○ What is the most important characteristic that made the cars go fast?
	  ○ What effect does changing the angle of the track have on the car speed?
	• Tips to build a faster car
	  ○ The lighter the materials, the faster the car, etc.
	• Discuss vocabulary, students make an entry in their Engineering Notebook.
	ELABORATION
	• Pose the following questions for class discussion or in the Engineering Notebooks. Students turn and talk and share out to the class.
	  ○ Did you decide to revise your original design or request additional materials while in the construction phase? Why?
	  ○ Did you revise your original design or request additional materials while in the construction phase? Why?
	  ○ If you could have had access to materials that were different than those provided, what would your team have requested? Why?
	  ○ Do you think that engineers have to adapt their original plans during the construction of systems or products? Why might they?
	EVALUATION
	• Evaluate your teams' results, complete the evaluation worksheet, and present your findings to the class. (See attachment)
	• Did you succeed in creating a recycled race car that traveled down the ramp?
	• If so, how far did it travel?
	  If not, why did it fail?

Extension	• Students can add a balloon to the car to make it wind powered. • Calculate the speed of your car. • S=d/t • What is the average speed your car achieved?

Recycled Racer Data	
Test	**Distance Traveled within Track (ft)**
Test One	
Test Two	
Test Three	
Average	

Recycled Racer Data	
Test	**Distance Traveled within Track (ft)**
Test One	
Test Two	
Test Three	
Average	

Recycled Racer Data			
	Distance Traveled within Track (ft)	Time Traveled within Track (s)	Speed (ft/s)
Test One			
Test Two			
Test Three			
Average			

Recycled Racer Data			
	Distance Traveled within Track (ft)	Time Traveled within Track (s)	Speed (ft/s)
Test One			
Test Two			
Test Three			
Average			

Formula Goblin Curriculum

Unit	Design Concepts
Lesson Title	Greenpower Team Application
Duration	One hour
Lesson Focus	In this lesson, students will discuss the importance of teamwork and complete an application to be on the Greenpower team. • Why might conflict occur in teamwork? • Why is it beneficial to work in groups? • How is leadership accomplished?
Standard(s)	• 5.EHA16 Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment. • W.5.2 Write informative or explanatory texts to examine a topic and convey ideas and information clearly. • SL.5.1 Engage effectively in a range of collaborative discussions with diverse partners on *Grade 5 topics and texts*, building on others' ideas and expressing their own clearly. • SL.5.2 Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
Lesson objective(s)	The students will: • Cooperate with others and work in a team • Explain what it means to work as a team • Complete an application to apply for a position on the Greenpower team.
Materials	• ActivBoard • Internet acess • Engineering Notebook • *The Four Oxen and the Lion* Aesop's Fable • 5 questions on index cards related to fable • Sticky notes • Greenpower Application
Vocabulary	cooperation, communication, teamwork, responsibility, collaboration, conflict

Procedures	**ENGAGEMENT/EXPLORATION**
	• Display *The Four Oxen and the Lion Aesop's Fable*. Groups will read the fable together.
	• Each group will have a separate question. Students will individually write all of their ideas regarding that question on sticky notes. After two minutes, groups will discuss the sticky notes together and create a team answer for their question.
	  ○ Why would turning their tails to one another save the oxen from the lion?
	  ○ Was there conflict in the fable? Explain your answer.
	  ○ When the four oxen stopped working as a team, what happened next?
	  ○ What lesson about teamwork do you think can be learned from this fable?

	○ What does teamwork mean to you? Why do you think some teams aren't successful? • Groups will present their questions and answers to the class. • Whole group discussion about teamwork and why it's important. **EXPLANATION** • Explain the Greenpower program and competition. • https://www.youtube.com/watch?v=3BUGXV4L6wc (Greenpower overview) **EVALUATION** • Students will be provided with a Greenpower Application to complete.
Extension	• Select a team building activity as a hook for the lesson • Create a graphic organizer describing the qualities that a good team member should possess. Complete the graphic organizer in the Engineering Notebook. 

Greenpower Team Application

Student Name: _____ Homeroom Teacher: _____

All students applying to join the 5th grade Greenpower team must complete and submit the following application and parent permission form to _____ by _____, 2016.

Please answer the following questions. You may write on the back or use additional paper if necessary.

1) Why do you want to join the Greenpower team?

_____

_____

_____

_____

2) What qualities do you possess that make you a good team member?

_____

_____

_____

_____

3) A key component of Greenpower team is teamwork. Look up the word "cooperation" in the dictionary. Explain how you think cooperation affects a team.

_____

_____

_____

_____

I would like to be considered to become a member of the Greenpower team. Yes No

Student Signature: _____ Date: _____

Personal Information and Parent Permission

Student Name: _____

Homeroom Teacher: _____

Contact Information

Parent/Guardian Name: _____

Phone Number: _____

Email Address: _____

Emergency Contact: _____ Relationship: _____

Emergency Contact Number: _____

If chosen to be a member of the _____ Greenpower team, my child will attend the Fall 2016 and Spring 2017 team meetings and the Friday evening/Saturday competitions. I understand that it will be my responsibility to pick up my child promptly at _____ each meeting day. I understand that my child must maintain satisfactory behavior and academic grades in order to be eligible to participate in the Greenpower program.

The inaugural race will be on November 11-12, 2016 at Jemison High School. Additional practices may be scheduled prior to this event in order to prepare. The second competition will take place in the Spring (TBD).

Parent Signature: _____ Date: _____

Formula Goblin Curriculum

Unit	Design Concepts
Lesson Title	History of Cars
Duration	One hour
Lesson Focus	In this lesson, the students will research the history of the automobile. • How have cars changed over time? • What improvements have been added to increase safety?
Standard(s)	• RI.5.2 Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text. • RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. • SS.5.13 Describe social and economic influences on United States' expansion prior to World War I. • Tech 5 Practice safe use of technology devices. • Tech 7 Explain the influence of technology on science. • Tech 8 Collect information from a variety of digital sources. • Tech 9 Use technology to organize, interpret, and display data. • Tech 12 Create a product using digital tools.
Lesson objective(s)	The students will: • Use Internet sources to research the history of the automobile • Determine the accuracy of online information • Use research to create a timeline about the production of the automobile • Introduce students to the technological innovations that contributed to the current automobile
Materials	• Internet access • ActivBoard • Engineering Notebook • http://padlet.com/greenpowerHCS/homepage • Reference materials concerning automobile history • http://www.readwritethink.org/files/resources/interactives/timeline_2/
Vocabulary	Model T, timeline

Procedures	**ENGAGEMENT** • Watch a video on the history of the automobile https://www.youtube.com/watch?v=hDeTPdUNw0Y • Students write in their Engineering Notebooks how they think automobiles have developed American cultural changes (social status, westward expansion, mass production, etc.) • Point out to students that the invention of the automobile helped create suburban communities. **EXPLORATION** • Tell students they will be gathering information on the history of the automobile. • Brainstorm keywords that might be related to the history of automobiles. (ex: Henry Ford, Model T) • Have students identify questions about automobiles and how they are made? • Allow students to find information using the Internet. • Have students evaluate and analyze information to compose a timeline on the history of automobiles. **-OR-** • Students will select a car of their choice. If students do not have a favorite car, one can be assigned to them. Students will draw a card. • Students will research the history of that specific car and list 10 facts about the model including when it was first invented, dates of added features (ex: seat belts), price of the first car vs. current price. **ELABORATION** • Students will create a timeline listing 10 important historical dates using http://www.readwritethink.org/files/resources/interactives/timeline_2/ **EVALUATION** • Have students use automobile facts to formulate a paragraph about how this invention affected the world. ▪ What did the invention of the car allow people to do? ▪ How did it change where people lived? ▪ How has the car changed over time?
Extension	• Create a PowerPoint or Prezi presentation on your researched vehicle. • Students create accurate hand-written timeline in Engineering Notebook. • Interview older relatives or neighbors who have stories to share about automobiles. Write interview questions and answers in Engineering Notebook.

Formula Goblin Curriculum	
Unit	Design Concepts
Lesson Title	Cars in the Community
Duration	Two Hours
Lesson Focus	In this lesson, students will observe the cars in the parking lot and record the observations. They will then graph the data that was collected. • What does a typical car look like in your community? • Which car company is the most popular in your community?
Standard(s)	• 5.EHA.16 Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources • 4.G.2 Classify two-dimensional figures based on the presence of absence of parallel or perpendicular lines or the presence or absence of angles of a specified size. • 5.MD.2 Make a line plot to display a data set of measurements in fractions of a unit (1/2, ¼, 1/8). Use operations on fractions for this grade to solve problems involving information presented in line plots. • 6.SP.1 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. • 6.SP.5 Summarize numerical data sets in relation to their context • 6.SP.5a Reporting the number of observations • RI.5.5 Compare and contrast the overall structure of events, ideas, concepts and information in two or more texts. • W.5.3 Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences. • W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources. • L.5.3 Use knowledge of language and its conventions when writing, speaking, reading, or listening. • Tech 1 Use input and output devices of technology systems. • Tech 2 Use various technology applications, including word processing and multimedia software. • Tech 9 Use technology tools to organize, interpret and display data.
Lesson objective(s)	The students will: • Compile data and display data in various forms • State an opinion and support it using facts and details.
Materials	• Picture of older Ford truck and new Ford truck • ActivBoard • Engineering Notebooks • glue stick • *Cars in My Community* Data Collection sheet • Laptops and Excel program • *Car Design Application* (extension)

Vocabulary	bar graph, pie chart, line plot

Procedures	**ENGAGEMENT**
	• Display a picture of an older model car, like a Ford truck, and the newest model of that truck.
	• In small groups, students will discuss how the cars are similar and different.
	• Students will create a Venn diagram in their Engineering Notebooks comparing the two trucks.
	• Discuss what types of characteristics the new model of the truck possesses that the old model does not.
	-OR-
	• Show students the video on the Top 10 most expensive cars of 2016. https://www.youtube.com/watch?v=2u_Tpuj1pZI
	  ○ Have you ever seen cars like this?
	  ○ Are these the typical cars you see around your city?
	  ○ Why do you think these types of cars are not popular where your live?
	• As a class discuss the specific characteristics of cars people look for when buying a car. (ex: make, model, size, color, tech features)
	• Brainstorm a list of car styles (sedan, hatchback, SUV, truck), brands (foreign vs. domestic) and features (sunroof, 2 or 4 door, color, etc.).
	• Ask students to think of a response to the following focus question for the experiment and write an answer in complete sentences in their Engineering Notebook. Focus Question: If you were going to open a car dealership in your community, what brand, type, and color of cars would you have available to sell?
	• Provide students with a copy of the *Cars in My Community* Data Collection sheet. Students will glue the data sheet into their Engineering Notebooks.
	
	EXPLORATION
	• Discuss safety procedures students need to follow while in the school parking lot.
	• Take students on a mini field trip to the school parking lot.
	• Students will observe the cars in the parking lot and record the observations using the tally tables on the provided data sheet glued in their Engineering Notebooks. Data collected will include car brands, body types, and colors.
	
	ELABORATION
	• Students will create three line plots displaying the data they collected.
	• Students will input information into Excel and then create various graphs using the same program. Students will determine which graph best represents the collected data.
	
	EVALUATION
	• Students will submit final graph to teacher (ex: using Edmodo).
	• Review meaning of mode and why it is important when discussing the data collected.
	• Using their data, students will determine which cars they would have available to sellers if they were to open a car dealership in their community. Responses will be written in student Engineering Notebooks and must refer to the data for evidence.

Extension	• Marking the Greenpower Car- Students will create a unique team name, motto, and car design for their schools' 2016-2017 Greenpower team. Information will be completed using the *Car Design Application*. • Students will be given a card with a type of car on it. (ex: old car, used car, sport car, truck, etc.) Students will pretend they are that car and they are sitting in the school parking lot. Students will write a narrative essay from the viewpoint of that car. Encourage students to think about how that car might feel compared to the other cars. • Invite local car dealer to address class about the demand of current cars.

Cars in My Community Data Collection

Car Brands **Car Colors** **Body Style**

	Tallies			Tallies			Tallies
BMW			Black			Car	
Ford			Red			SUV	
Hyundai			Silver			Truck	
Nissan			White			Van	
Toyota			Other				
Other							

Other observations:

Cars in My Community Data Collection

Car Brands **Car Colors** **Body Style**

	Tallies			Tallies			Tallies
BMW			Black			Car	
Ford			Red			SUV	
Hyundai			Silver			Truck	
Nissan			White			Van	
Toyota			Other				
Other							

Other observations:

Each school is responsible for having a team name, team motto, and unique car design for the Greenpower competition. Your 2016-2017 Greenpower team needs your help! Complete the application below to provide your input to your schools' Greenpower team.

Name: _____ Homeroom Teacher: _____

Team Name: _____
Explain why chose this as a team name. _____
_____
_____

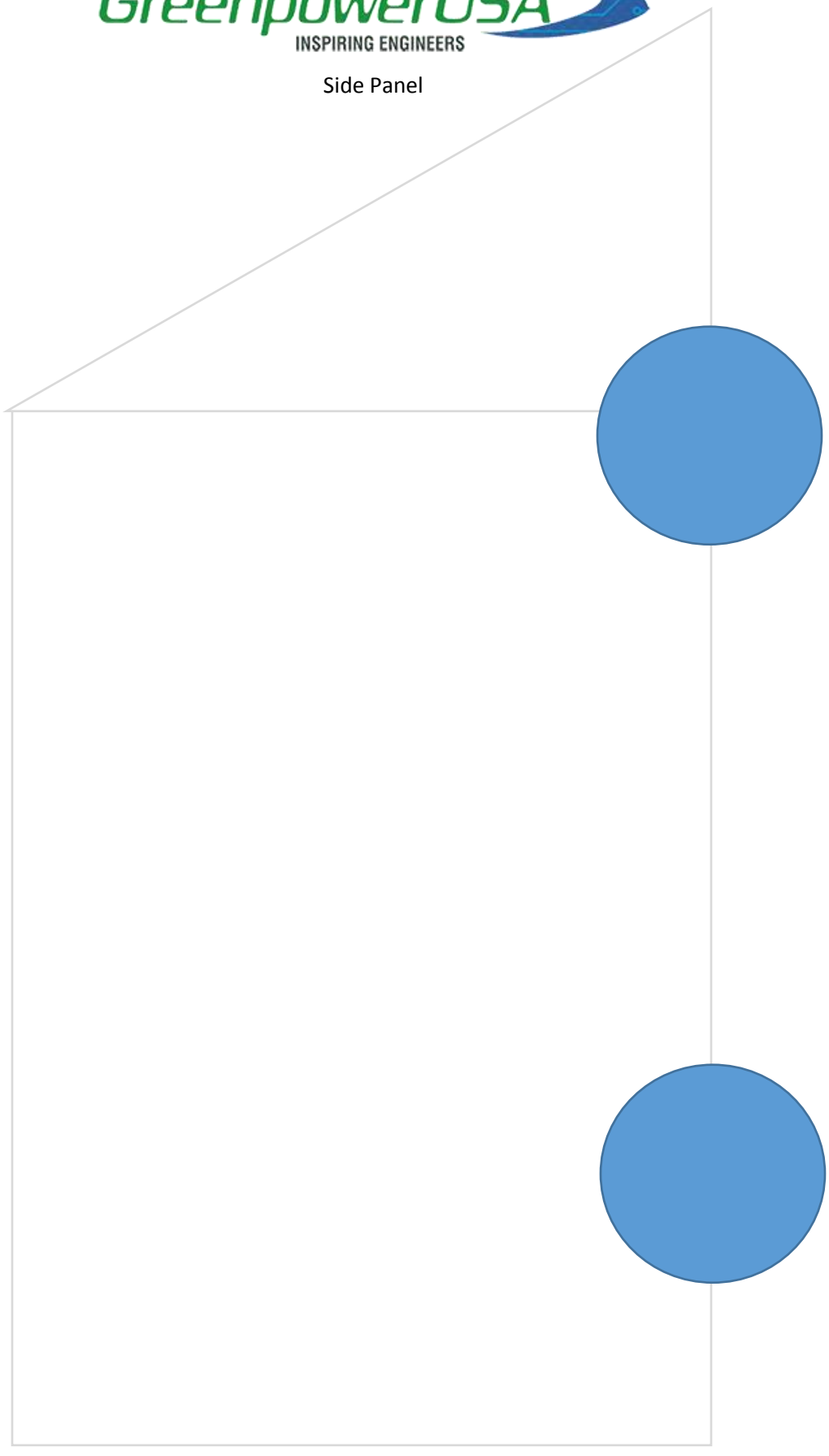
Team Motto: _____
Explain why chose this as a team motto. _____
_____
_____

Car Design:

Front Panel

Materials Used for Body of Car

Side Panel



Formula Goblin Curriculum

Unit	Design Concepts
Lesson Title	"If I Built a Car…"
Duration	Two hours (Three hours if including *Student Treasures* book)
Lesson Focus	In this lesson, the students will brainstorm what a car of the future would be like. They will then write a 5-paragraph paper about their improved vehicle/ultimate fantasy car. • What do you think the cars of the future will include? • What do you think the Goblin car could look like?
Standard(s)	• 5.EHA.16 Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment. • RL.5.2Determine a theme of a story, drama, or poem from details in the text, including how characters in a story or drama respond to challengers or how the speaker in a poem reflects upon a topic; summarize the text. • RL.5.3 Compare and contrast two or more characters, settings, or events in a story or drama, drawing on specific details in the text • RI.5.6 Analyze multiple accounts of the same event or topic, noting important similarities and differences in the point of view they present • RF.5.4 Read with sufficient accuracy and fluency to support comprehension. • W.5.3 Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences • W.5.6 With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of two pages in a single setting • L.5.1 Demonstrate command of the conventions of Standard English grammar and usage when writing or speaking. • L.5.2 Demonstrate command of the conversation of Standard English capitalization, punctuation, and spelling when writing. • Tech 2Use various technology applications, including word processing and multimedia software.
Lesson objective(s)	• write a descriptive narrative • research historical events • arrange events in chronological order
Materials	• If I Built a Car by Chris Van Dusen* (can be viewed on Youtube) • Engineering Notebook • Pencils • Internet access • Markers • *Student Treasures* book kit (extension)
Vocabulary	fantasy, design, compare, contrast, analyze, create

Procedure	**ENGAGEMENT** • Read aloud the book <u>If I Built a Car</u>. **EXPLORATION** • In small groups, students will create a Venn diagram comparing the vehicle from the story to their personal vehicle (or bus). Venn diagrams will be drawn in Engineering Notebooks. • Discuss the important differences between the two modes of transportation. (Notice one is powered by gas and one is powered by human energy.) **EXPLANATION** • If you could design and build a car of the future, what features would you include in your ultimate fantasy car? • Get students thinking about the current vehicle (car or bus) the ride in on a daily basis. • Students then brainstorm in Engineering Notebooks three unique characteristics (not necessarily realistic) they would change about that vehicle in order to improve it. **ELABORATION** • Students type a 5-paragraph paper about their improved vehicle/ultimate fantasy car. ○ 1st paragraph: Introduction/explanation of current vehicle ○ 2nd paragraph: First improvement description and why you would add this improvement ○ 3rd paragraph: Second improvement description and why you chose this ○ 4th paragraph: Third improvement description and why you chose this ○ 5th paragraph: Conclusion/what an engineer would think of the newly developed vehicle **EVALUATION** • Students will submit their essays to the teacher via Edmodo.
Extension	• If creating *Student Treasures* book, hold a contest for the cover of the book. • Students will present the main idea of their essay to the class. • Students will illustrate their futuristic concept car. • Teacher will compile student stories and illustrations to publish a class book with *Student Treasures*. • Students check out automobile license plates and determine the meaning of the plates. • Students design a license plate for a person of their choice. Ex: The President-USAVIP or PREZ1 License plates will be submitted via Edmodo.

Going Green Overview

In this unit, the students will learn about the effects of pollution in their environment. They will also learn about renewable and nonrenewable energy sources and how they relate to energy conservation. The students will research types of energy, electric vs. gas cars, and sources of energy for cars. They will also have the opportunity to build a wind powered car.

Formula Goblin Curriculum	
Unit	Going Green
Lesson Title	Pollution & Energy
Duration	Two hours
Lesson Focus	• Reasons and ways for protecting the Earth's resources and environment. • How do we affect the environment we live in? • What can we do to protect our environment?
Standard(s)	• 4.E.5 Compile information to describe how the use of energy from natural renewable and nonrenewable resources affects the environment (e.g., constructing dams to harness energy from water, a renewable resource, while causing a loss of animal habitats; burning of fossil fuels, a nonrenewable resource, while causing an increase in air pollution; installing solar panels to harness energy from the sun, a renewable resource, while requiring specialized materials that necessitate mining). • 5.EHA.16 Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment (e.g. terracing land to prevent soil erosion, utilizing no-till farming to improve soil fertility, regulating emissions from factories and automobiles to reduce air pollution, recycling to reduce overuse of landfill areas). • RI.5.1 Quote accurately from a text when explaining what the text says and when drawing conclusions from the text. • RI.5.6 Analyze multiple accounts of the same event or topic, noting important similarities and differences in the point of view they represent. • RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. • RI.5.8 Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). • RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. • RI.5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the Grades 4-5 text complexity band independently and proficiently. • W.5.2 Write informative or explanatory texts to examine a topic and convey ideas and information clearly. • W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. • W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. • W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. ○ B. Apply *Grade 5 Reading standards* to informational text. • Tech 5 Practice safe use of technology systems and applications.

	• Tech 8 Collect information from a variety of digital sources.
Lesson objective(s)	The students will: • Better understand the many ways that they consume energy on a daily basis • Realize effects of pollution on the environment • Understand the difference between renewable and nonrenewable resources • Practice graphing and analyzing data • Reflect on ways in which they can reduce their energy use
Materials	• Engineering Notebook • Internet access • ActivBoard • Environmental Video • http://www.ducksters.com/science/environment/renewable_energy.php • *I Need Energy!* sheet • *Save My Energy* sheet (extension) Per group: • Two clear plastic cups (12oz-16oz) • Shaving cream • Food coloring • Black paint • Small paint brush
Vocabulary	energy, renewable, nonrenewable, conservation, energy efficiency, pollution, environment, hydropower, wind power, solar power, geothermal energy, biomass energy, electrical energy, biogas energy, fossil fuels

Procedures	**ENGAGEMENT**
	• What do I do each week that uses energy? Make a list on board and let students record in Engineering Notebook.
	• Additional Engagement: See attachment – *Save My Energy* (bead and paperclip activity)
	• Share pollution statistics with students.
	  ○ The USA is responsible for 30.3% of the world's gas emissions.
	  ○ 33% of Chinese people live in such polluted cities, that the air they breathe is equivalent to smoking 2 packs of cigarettes a day.
	  ○ In Asia, the pollution and smog is so thick that on some nights, you can't see the stars.
	  ○ Teachers in Mexico City say when children draw the sky, they rarely use the color blue
	  ○ Globally, an estimated 200,000 to 570,000 people die each year from ambient air pollution.
	  ○ Cars are responsible for 40% - 90% of the world's air pollution.
	  ○ Last year, 100,000 new cars hit Beijing's roads every day, bringing the total to 2.6 million.
	  ○ In China's 14 largest cities alone, air pollution is responsible for the death of 50,000 newborn babies each year.

EXPLORATION

Environmental Video

- https://www.youtube.com/watch?feature=player_embedded&v=tmhiglxga-4
- Watch the video to get students talking about the different ways we affect our environment.
- Teacher can stop the video each time the word STOP appears.
- Students share their ideas on how to conserve energy or decrease pollution.
- Teacher stops video in between each of the six lessons.
- Students then draw conclusions after each of the six lessons that show how we are affecting our environment. The video can be stopped after each lesson to allow students to write down what they concluded about the section in their Engineering Notebook and share with the class.

Make It Rain

- Description:
  "Make It Rain" is an experiment showing the difference between a dirty atmosphere and a clean atmosphere. The food coloring will be the rain, and the shaving cream will be the clouds. The food coloring will react differently when being placed through the clouds depending if the water is clean or dirty.
- Divide class in to groups and pass out materials.
  - Fill the first plastic cup with water.
  - Spray a layer of shaving cream on the top of the water in the plastic cup.
  - Drop five drops of food coloring on top of the shaving cream in the plastic cup.
  - Observe the food coloring to see what it does in the shaving cream and water.
  - Fill the second plastic cup with water.
  - Place the black paint into the water and stir to make the water look grey.
  - Spray a layer of shaving cream on the top of the water in the plastic cup.
  - Drop five drops of food coloring on top of the shaving cream in the cup. Observe to see the difference between the clean water in the first cup and the dirty water in the second cup.

EXPLANATION

- Show the virtual field trip video about energy:
- https://www.youtube.com/watch?v=nmHm4Sbb2Jc
- Discuss Renewable and nonrenewable resources.
- http://www.eschooltoday.com/energy/renewable-energy/what-is-renewable-energy.html (teacher background knowledge)
- Use the previous website for background knowledge on renewable and nonrenewable energy. Discuss renewable and non-renewable resources. Students can make entry in Engineering Notebook.
- What is renewable energy? – use website for background knowledge
- You will notice that water, wind, sun and biomass (vegetation) are all available naturally and were not formed. The others do not exist by themselves, they were formed. Renewable energy resources are always available to be tapped, and will not run out. This is why some people call it ***Green Energy***.

	• When can energy be called renewable?
	• When its source cannot run out (like the sun) or can easily be replaced (like wood, as we can plant trees to use for energy)
	  ○ When their sources are carbon neutral. This means they do not produce Carbon compounds (such as other greenhouse gases)
	  ○ When they do not pollute the environment (air, land or water)
	Renewable energy includes Biomass, Wind, Hydro-power, Geothermal and Solar sources. Renewable energy can be converted to electricity, which is stored and transported to our homes for use. In this lesson, we shall take a closer look at how renewable energy is converted into electricity.
	
	ELABORATION
	• Jigsaw types of energy. Group students into 8 groups and assign each group a type of energy to research (hydropower, wind power, solar power, geothermal energy, biomass energy, electrical, biogas energy, and fossil fuels). The students will find out what it is, how it works, where it is used, and how it affects their environment and record in their Engineering Notebook.
	• Groups can share their findings with the class.
	• Interesting Facts:
	  ○ Half of the electricity in the United States is still generated by burning coal. Burning coal is a major source of carbon dioxide gas.
	  ○ A single large wind turbine used instead of burning coal can prevent the emission of 5000 tons of carbon dioxide each year.
	  ○ In 2008 only around 10% of the world's energy came from renewable sources.
	  ○ The United States has around 5 percent of the world's population, but consumes 26 percent of the world's energy.
	  ○ Around 28% of the energy used in the United States is for transportation.
	  ○ As of 2010 there were around 9 million cars that were capable of using biofuel.
	  ○ If you could harness the energy from all the sunlight that falls on the Earth in one hour, you would have enough energy to supply the world for a year.
	  ○ Around 50% of renewable energy is used to produce electricity.
	  ○ In some areas you can generate your own renewable energy, like with a solar cell or wind turbine, and then sell it back to the local energy company.
	
	EVALUATION
	• Use Kahoot It or Quizizz as a formative assessment.

Extension	• Present their jigsaw energy research to the class. They will teach the class what they learned in any way they decide, such as a presentation, skit, etc. • *Save My Energy!* sheet

I Need Energy!

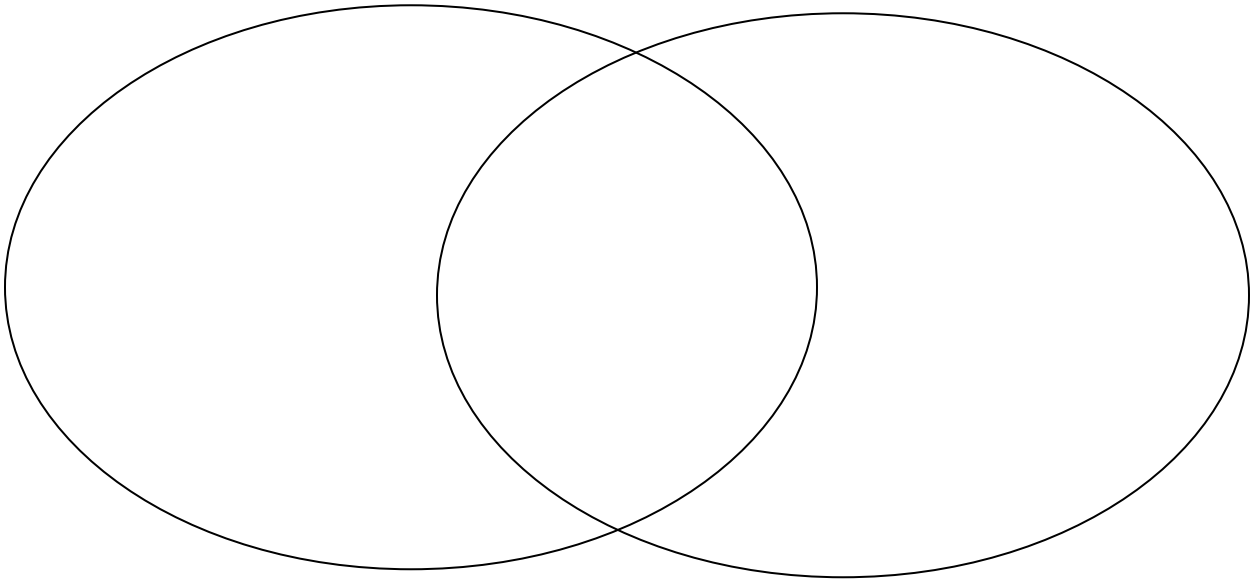
We use energy every day, from the time we brush our teeth in the morning, to the time we turn off the bedroom light at night. Energy comes from many different sources, including coal, natural gas, oil, water, wind, and even the sun. But many energy sources are nonrenewable, which means they cannot be replaced. One way we can help preserve the world's energy sources is by conserving energy. Every little bit helps! In the chart below, list 10 ways that you use energy in a typical week.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Save My Energy!

Throughout this lesson, you have learned how simple actions you take each day can make a big difference for our future energy supply. Now it's time to take action! In the Venn diagram below, write a personal energy conservation plan that includes at least two things you pledge to do consistently over the next month to conserve energy at home, two things you pledge to do at school and two things that you could do at both home and school. (Refer to the weekly activity list you made if you need ideas!) When you have finished writing your plan, sign and date the bottom. Then present your plan to one friend and one adult and ask them to sign and date it. At the end of the month, be prepared to present your progress and hopefully celebrate your success!

Home School



Formula Goblin Curriculum

Unit	Going Green
Lesson Title	Renewable and Nonrenewable Energy
Duration	One hour
Lesson Focus	The students will understand how their actions and population relate to renewable and nonrenewable energy consumption.
Standard(s)	• 4.E.5 Compile information to describe how the use of energy from natural renewable and nonrenewable resources affects the environment (e.g., constructing dams to harness energy from water, a renewable resource, while causing a loss of animal habitats; burning of fossil fuels, a nonrenewable resource, while causing an increase in air pollution; installing solar panels to harness energy from the sun, a renewable resource, while requiring specialized materials that necessitate mining). • 5.EHA.16 Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment (e.g., terracing land to prevent soil erosion, utilizing no-till farming to improve soil fertility, regulating emissions from factories and automobiles to reduce air pollution, recycling to reduce overuse of landfill areas).
Lesson objective(s)	The students will: • Understand how population relates to energy resources • Evaluate problems related to resource availability • Discover differences between renewable and nonrenewable energy resources • Learn strategies to prevent resource depletion
Materials	• Internet access • ActivBoard • Renewable/Nonrenewable PowerPoint http://padlet.com/greenpowerHCS/homepage Per Group • 16 pieces of popcorn (teacher will need the bag with leftover popcorn to replenish the "used resources") • 4 paper towels • Pencil • Paper
Vocabulary	renewable resources, nonrenewable resources, nuclear, natural gas, biomass energy, hydro-electric energy, geothermal energy, solar energy, tidal energy, wave energy, wind energy, wood energy, perpetual energy
Procedures	**ENGAGEMENT** http://www.childrensuniversity.manchester.ac.uk/media/services/thechildrensuniversityofmanchester/flash/renewable.swf • Show the renewable and nonrenewable resources slideshow from the above website, stopping to discuss throughout.

- Students can turn and talk and share out after each question.

EXPLORATION

- Use the Renewable and Nonrenewable PowerPoint for the following activity.
- Divide class into four groups

Part 1: Renewable Activity

- Each team begins with 16 pieces of popcorn. Each student must take at least 1 piece of popcorn per round to survive, and may take as many as he/she likes.
- One student per team records the number of pieces each team member takes per round, and the number of pieces remaining for the team.
- The resource is then "renewed" by half (if there are 8 remaining pieces after round 1, the teacher will add 4 more pieces to the bag for round 2).
- 6 rounds are played in this manner. The object of the game is to have the most pieces of popcorn per team member after the final round.
- At the end of the game, discuss different strategies used by teams:
  Some may die because they'll consume too much of the resource early on
  Others may take one piece at a time and build up a store by the end
  Others may take more throughout but will always keep enough in reserve to be sufficiently renewed

Part 2: Non-Renewable Resources Activity

- Students each pick up a slip of paper from a bag (there are 4 "1st generation", 6 "2nd generation", 9 "3rd generation," and 14 "4th generation" slips)
- Teacher goes to the front of the classroom with a bag of popcorn, and leads a brief discussion of what it means when one generation finds a resource and how future generations are affected by it.
- 1st generation students then come up and take as much popcorn as they want back to their seats. 2nd generation students then do the same, followed by 3rd and 4th generations.

EXPLANATION

Teacher and students then discuss:

- how the students acted in "using" the resource
- any waste that occurred (popcorn dropped on the floor)
- whether any thought was given to students coming afterwards
- if there were protests from other students
- the degraded quality of popcorn towards the end (everyone's hands were in it before, and it's been crushed into smaller, less desirable pieces

ELABORATION

Categorize the following as renewable, non-renewable or perpetual resources:

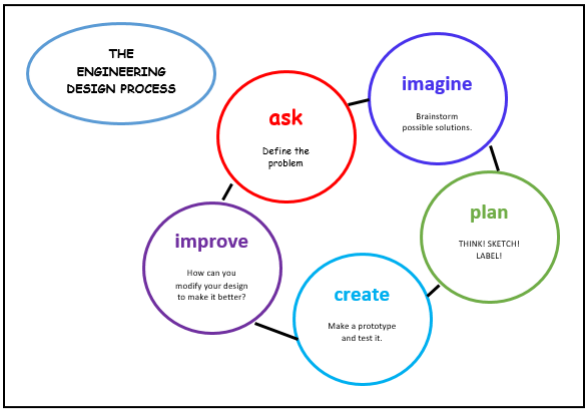
- A field of corn
- Oil in the Arctic tundra
- Coal in the Appalachian mountains
- Sunshine
- Trees in a forest
- Tuna in the ocean
- Sand on a beach
- A breeze over the Texas plains
- Water in a river

	• Which resources would continue to be available no matter how much people used them? • Under what circumstances would a renewable resource *not* be renewable? **EVALUATION** • What could be some effects of population growth, natural disasters, disease, and advanced technology systems on resource availability? • What are some advantages and disadvantages of using renewable resources in place of non-renewable resources? • List as many renewable resources as you can find in your classroom. • List as many non-renewable resources as you can that are found in your classroom.

Formula Goblin Curriculum

Unit	Going Green
Lesson Title	Wind Powered Car
Duration	One hour
Lesson Focus	Reasons and ways for protecting the Earth's resources and environment. • How do we affect the environment we live i? • What can we do to protect our environment?
Standard(s)	• 4.E.5 Compile information to describe how the use of energy from natural renewable and nonrenewable resources affects the environment (e.g., constructing dams to harness energy from water, a renewable resource, while causing a loss of animal habitats; burning of fossil fuels, a nonrenewable resource, while causing an increase in air pollution; installing solar panels to harness energy from the sun, a renewable resource, while requiring specialized materials that necessitate mining). • 5.EHA.16 Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment (e.g., terracing land to prevent soil erosion, utilizing no-till farming to improve soil fertility, regulating emissions from factories and automobiles to reduce air pollution, recycling to reduce overuse of landfill areas). • W5.1 Write opinion pieces on topics or texts, supporting a point of view with reasons and information. • W5.2 Write informative or explanatory texts to examine a topic and convey ideas and information clearly. • W5.4 Produce clear and coherent writing n which the development and organization are appropriate to task, purpose, and audience. • L.5.2 Demonstrate command of the conventions of Standard English capitalization, punctuation, and spelling when writing. • L.5.3 Use knowledge of language and its conventions when writing, speaking, reading, or listening. • SL.5.3 Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence. • Tech 1 Use input and output devices of technology systems. • Tech 2 Use various technology applications, including word processing and multimedia software. • Tech 5 Practice safe use of technology systems and applications. • Tech 10 Use digital environments to collaborate and communicate. • Tech 12 Create a product using digital tools.
Lesson objective(s)	The students will: • Identify ways to protect the Earth • Design and construct a wind powered car • Write a persuasive letter

Materials	• Internet access • ActivBoard • Engineering Notebook • Energy Island by Allan Drummond (can be viewed on Youtube) Per Group • 3 straws • 4 Lifesavers • 1 piece of paper or index card • 2 paper clips • 50 centimeters of tape
Vocabulary	wind energy, conservation, energy efficiency

Procedures	**ENGAGEMENT**
	• Pre-assessment Quizizz-Save or Waste: quiz on energy efficiency
	• Search the quiz "Save or Waste" on Quizizz. Provide the students with the access code.
	• Students go to quizizz.com/join/, type in the code, and complete the quiz.
	
	EXPLORATION
	
	Engineering Challenge: Puff Mobile
	
	 
	• **Problem/Ask**
	  ○ Students will be making a car that will harness the wind to move. Students can only blow on the car to make it move.
	  ○ Put students into 4 or 5 groups
	  ○ Give students the materials.
	• **Imagine & Plan: 5 mins**
	  ○ Students plan and design their puff mobile. They may wish to make a sketch in their Engineering Notebook.
	• **Create & Improve: 10 mins**
	  ○ Set time for 10 minutes.
	  ○ Make a car out of 3 straws, 4 Lifesavers, 1 piece of paper or index card, 2 paper clips and 50 centimeters of tape.
	• **Team competition**
	  • Race them on a flat surface against the other groups.
	  • Here's the catch: you can only blow on them to make them move!

	EXPLANATION • How can you change your environment? • Read *Energy Island: How one Community Harnessed the Wind and Changed Their World* by Allan Drummond • In their Engineering Notebook, students will discuss and list ways Samso changed their island to be more energy efficient. **ELABORATION** • Students brainstorm ways they could make their school and/or city more energy efficient. • Record ideas in their Engineering Notebook and share ideas with the class. • Create a class master list. **EVALUATION** Dear Mayor • Students write a persuasive letter to their principal, superintendent, and/or mayor convincing them to make their school and/or city more energy efficient. Students use facts from their energy research project and Quizzit to support their point of view, including specific ways to change from nonrenewable to renewable sources of energy. Students can learn how to address an envelope and mail it to the recipient.
Extension	• Why Do We Need Electricity? • This is a variation of "No, You Can't Take Me!" It teaches critical thinking skills while hammering home the idea of just how much we rely on electricity in modern life. • Each student chooses (but keeps secret) a particular electrical device. It could be anything from an electric hair dryer or toaster to an electric cable car or a photocopier. • Each student arranges her or his body to resemble the chosen device. • I survey the room and say, "My, look at all this junk. I don't need all this junk. I think I'll get rid of some of it." I then choose a particular student and say, "I think I'll take this thing away." • The student (we've discussed the rules of the game ahead of time) says, "No, you can't take me!" I reply, "Why not?" The student says, "Because without me. . ." (Here the student must come up with something bad that would happen if that particular device were not there. For example, a toaster might say, "Because without me you'd have to eat squishy soggy bread all the time." A photocopier might say, "Without me you'd get writer's cramp copying all those papers by hand." The idea here is that the students must come up with several real purposes for their objects. I often don't let them off the hook with only one answer. "Well, I like soggy squishy bread. I'm still taking you." • I repeat the process with each student. • Additional Resources http://www.nrel.gov/education/pdfs/educational_resources/elementary/energy_basics.pdf

Formula Goblin Curriculum

Unit	Going Green
Lesson Title	Electric Vs. Gas Car
Duration	Two Hours
Lesson Focus	The students will: • Utilize digital resources to research information • Identify types of renewable energy • Identify ways to protect the Earth • Support their point of view
Standard(s)	• 4.E.5 Compile information to describe how the use of energy from natural renewable and nonrenewable resources affects the environment (e.g., constructing dams to harness energy from water, a renewable resource, while causing a loss of animal habitats; burning of fossil fuels, a nonrenewable resource, while causing an increase in air pollution; installing solar panels to harness energy from the sun, a renewable resource, while requiring specialized materials that necessitate mining). • 5.EHA.16 Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment (e.g., terracing land to prevent soil erosion, utilizing no-till farming to improve soil fertility, regulating emissions from factories and automobiles to reduce air pollution, recycling to reduce overuse of landfill areas). • RI.5.1 Quote accurately from a text when explaining what the text says and when drawing conclusions from the text. • RI.5.6 Analyze multiple accounts of the same event or topic, noting important similarities and differences in the point of view they represent. • RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. • RI.5.8 Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). • RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. • RI.5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the Grades 4-5 text complexity band independently and proficiently. • W.5.2 Write informative or explanatory texts to examine a topic and convey ideas and information clearly. • W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. • W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. • W.5.8 Draw evidence from literary or informational texts to support analysis,

	reflection, and research. • SL.5.4 Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace. • SL.5.5 Include multimedia components (e.g. graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. • SL5.6 Adapt speech to a variety of contexts and tasks, using formal English when appropriate to task and situation. • Tech 1 Use input and output devices of technology systems. • Tech 2 Use various technology applications, including word processing and multimedia software. • Tech 8 Collect information from a variety of digital sources. • Tech 12 Create a product using digital tools.
Lesson objective(s)	The students will: • Utilize digital resources to research information • Identify types of renewable energy • Identify ways to protect the Earth • Support their point of view during an oral presentation
Materials	• Engineering for Efficiency PowerPoint http://padlet.com/greenpowerHCS/homepage • Internet access • ActivBoard • Engineering Notebook • Greenpower Informative Writing Rubric • Computer • Poster board • Art supplies
Vocabulary	electric-powered car, gas-powered car
Procedures	**ENGAGEMENT** • Show the Engineering for Efficiency PowerPoint about energy efficient cars. • Discuss the distinguishing characteristics you notice about these cars? **EXPLORATION** Electric vs. Gas Car Research Project • This is a partner research project focusing on electric versus gas powered vehicles. • One team partner will research electric cars and the other partner will research gas powered cars. • Students will research each of the vehicles sources of energy. • Students will find pros and cos for their type of vehicle, specifically focusing on the environment. • Students will explain how going green relates to cars.

	EXPLANATION • Then teams will create a project to present to the class combining both electric and gas powered car research. • Projects might include PowerPoints, Prezis, posters, skits, etc. **ELABORATION** • Provide students with the rubric before they start their research and presentation. • Students include specific criteria in order to elaborate on their type of car. **EVALUATION** • Refer to presentation rubric for the evaluation
Extension	• Students can go above and beyond what's on the rubric including additional information.

Greenpower Informative Writing Rubric

Homeroom Teacher: _____ School: _____

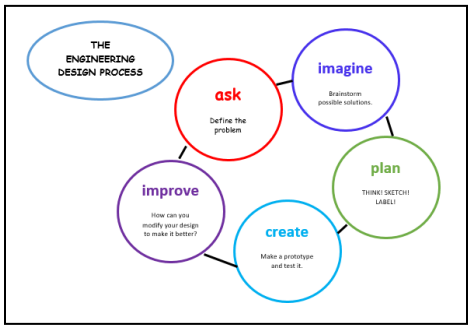
Student Name: _____

Standard	Points
W.5.2a- Introduces the topic, provides a focus, and groups related information logically	/20
W.5.2b- Develops the topic with facts, definitions, details, quotations, or other examples	/20
W.5.2c- Uses linking words, phrases, and clauses to connect ideas within and across categories (*in contrast, in addition, however*)	/10
W.5.2d- Uses precise word choice, including domain-specific vocabulary	/15
W.5.2e- Ends with a relevant concluding sentence/paragraph	/15
L.5.1- Uses correct grammar	/5
L.5.2- Uses correct capitalization	/5
L.5.2- Uses correct punctuation	/5
L.5.2e- Spells grade-appropriate words correctly	/5
Final Writing Grade	**/100**

Teacher Notes:

4- Mastering Standards (95-100)
3-Meeting Standards (80-94)
2-Approaching Standards (60-79)
1-Not Meeting Standards (<59)

Formula Goblin Curriculum

Unit	Going Green
Lesson Title	Gumdrop Structure Challenge
Duration	One hour
Lesson Focus	Using 10 gumdrops and 20 toothpicks, how can you design a structure that can hold the weight of a large library book?
Standard(s)	• SL 5.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *Grade 5 topics and texts*, building on others' ideas and expressing their own clearly.
Lesson objective(s)	The students will: • collaborate with a partner to design and build a structure that can hold the weight of a large library book using 10 gumdrops and 20 toothpicks.
Materials	Per student: • Engineering Notebook • 10 gumdrops • 20 toothpicks • 1 ruler • Disposable surface on which to work: small paper plate, or paper towels
Vocabulary	
Procedures	**ENGAGEMENT** • Show students the different shapes they can use to make the structure. • Have students make a prediction of which shaped house will be able to hold the weight of a book and record it in their Engineering Notebook. **EXPLORATION** **Engineering Challenge: Gumdrop Structure**  • **Problem/Ask:** ○ You have been tasked with creating a structure out of reused materials that will hold the weight of our Greenpower trophy (large library book). We need to make a prototype of what the structure will look like. ○ You will get 10 gumdrops, 20 toothpicks, and a ruler (cannot be used in

	the structure)
	• **Imagine & Plan:** 5 mins
	  ○ Pass supplies out to students.
	  ○ Students then plan the design of their structure.
	  ○ Students draw a sketch of the Gumdrop structure in their Engineering Notebook.
	• **Create & Improve:** 15 mins
	  ○ Students now begin building.
	  ○ Have students record the process of what they are doing and learning in their Engineering Notebook. Encourage them to draw sketches, take measurement, and describe what happens during their testing sessions.
	  ○ What structure or methods of construction have you tried that aren't working? Draw a sketch to help explain. Why do you think this structure doesn't work well? Can you modify it, or will you abandon this structure all together?
	  ○ What structures or methods of construction are you planning to include in your final design? What have you found about this structure that will help your design meet the challenge?
	• **Testing Your Design**
	  ○ Take measurements and label them on your drawing in your Engineering Notebook.
	  ○ Teacher circulates the class and tests each structure to see if it holds the weight of the textbook.
	  ○ Did your gumdrop structure hold up under testing? If so, why was the design successful? If not, what aspect of your design could be improved?
	  ○ Whether or not your design was able to meet the challenge, what did you learn while completing this activity?
	
	EXPLANATION
	• Describe a way in which the gumdrop homes could be tested to show varying results so that the structures could actually be "measured" for their strength.
	• With more toothpicks and gumdrops, what modifications would you make to test for strength?
	• As you consider what made your design both weak and strong, provide a few engineering elements that you might be able to observe in structures in your own environment (both indoor and outdoor).
	
	EVALUATION
	• What shape made the weakest home?
	• What shape made the strongest home?
	• If you had more gumdrops and toothpicks, how would you make your home stronger?

Extension	Mid-Level Inquiry: Introduce the challenge, explain how the houses will be tested (show the book), and then have them begin building. No additional talk or help! Failure is an option. Encourage students to rebuild.

Formula Goblin Curriculum	
Unit	Going Green
Lesson Title	Sources of energy for Cars
Duration	Two hours
Lesson Focus	Recognize what makes a car move. • What are alternative forms of energy? • What is the difference between renewable and nonrenewable energy?
Standard(s)	• 4.E.5 Compile information to describe how the use of energy from natural renewable and nonrenewable resources affects the environment (e.g., constructing dams to harness energy from water, a renewable resource, while causing a loss of animal habitats; burning of fossil fuels, a nonrenewable resource, while causing an increase in air pollution; installing solar panels to harness energy from the sun, a renewable resource, while requiring specialized materials that necessitate mining). • 5.EHA.16 Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment (e.g., terracing land to prevent soil erosion, utilizing no-till farming to improve soil fertility, regulating emissions from factories and automobiles to reduce air pollution, recycling to reduce overuse of landfill areas). • RI.5.1 Quote accurately from a text when explaining what the text says and when drawing conclusions from the text. • RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. • RI.5.8 Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). • RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. • RI.5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the Grades 4-5 text complexity band independently and proficiently. • W.5.2 Write informative or explanatory texts to examine a topic and convey ideas and information clearly. • W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. • W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. • W.5.8 Draw evidence from literary or informational texts to support analysis, reflection, and research. • SL.5.3 Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence.

Lesson objective(s)	The students will: • Identify alternative forms of energy • Compare renewable and nonrenewable energy • State an opinion and support it using facts and details
Materials	• Engineering Notebook • Internet access • ActivBoard • Picture of Bangladesh, Japan, China, NYC, etc. • Greenpower Activity Rubric • Greenpower Informative Writing Rubric
Vocabulary	renewable energy, nonrenewable energy, hybrid electric vehicle, biomass fuel, fossil fuel
Procedures	**ENGAGEMENT** • "If you were to build a car, how would you make it move?" • Allow students time to brainstorm sources of energy and determine if they are renewable or nonrenewable. • Record in Engineering Notebook and share out with class. • Streets of Bangladesh: display a picture of the streets in Bangladesh. Inform students that many people in various countries use bikes as their sole method of transportation (China, Japan, Bangladesh). • Discuss with a partner the advantages and disadvantages of this method of transportation. **EXPLORATION** Activity 1: Sources of Energy • Sources of Energy-write the types of cars driven today with various kinds of energy sources: electric cars, solar powered cars, HEVs, and gasoline powered cars. • Divide students into four teams and provide each team with the project and presentation rubrics. • Teams research one type of vehicle and record the advantages and disadvantages in their Engineering Notebooks. Activity 2: Persuade Me • Persuade Me: Assign students a persuasive speech using the following prompt: The first car ever built was powered by steam. Select one of the cars we researched today and persuade someone to purchase it as their method of transportation. **EXPLANATION** **Activity 1: Sources of Energy** • After researching, students share their information by presenting it to the class. • Review renewable and nonrenewable resources (fossil fuels, wind, steam, solar, electricity, biomass fuels) Activity 2: Persuade Me • Use text from your research to support your point of view.

	• Students present their information to the class. **ELABORATION** • Groups can choose to create a poster, PowerPoint, or Prezi to present their information if time permits. **EVALUATION** • Use attached rubrics to evaluate the research and presentation.
Extension	• Tesla Research – research the car "Tesla". Make a list of its pros and cons. • Price Shopping – Make tables listing the prices of vehicles that use alternative sources of energy and gasoline. Find the differences between prices and determine the better deal. • Bring in guest speakers: Engineers, car salesman to bring an electric car to your school

Greenpower Activity Rubric

Homeroom Teacher: _____ School: _____

Student Name: _____

CATEGORY	4	3	2	1
Participation	Used time well in class and focused attention on the activity.	Used time pretty well. Stayed focused on the activity most of the time.	Did the activity but did not appear very interested. Focus was lost on several occasions.	Participation was minimal OR student was hostile about participating.
Materials	All materials in the activity are handled properly.	Almost all materials in the activity are handled properly.	Most of the materials in the activity are handled properly.	Many materials in the activity were not handled properly.
Data	Professional-looking and accurate representation of the data. Graphs and tables are labeled and titled (if applicable).	Accurate representation of the data. Graphs and tables are labeled and titled (if applicable).	Data is present but hard to read/ unorganized. Graphs and tables are not labeled OR are not titled (if applicable).	Data is not shown OR is inaccurate.
Engineering Notebook	Dated, clear, accurate notes are taken regularly.	Dated, clear, accurate notes are taken occasionally.	Dated not are taken occasionally, but accuracy of notes might be questionable.	Notes rarely taken or of little use.
Summary	Summary describes the skills learned, the information learned and some future applications to real-life situations.	Summary describes the information learned and a possible application to a real-life situation.	Summary describes the information learned.	No summary is written.

Greenpower Informative Writing Rubric

Homeroom Teacher: _____ School: _____

Student Name: _____

Standard	Points
W.5.2a- Introduces the topic, provides a focus, and groups related information logically	/20
W.5.2b- Develops the topic with facts, definitions, details, quotations, or other examples	/20
W.5.2c- Uses linking words, phrases, and clauses to connect ideas within and across categories (*in contrast, in addition, however*)	/10
W.5.2d- Uses precise word choice, including domain-specific vocabulary	/15
W.5.2e- Ends with a relevant concluding sentence/paragraph	/15
L.5.1- Uses correct grammar	/5
L.5.2- Uses correct capitalization	/5
L.5.2- Uses correct punctuation	/5
L.5.2e- Spells grade-appropriate words correctly	/5
Final Writing Grade	**/100**

Teacher Notes:

4- Mastering Standards (95-100)
3-Meeting Standards (80-94)
2-Approaching Standards (60-79)
1-Not Meeting Standards (<59)

Formula Goblin Curriculum

Unit	Going Green
Lesson Title	Cars of the Future
Duration	Two hours
Lesson Focus	What can you do to help sustain the planet's natural resources?
Standard(s)	• 5.E.16 Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment. • RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. • RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. • W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. • SL.5.4 Report on a topic or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace. • SL.5.5 Include multimedia components and visual displays in presentations when appropriate to enhance the development of main ideas or themes. • Tech 2 Use various technology applications, including word processing and multimedia software. • Tech 5 Practice safe use of technology systems and applications. • Tech 6 Collect information from a variety of digital sources. • Tech 12 Create a product using digital tools.
Lesson objective(s)	• Understand the pros and cons of adopting new technologies or alternative fuels to replace existing gasoline-powered vehicles • Describe the environmental impact of alternative fuels
Materials	• Internet access • Engineering Notebooks • Your City's Car of the Future student handout
Vocabulary	alternative fuels, hydrogen fuel, ethanol, hybrid
Procedures	**ENGAGEMENT** • Ask students what they think the term "going green" means. What have students or family members done at home, work, or school to help sustain the planet's natural resources? As a class, brainstorm some things they could do to achieve this goal. Ask if any of their family members currently drives and alternative-fuel-powered vehicle. If so, how does it work?

	EXPLORATION
	• Provide each time with the Your City's Car of the Future handout and a piece of poster board. Tell students they have been hired to help the city go green by decreasing the amount of CO2 emissions from public transportation in the community. The community's objectives are to:
	  ○ Conserve natural resources
	  ○ Reduce the release of CO2 into the atmosphere
	  ○ Introduce a new technology or alternative fuel that is reliable, safe, and practical
	• Organize students into four teams to study and work on the objectives and options. Each team will investigate the benefits and drawbacks of a different new technology or an alternative fuel option.
	  ○ Team 1: hydrogen fuel
	  ○ Team 2: ethanol fuel
	  ○ Team 3: vehicle engineering
	  ○ Team 4: hybrid and electric cars
	• Direct students to watch the video clips for their assigned topic, and use the websites provided to conduct research. During the research, students will answer their team's focus questions in their Engineering Notebooks. Videos can be found here. https://padlet.com/4aHoot/CarOfFuture
	ELABORATION
	• Teams will use their research to prepare a digital presentation (PowerPoint, Prezi, etc.) explaining the benefits and drawbacks of their technology/alternative fuel option. Encourage them to consider both short-term and long-term solutions, how each plan might be financed, and whether a combination of one or more of the new technologies or alternative fuels might make the most sense for the city.
	EVALUATION
	• Teams will present their presentations during a mock town meeting. Presenters will debate the pros and cons of each plan.
	• After all presentations, students (townspeople) will vote on which plan to adopt based on the evidence presented in the four team proposals.

Extension	• Students will write a letter to the mayor asking him to implement the plan they created to help save their city's natural resources. Discuss the pros and cons of the plan, making sure to provide evidence showing how the pros outweigh the cons.

GreenpowerUSA
INSPIRING ENGINEERS

Your City's Car of the Future

Your class has been hired to help your city "go green" by decreasing the amount of CO_2 emissions from public transportation in your community. The community's objectives are to:

a) conserve natural resources
b) reduce the release of CO_2 into the atmosphere
c) introduce a new technology or alternative fuel that is reliable, safe, and practical

Your class will be organized into four teams to examine the different options. Each team will investigate the benefits and drawback of one of the four options. After each team has presented its finding, the class will vote on a proposal.

Procedure

1) Resources are found on the Padlet page. Start by watching the video clips and taking notes on your topic. Then answer the focus questions listed with the video clip for your team.
2) In your Engineering Notebook, list the current fuel resources, fueling infrastructure, and public transportation systems in place for your city.
3) Research your topic using the websites your teacher provided on the Padlet page.
4) Prepare a team presentation that demonstrates that the community's objectives can be met through your research option. Make a chart that includes the following categories:
    a. how each fuel is made (or how each new technology works)
    b. the environmental impacts, if any, of each alternative fuel or new technology
    c. the advantages and disadvantages of using each alternative fuel or new technology
    d. the major challenges facing implementation of each alternative fuel or new technology
5) Provide a list of references for the facts you use in your presentation, including the websites you use and the name of the person or organization sponsoring the website.

Formula Goblin Curriculum

Topic	Going Green
Lesson Title	Environmental Issues Big Book: Water Pollution
Duration	4 hours
Lesson Focus	In this lesson, students continue creating a big book on environmental issues. Today, they explore water pollution by researching the problem, causes, impact, and the steps humans can take help protect the environment.
Standard(s)	• 5.EHA.16 Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment (e.g., terracing land to prevent soil erosion, utilizing no-till farming to improve soil fertility, regulating emissions from factories and automobiles to reduce air pollution, recycling to reduce overuse of landfill areas). • RI.5.1 Quote accurately from a text when explaining what the text says and when drawing conclusions from the text. • RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. • RI.5.8 Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). • RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. • RI.5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the Grades 4-5 text complexity band independently and proficiently. • W.5.2 Write informative or explanatory texts to examine a topic and convey ideas and information clearly. • W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. • W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources. • W.5.8 Draw evidence from ~~literary~~ or informational texts to support analysis, reflection, and research.
Lesson objective(s)	The students will: • Create a big book on environmental issues. • Explore water pollution by researching the problem, causes, impact and what humans can do to protect the environment. • explain the steps humans can take to protect the environment.
Materials	Per two student teams: • 5 pieces of 11 x 17 paper • Art supplies

Vocabulary	• Water pollution • Biotic factors • Abiotic factors • Overfishing • Global warming • deforestation
Procedures	**ENGAGEMENT** *For the next four lessons, you will be researching four different environmental issues: water pollution, overfishing, global warming, and deforestation; and you will work together with a partner to identify a list of ways humans can take steps to protect the water in the environment.* Teacher Note: Continually remind students of the importance of having a positive and hopeful attitude when learning about problems in our global environments. *The good news is... there are steps human can take to help solve all of the environmental issues that we will discuss.* Show two videos on water pollution: *World Water Day: Animation* and *Water Quality Basics.* http://montana.pbslearningmedia.org/resource/e704f189-42ce-4dd3-82b4-18787100c43c/water-quality-basics/ https://www.youtube.com/watch?v=AxfEVXNm_-4 By kicking off today's lesson with these videos, students are immediately provided with background knowledge that inspires students to ask questions and to take as many notes as possible on this environmental issue! Throughout the videos, pause for students to discuss key points. The goal is to encourage activate listening and to help students connect this environmental issue with their own lives. Students also identify relevant details that help explain either the problem, causes, impact on the environment, or steps to protect the environment. They eagerly take bulleted notes on the *Water Pollution* page of their big books! **EXPLORATION** Now that students have some background knowledge on water pollution, provide students with the opportunity to work in teams of two to continue their research. Use only one laptop between the two students. By having one laptop between two students, each pair of students is able to fit their big books and the computer on two desks. Sharing one computer also encourages students to collaborate and discuss.

	Online Resources Prior to the lesson, provide the following online resources to students for their research today. • http://eschooltoday.com/pollution/water-pollution/what-is-water-pollution.html • http://nationalgeographic.org/encyclopedia/pollution/ **Monitoring Student Understanding** Once students begin working, conference with every group. The goal is to support students by asking guiding questions (listed in elaboration). **EXPLANATION** **Sharing Findings** Now that students have built meaning and understanding by observing, questioning, and exploring, it is important to provide students with the opportunity to share their findings. For this reason, invite students to participate in a conversation with a Discussion Group. **ELABORATION** 1. What patterns have you noticed? 2. Why do you suppose ____? 3. What have you found so far? 4. Has your thinking changed? 5. What evidence do you have? 6. How did you decide _____? 7. What conclusion can you draw about ____?
Extension	1. Follow the above procedures to add to the big book that the students are creating. Have students research overfishing, global warming, and deforestation. Once the four factors have been researched, students will have a book of research on each topic. 2. After identifying ways that humans pollute the air, soil, and water on Earth, students work in groups to create a new sign to stop pollution. These signs can be hung throughout the school.

Environmental Issue: _____

Problem	Cause
Impact on the Environment	Steps to Protect the Environment

Force and Motion Overview

In this unit, the students will learn the basics of force, motion, and friction. They will race hot wheels down ramps, explore potential and kinetic energy, and investigate how collisions affect how energy transfers. They will also test cars on different surfaces to investigate the effect of friction on speed and distance traveled. The students will also construct a balloon rocket and light a light bulb by constructing a battery out of a potato.

Formula Goblin Curriculum	
Unit	Force and Motion
Lesson Title	Toy Car Speedometry: Toy Car Ramps
Duration	One hour
Lesson Focus	In this lesson, students will test a car rolling off different ramps. • What happens to the distance your car travels as you increase the height of the ramp?
Standard(s)	• 4.E.1 Use evidence to explain the relationship of the speed of an object to the energy of that object. • 5.NBT.7 Add, subtract, multiply and divide decimals to hundredths. • 5.MD.1 Convert among different-sized standard measurement units within a given measurement system • W.5.2.b Write informative or explanatory texts to examine a topic and convey ideas and information clearly. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic. • Tech 1 Use input and output devices of technology systems. • Tech 2 Use various technology applications, including word processing and multimedia software
Lesson objective(s)	The students will: • Make reasonable mathematical estimates based on their collected data. • Analyze patterns in the collected data
Materials	• Internet access • ActivBoard • Engineering Notebook Per group: • Small toy cars (3-4 different models for each group) • 1-2 long piece of track (for each group) • 3 textbooks, approx. 2 inches thick (per group) • Measuring tape (1 for each group)
Vocabulary	kinetic energy, potential energy, average, mass, slope, height
Procedures	**ENGAGEMENT** • Show video https://www.youtube.com/watch?v=7SjX7A_FR6g • In Engineering Journals students will jot down questions they develop while watching the video. (Prompt: What would you ask the driver of this car? What would you ask the engineer who created this car?) **EXPLORATION** • Show students the Hot Wheels cars, tracks, and books. As an engineer, how would you build a ramp to get your Hot Wheels car to go as far as it can?

	• Students formulate hypothesis. • Students test the car rolling off different ramps. They will build a ramp consisting of 1, 2, and 3 books, and results will be recorded in Engineering Notebooks. The measurements will be recorded in inches and then (if time) converted to centimeters. CHALLENGE: Have students find the average length of the trials. • Have students share what they discovered as they explored the ramp heights. • Looking at the all the class data, what pattern did you see? • Discuss how differences in the cars each group used may have affected their results. How can you ensure your data is consistent in the next experiments? • Discuss potential and kinetic energy. (Examples of potential: ball about to be thrown, bow and arrow stretched out to shoot, bike rider waiting on top of hill, roller coaster at the top of the hill; Examples of kinetic: ball or arrow flying through the air, bike riders coming down a hill, roller coaster going down the track) **EVALUATION** • Students will draw a diagram of the ramp in their Engineering Notebooks. Students will label where the car possesses kinetic and potential energy on the ramp. (At the top of the ramp the car has potential energy; and when released down the ramp it turns into kinetic energy that moves the car • Students will use the terms potential and kinetic energy to explain why the distances in their data increased as the height of the ramp increased. (As students increase the number of books, they increase the potential energy, which increases the distance the car can travel.)
Extension	• Students will create a chart and bar graph on the computer to represent their data. • Students will see if they can build a ramp tall enough for a car to successful do a loop through the track.

HOW TO PUT TOGETHER YOUR OWN SPEEDOMETRY CLASSROOM KIT

A Speedometry classroom kit includes the following:

- 40 Hot Wheels cars
- 112 orange track pieces
- 64 track connectors
- 16 track loops
- 16 gravity clamps
- Instructions for track assembly

However, you can assemble your own kit out of items you already have.

For each group of 4-5 students you'll need:

- 3-5 cars of different sizes, weights, and designs (make sure each group has the same set)
- 10-15 feet of track
- 2 clamps or heavy items for attaching track to a chair or table
- 1-2 track loops (optional)

Cars

You can use any kind of toy car with Speedometry, not just Hot Wheels. It's a good idea to have a variety of models available (different sizes, weight, and designs) so that students can experiment with the effects of using different types of cars. If students are working in multiple groups, each group should have an identical set of cars so that they are testing the same materials.

Track & Loops

You can improvise a track using measuring sticks, metal cooking sheets, plywood, manila folders, poster board, cardboard, plastic rain gutters, or naturally occurring slopes around your school or classroom. Flexible materials such as cardboard, poster board, or manila folders can also be shaped into loops and glued or taped in place.

Clamps

Use binder clips, a brick or heavy book, or a vise to attach your track to a chair or table and make a taller ramp. For shorter, less inclined ramps, place the end of the track on top of a stack of books.

Ramp
Data Sheet

	Trial 1	Trial 2	Trial 3	Challenge: Average
One Book	_____ in _____ cm	_____ in _____ cm	_____ in _____ cm	
Two Books	_____ in _____ cm	_____ in _____ cm	_____ in _____ cm	
Three Books	_____ in _____ cm	_____ in _____ cm	_____ in _____ cm	

Ramp
Data Sheet

	Trial 1	Trial 2	Trial 3	Challenge: Average
One Book	_____ in _____ cm	_____ in _____ cm	_____ in _____ cm	
Two Books	_____ in _____ cm	_____ in _____ cm	_____ in _____ cm	
Three Books	_____ in _____ cm	_____ in _____ cm	_____ in _____ cm	

Formula Goblin Curriculum	
Unit	Force and Motion
Lesson Title	Toy Car Speedometry: Car Design (Lesson Two)
Duration	One hour
Lesson Focus	As an engineer, how would you design a Hot Wheels car that would travel the farthest distance?
Standard(s)	• 4.E.1 Use evidence to explain the relationship of the speed of an object to the energy of that object. • W.5.2.b Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic.
Lesson objective(s)	The students will: • Explore how to increase the potential and kinetic energy of Hot Wheels • Understand potential and kinetic energy • Make reasonable mathematical estimates based on their collected data. • Analyze patterns in the collected data • Investigate potential and kinetic energy by introducing different variables
Materials	• Engineering Notebook Per Group: • Hot Wheels cars (2-4 for each group) • 1-2 long piece of track (for each group) • 3 textbooks, approx. 2 inches thick (per group) • Hot Wheels Design Data sheet • Scale
Vocabulary	kinetic energy, potential energy, average, mass, slope, height
Procedures	**ENGAGEMENT** • Discuss the prior lesson in which students changed the height of the different ramps. What variables made your car travel the farthest? Why do you think that is? **EXPLORATION** • Students will set up a 3-book (6 in.) ramp. • Students will receive 4 different types of Hot Wheels. (Make sure each group receives the same Hot Wheels so they can discuss data later.) • Students will test how far each Hot Wheels travels on a 3-book ramp. Results will be recorded in Engineering Notebooks. • Students will conduct a class-wide comparison of the data to ensure no mistakes were made in the data collecting process.

	ELABORATION • Students will complete the Hot Wheels Design Data sheet. Students will record the weight, length, width, distance between front and back tires, and tire design for each car. **EVALUATION** • Students will compile an informative paragraph explaining which car design would travel the farthest and why.
Extension	• Teacher will set up a Hot Wheels "junkyard." Teams will be able to choose **one** Hot Wheels car to race. Students will use their data to analyze which car would be the best option. Teams will race their cars.

GreenpowerUSA
INSPIRING ENGINEERS

Design Data Sheet

As an engineer, how would you design a toy car car to get your car to go as far as you can?

1) Brief description of car:

_____

Weight of car: _____ Length of car: _____ Width of car: _____

Distance between front and back tires: _____
Tire design (circle one): front tires same as back tires (both are thin)
front tires same as back tires (both are thick)
front tires are smaller than back tires

Draw underside of the car:

2) Brief description of car:

_____

Weight of car: _____ Length of car: _____ Width of car: _____

Distance between front and back tires: _____
Tire design (circle one): front tires same as back tires (both are thin)
front tires same as back tires (both are thick)
front tires are smaller than back tires

Draw underside of the car:

3) Brief description of car:

_____

Weight of car: _____ Length of car: _____ Width of car: _____

Distance between front and back tires: _____
Tire design (circle one): front tires same as back tires (both are thin)
front tires same as back tires (both are thick)
front tires are smaller than back tires

Draw underside of the car:

4) Brief description of car:

_____

Weight of car: _____ Length of car: _____ Width of car: _____

Distance between front and back tires: _____
Tire design (circle one): front tires same as back tires (both are thin)
front tires same as back tires (both are thick)
front tires are smaller than back tires

Draw underside of the car:

Formula Goblin Curriculum	
Unit	Force and Motion
Lesson Title	Toy Car Speedometry: Collision Course (Lesson Three)
Duration	One hour
Lesson Focus	• How will the speed of a car affect a collision? • How do different types of collisions affect how energy transfers from one object to another? • How can you increase or decrease the transfer of energy from one object to another? • Using understanding of the transfer of potential and kinetic energy, how do engineers and scientists design safer cars?
Standard(s)	• 4.E.3 Investigate to determine changes in energy resulting from increases or decreases in speed that occur when objects collide. • 5.MD.1 Convert among different-sized standard measurement units within a given measurement system, and use these conversions in solving multistep, real-world problems. • W.5.2 Write informative or explanatory texts to examine a topic and convey ideas and information clearly. • W.5.2d Use precise language and domain-specific vocabulary to inform about or explain the topic.
Lesson objective(s)	The students will: • Ask questions and predict outcomes about changes in energy when objects collide.
Materials	Per Group: • Hot Wheels cars • 1 long piece of track (if not available, use a measuring tape) • Textbooks • Ruler, measuring stick, or measuring tape • Collision Course Data Sheet • Engineering Notebook and pencil • Internet access
Vocabulary	Potential energy, kinetic energy, collision
Procedures	**ENGAGEMENT** • Show video clip of safety crash test with and without safety belts. https://www.youtube.com/watch?v=d7iYZPp2zYY • Have students discuss with a partner what they find interesting about these videos. • Have class discussion comparing and contrasting the two types of collision. (Guiding questions: What do you think engineers need to do to be able to get cars to be safer? What do you think drivers need to do to be able to get the cars to be

	safe? How are the cars similar or different from your own car?) **EXPLORATION** • Divide students into small groups of 4-5. • Students build ramps using the Hot Wheels tracks and observe collisions between two Hot Wheels cars, one starting at the top of the ramp and one at the bottom of the ramp. • Students incrementally increase the height of the ramps and measure the changes in the distance the car at the bottom of the ramp travels upon impact. • Students record the measurements on the data sheets located in the Engineering Notebooks. (repeat using two different Hot Wheels) • At the end of the lesson, students share their observations about energy and collisions. **EVALUATION** • In their Engineering Notebooks, ask students to write a letter to the National Safety Transportation Board explaining what they've learned about potential and kinetic energy and how energy is transferred. Suggest one thing that every driver should know based on what was learned.
Extension	• Challenge: Convert data to yards. (Understanding of fractions will be necessary.)

Collision Course
Data Sheet

	Set 1	Set 2	Challenge: Convert to Yards
One Book	_____ in _____ cm	_____ in _____ cm	
Two Books	_____ in _____ cm	_____ in _____ cm	
Three Books	_____ in _____ cm	_____ in _____ cm	
Four Books	_____ in _____ cm	_____ in _____ cm	

Formula Goblin Curriculum

Unit	Force and Motion
Lesson Title	Friction
Duration	Two hours
Lesson Focus	How do different surfaces effect motion?
Standard(s)	• 4.E.1 Use evidence to explain the relationship of the speed of an object to the energy of that object • 5.NBT.7 Divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/ or the relationship between addition and subtraction; relate the strategy to a written method, and explain the reasoning used. • Tech 2 Use various technology applications, including word processing and multimedia software.
Lesson objective(s)	The students will: • Gather and questioning data from scientific investigations. • Apply evidence and reasoning using knowledge and observations. • Develop explanations using prior knowledge/experiences from everyday life and observational evidence.
Materials	Per student: • Engineering Notebook Per class: • Force and Motion PowerPoint • http://Padlet.com/greenpowerHCS/homepage • Aluminum foil • wax paper • cardboard • carpet • sandpaper • paper towel Per Group: • Books for incline • ruler • Tape • Stopwatch • Measuring tape • cardboard boxes • scissors • a ruler • Hot wheels Car (3 per group) • ramp
Vocabulary	position, force, speed, velocity, motion, friction, texture, gravity, incline, simple machines
Procedures	**ENGAGEMENT** • I want you to imagine that you're wearing roller skates. I asked you to roller skate down the hall, outside on the sidewalk, and outside in the grass of the playground. Turn and talk and share out and/or record in Engineering Notebook: Describe to me what that experience would be like. Which one do you think you could skate the fastest on? Why? Which do you think you would skate the slowest on? Why? What forces do you think are acting on your skates?

	EXPLORATION Hot Wheels Friction – teacher led • Compare and contrast the effect of hot wheel speed on different surfaces: • Aluminum foil, wax paper, cardboard, carpet, sandpaper, paper towel Hot Wheels Friction – group experiment • Using just a few basic materials, students will build tracks and conduct race car experiments to test the effects of changing the tracks' surface texture on the speed of the cars and the distance traveled. • Students will also need something to prop up the tracks. In a classroom, stacks of identical textbooks are an obvious choice. • Divide students into groups. • Give each group three equal tracks made from cardboard, 1 1/2 feet x 4 inches, two of which are covered in a different material: aluminum foil and paper towel. • Students attach the tracks to the three stacks of different heights using a small piece of tape. • Students make a hypothesis about the outcome of the races and record in their Engineering Notebook. • Using three of the same toy cars (hot wheels), line the cars up at the starting line and observe which car finishes first, second and third. • Compare results to their hypotheses. • Next, groups will test each car individually. Have a time keeper start the stopwatch when the car is let go and stop it when the car stops. • Record the time on the data collection sheet. Measure the distance traveled and record on data sheet. • Calculate the speed and record on data sheet. • Repeat three times per track surface. • Calculate the average speed of each track. **EXPLANATION** • Force and Motion PowerPoint – the PowerPoint details the terms listed in the Vocabulary section and clarifies race findings. **ELABORATION** • After collecting the data, let students reflect on the effect of the tracks' textures on the outcomes of the races. • Were their hypotheses correct? • How did friction affect the cars' racing times?
Extension	• Dragon Racer – refer to attached activity http://www.cape.k12.mo.us/blanchard/hicks/News%20Pages/Force%20pdf%20files/Dragon%20Racer.pdf

Formula Goblin Curriculum

Unit	Force and Motion
Lesson Title	Balloon Rockets
Duration	One hour
Guiding Questions	How can we transport cargo across a string using only these materials?
Standard(s)	• 5.MII.1 Plan and carry out investigations (e.g., adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, evaporating salt water) to provide evidence that matter is made of particles too small to be seen. • 5.MS.6 Construct an explanation from evidence to illustrate that the gravitational force exerted by Earth on objects is directed downward towards the center of Earth. • 5.MS.7 Design and conduct a test to modify the speed of a falling object due to gravity (e.g., constructing a parachute to keep an attached object from breaking).
Lesson objective(s)	The students will: • demonstrate basic principles of rocketry by applying the concept of pressure and Newton's Second and Third Laws of Motion • use a balloon to explore these concepts
Materials	• Internet • ActivBoard • Engineering Notebook • 1 balloon (round ones will work, but the longer "airship" balloons work best) • 1 long piece of kite string (about 10-15 feet long) • 1 plastic straw • tape • picture of car
Vocabulary	friction, force, motion, thrust
Procedures	**ENGAGEMENT** • Refer to last week's lesson on friction • Show the video: http://www.nsf.gov/news/mmg/mmg_disp.jsp?med_id=69291&from=vid **EXPLORATION** • Tie one end of the string to a chair, door knob, or other support. • Put the other end of the string through the straw. • Pull the string tight and tie it to another support in the room. • Blow up the balloon (but don't tie it) and pinch the end of the balloon. Tape the balloon to the straw (refer to pictures on http://www.housingaforest.com/racing-

balloon-leprechauns/) You're ready for launch! Make sure to have the "tail" of the balloon facing in the opposite direction that you want your car to race.
- Let go and watch the rocket fly!

EXPLANATION

- So how does it work? It is all about the air and thrust. As the air rushes out of the balloon, it creates a forward motion called thrust.
- Thrust is a pushing force created by energy. In the balloon experiment, our thrust comes from the energy of the balloon forcing the air out.
- Different sizes and shapes of balloon will create more or less thrust.
- In a real rocket, thrust is created by the force of burning rocket fuel as it blasts from the rocket's engine—as the engines blast down, the rocket goes up!

ELABORATION

- In this experiment, the rocket is propelled by pressure. Pressure is the amount of force exerted on an area. When you blow up the balloon, you are filling the balloon with gas particles (mainly oxygen). The gas particles move freely within the balloon and may collide with one another. As more gas is added to the balloon, the number of gas particles in the balloon increases, as well as the number of collisions. While the force of a single gas particle collision is too small to notice, the total force created by all of the gas particle collisions within the balloon is significant. As the number of collisions within the balloon increases, so does the pressure within the balloon.
- In addition, the pressure of the gas inside the balloon becomes greater than the air pressure outside of the balloon. The pressure inside the balloon serves as the fuel for the rocket. When you release the opening of the balloon, gas quickly escapes to equalize the pressure inside with the air pressure outside of the balloon. As the gases escape from the balloon, the gas particles exert a force on the ground and the air outside of the balloon. According to Newton's Third Law of Motion, every action has an equal and opposite reaction. Therefore, as the gas is released from the balloon, it pushes against the outside air, and the outside air pushes back. As a result, the rocket is propelled forward by the opposing force. This opposing force is thrust.
- In an aircraft or rocket, the engine provides power to the propeller, which produces the thrust. Power is the rate at which energy is converted or work is performed. In general, an engine with more power produces more thrust. In addition, the thrust must be greater than drag in order for an aircraft or rocket to accelerate forward for takeoff and to increase its speed during flight. If an aircraft is flying at a constant speed, the amount of thrust will equal drag.

EVALUATION

- Does the shape of the balloon affect how far (or fast) the rocket travels?
- Does the length of the straw affect how far (or fast) the rocket travels?
- Does the type of the string affect how far (or fast) the rocket travels? (try fishing line, nylon string, cotton string, etc.)
- Does the angle of the string affect how far (or fast) the rocket travels?

Extension	• Use this lesson to practice measurement and apply calculations. Measure the distance from the start to the finish line on the string. Measure the mass of the inflated balloon. (They can use a clip to keep the balloon opening closed and then subtract the mass of the clip.) Then, time how long it takes for the balloon to move across the finish line. Students can then use these measures to calculate the rocket's force. • Slant the string to see how much of a difference it makes with the balloon rocket.

Formula Goblin Curriculum

Unit	Batteries
Lesson Title	Potato Battery
Duration	One hour
Lesson Focus	• Why do we use batteries? • How do we measure the strength of a battery?
Standard(s)	• 4.E.2 Plan and carry out investigations that explain transference of energy from place to place by sound, light, heat, and electric currents. • 4.E.4 Design, construct, and test a device that changes energy from one form to another (e.g., electric circuits converting electrical energy into motion, light, or sound energy; a passive solar heater converting light energy into heat energy). • RI 5.2 Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text. • RI 5.3 Explain the relationships or interactions between two or more individual, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in a text. • RI 5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a questions quickly or to solve a problem efficiently. • W 5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. • SL 5.2 Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally. • Tech 8 Collect information from a variety of digital sources.
Lesson objective(s)	The students will: • create a timeline of the history of the battery • identify the parts of a battery • describe how a battery works
Materials	• Internet • ActivBoard • Engineering Notebook • Highlighters • *History of the Battery* (extension) Per Group • various batteries • one potato • one lemon • two short pieces of heavy copper wire • two common galvanized nails (1 zinc, 1 copper) • three alligator clip/wire units (alligator clips connected to each other with wire) • one small light bulb (ex: holiday light bulb)

Vocabulary	battery, voltage, voltmeter, conductor, electricity
Procedures	**ENGAGEMENT** • Ask students: "What is a battery? When do we use batteries?" • Create a class list of various places we use batteries in and out of school. • Watch Bill Nye "World Without Batteries" video **https://www.youtube.com/watch?v=azRUy5_NAUA** **EXPLORATION** Edible Batteries • Roll the fruits around on the table to activate the juices. • Insert the nails (one zinc and one copper) into the potato, two inches apart so they are not touching. Do not let the nails go all the way through the potato. • Remove insulation from the tip of the holiday light bulb. • Wrap one lead wire to the zinc nail and the other lead wire to the copper nail. • Connect the wires with alligator clips. • The bulb should light up. • Use the voltmeter to test the voltage in each food. • Students can subtract the voltage in each type of food (potato and lemon). • http://mathinscience.info/teach/k5_science/physics/electric_circuits/potatolight.pdf **EXPLANATION** • Watch Bill Nye "Batteries" **https://www.youtube.com/watch?v=GMwJj1fHfCc** • Have students tell you one fact they learned from the video. **ELABORATION** • Have a class discussion on why they think the potato works and predict what else we could try using. • Look at article together as a class: ○ **www.kidzworld.com/article/4726-how-potato-batteries-work** **EVALUATION** • What is a battery? • Students will research using the internet and the "What is a Battery?" passage. They will draw a diagram of what a battery looks like and the components it has. They will label each part and describe its purpose in their Engineering Notebook.
Extension	• Read "History of the Battery" attachment and make a timeline of the history of batteries. • Compare and contrast the various sizes of batteries. Discuss what the voltage number means.

History of the Battery

Although the basics of electricity begin in 600 B.C., the first battery dates back to the 18th century. The credit for the first battery goes to Count Alessandro Volta, Italian physicist and pioneer in electricity. Count Allesandro Volta created his first battery using copper and zinc disks piled into a stack and separated by material soaked in salt water. This eventually became known as the "Voltaic Pile." The electrical unit called the volt is named in his honor. A volt is the electric force that causes electrons to move from one atom to another.

In 1802, Johann Ritter, a German physicist, conducted research on electricity and stumbled upon the possibility of a rechargeable battery. Research progressed in 1859 when Raymond Gaston Plante, a French physicist, invented the first lead acid battery. In 1881, other scientist improved the battery by using better materials and improving the manufacturing process.

Rechargeable battery development was very slow for the next 50 years. However, in the 1950s, European scientists developed a new form of battery that allowed them to seal the cell. These rechargeable batteries were very expensive and required up to 24 hours to recharge.

Due to advancements in technology, today the most popular rechargeable battery, Nickel-Cadmium, perform well, is clean, has high energy, and is found in electronics. These batteries can be recharged up to 1,000 times. Due to years of research and scientific discoveries, companies today such as Panasonic, SAFT America, SANYO Energy, Sony, and Varta Batteries offer rechargeable batteries which are inexpensive, recharge quickly, and hold charge much longer.

Formula Goblin Curriculum	
Topic	Force and Motion
Lesson Title	Marble Roller Coaster
Duration	1 hour
Lesson Focus	In this lesson, students use cardboard tubes to build marble roller coasters.
Standard(s)	• 4.E.1 Use evidence to explain the relationship of the speed of an object to the energy of that object.
Lesson objective(s)	The students will: • Build a roller coaster • Understand potential energy • Understand kinetic energy • Realize that energy cannot be created or destroyed, but transferred
Materials	Per Group: • 7 hard paper plates • 1 marble
Vocabulary	• Potential energy • Kinetic energy
Procedures	**ENGAGEMENT** Review the definition of Energy and its two main forms, potential and kinetic. Ask students to explain what they remember about energy and transfer of energy. Explain to the students that today they will be creating their own roller coasters with some simple everyday items to demonstrate energy and motion. To get students excited and engaged, I then show this fun marble roller coaster video. https://www.youtube.com/watch?time_continue=2&v=p-lzGAieZcA **EXPLORATION** 20 mins Introduce the idea of roller coasters. Discuss with students what they know about roller coasters and how they work (hills cannot be higher than the original height). Divide students into groups of four or five. Give each group materials that include 7 hard paper plates, and a marble. Students work together to build a roller coaster that their marble could ride.

	EXPLANATION Have students explain their results and SHOW the class their marble riding on the coaster. Students are then given a chance to demonstrate their roller coasters to the class. Be sure to draw students' attention to any roller coasters who used a hill. Point out the example to show that the marble will never climb a hill higher than the first hill. Remind students how energy cannot be created or destroyed. **ELABORATION** After discussing the information above, the students are given the opportunity to refine their roller coasters from earlier. Students then test their marbles after improvements have been made. **EVALUATION** Informal assessment - Observation As student groups work, I circulate around the room and ask questions to students. Types of questions I ask are: • Do you think the marble will go faster or slower on this part of your roller coaster? Why? • When the marble is rolling fast, what type of energy is being exhibited? • What can you tell about the energy when the marble slows down? • If your marble gets stuck, what do you think you can do to fix that?

Formula Goblin Curriculum	
Unit	Force and Motion
Lesson Title	Impact Crater
Duration	1 hour
Lesson Focus	How can you use evidence to describe the relationship between an object's speed and its energy?
Standard(s)	• 4.E.1 Use evidence to explain the relationship of the speed of an object to the energy of that object.
Lesson objective(s)	The students will: • Use evidence to describe the relation between an object's speed and its energy
Materials	Per Group: • Roasting pan • Flour • Glass marble • Measuring tape • Ruler Per student: • Impact Crater Data Sheet
Vocabulary	• energy • collisions • impact • crater
Procedures	**ENGAGEMENT** Have students answer the question "How do you know when something has energy?" in their Science Notebooks. Show about 30 seconds of an asteroid impact video. https://www.youtube.com/watch?v=5wBIQ-cwxM4&feature=youtu.be&t=21s Play with the sound off because the content (ending the dinosaur age) isn't relevant to our discussion of energy, and the idea is to keep them focused on the focus question. Ask if they think the asteroid has energy, and how much? Explain that they will be conducting an investigation to collect evidence they can use to support their claim.

	EXPLORATION Give each student an Impact Crater investigation data sheet and have them glue it into their Engineering Notebook, then demonstrate the investigation. Discuss what type of data we could collect. Considering he parameters, try to guide them towards height of the marble and the size of the crater. Have them add those headings to their data tables **ELABORATION** As they are working, I ask them how they think speed and energy are related, and restate what they are saying back to them as a relationship and ask for evidence. For example, when they say "When it's faster, it's more," I say, "So you're saying that the faster the marble is moving the greater the energy? What's your evidence?" **EVALUATION** This is the critical step for today: In their science notebooks, they need to explain how speed and energy are related, with evidence. I show them the Supporting Claims with Evidence Rubric, and read the Exceeds criteria and example, remind them to use the evidence they gathered today, and then give them time to work.

Date: _____

Impact Crater

Question: How does the height a marble is dropped from affect the size of the impact crater it creates?

Materials:

- roasting pan
- flour
- glass marble
- measuring tape or meter stick
- ruler

Procedure:

1. Use the ruler to smooth out the flour in the roasting pan.
2. Drop the marble from 10 cm above the flour.
3. Measure the width of the impact crater and record in the data table.
4. Repeat from 3 other heights.

Conclusion:

Reread the question at the top of the page. Use your results to describe the relationship between the height of the drop and the size of the crater.

Huntsville City Schools' 1st Annual Car Show

The Huntsville City Schools' 1st Annual Car Show is an opportunity for students to display their creative talents by developing a unique model car. This culminating activity requires students to use planning, decision making, problems solving, engineering, and productive thinking skills. Students will submit their car, index card, and presentation to the Greenpower teacher at their schools by _____. The Greenpower teacher will submit photos of the cars to be judged by Huntsville City personnel on _____.

RULES AND REGULATIONS:

- Materials must be recyclable household items
- Car width, length, and height: cannot exceed 2 feet

PRESENTATION:

Students will create a presentation using the **Engineering Design Process:**

- **Ask:** What is the problem? How have others approached it? What are your constraints?
- **Imagine:** What are some solutions? Brainstorm ideas. Choose the best one.
- **Plan:** Draw a diagram. Make lists of materials you will need.
- **Create:** Follow your plan and create something. Test it out!
- **Improve:** What works? What doesn't? What could work better? Modify your design to make it better. Test it out!

ENTRY FORM:

On a 3x5 index card, write your name, school name, homeroom teacher, and car name.

AWARDS:

Best in Show
Best Car Design
Best "Going Green" Car
Most Innovative Car
Best Presentation

Formula Goblin Curriculum

Unit	Pre-Assembly: Greenpower Lead Teacher
Lesson Title	Workshop Safety
Duration	1 hour
Lesson Focus	In this activity, team members will learn the importance of safety in the workshop area
Lesson objective(s)	The students will: • Learn how to stay safe during the building of the car • Understand the importance of safety during the building process
Materials	• Copy of Safety Contract for each student • Copy of Safety Quiz for each student • Liability Waiver
Vocabulary	Liability, consent, waiver, risk, safety
Procedures	**ENGAGEMENT** • **Problem/Ask:** What are safety features of a car? Allow students to discuss safety features of a car and the importance of the safety items. • Explain the importance and value of safety. **EXPLANATION** • Distribute the Greenpower Build Safety Contract to all the students • Discuss the basic safety rules • Review the safety contract and allow students to sign the contract • Students will need to have parent/guardian sign the contract ○ If you do not conduct a parent meeting, please send home the liability form for parents to sign with the safety contract **EVALUATION** • Students will need to take the Safety Quiz before building the car • Check the test together as a team and discuss each rule and why it is important
Extension	• Car Workshop Game – http://www.gazo.com/game/car-worksop

Unit	Pre-Assembly: Greenpower Lead Teacher
Lesson Title	Tools
Duration	1 hour
Lesson Focus	In this activity, teams of students will identify tools and their purpose for the assembly of the Goblin series car.
Lesson objective(s)	The students will: • identify tools and their uses. • use perspective and analysis to recreate a figure. • apply advanced language to explain my thinking through writing.
Materials	• Kahoot! Quiz "Goblin Tool Challenge" • laptop • projector • Goblin Tool Use Packet for each student • tools • "Using Tools Safety" attachment
Vocabulary	wrench, hammer, screwdriver, bolt, nut, washer
Procedures	1. **Guiding Question**: What is the importance of learning the names of tools and their purposes? 2. **Hook**: Display your basic tools out on a table. Ask them if they recognize any of the tools and/or its use (open-ended wrench, crescent wrench, hammer, Philips head screwdriver, flat head screwdriver, nut, bolt, washer, etc.) 3. **Kahoot! "Goblin Tool Challenge" –** Use Kahoot! Quiz as your introduction to the tools. Use the Kahoot! to promote discussions on the purposes of tools and their uses. **4. Using Tools Safety –** Review the attached safety rules for using tools. **5. Goblin Tool Use Packet –** Working in groups or individually, have students work on the "Tools" packet to review and check for understanding of the purpose and use for the Goblin tools.

IET Formula Goblin
Using Tools Safety

General

- Use a hand tool for the job it was manufactured to perform.
- Inspect tools for cracks, chips and wear. Discard damaged tools promptly.
- Be sure handles are fixed firmly onto tools working end.
- Make sure you know what you are doing before you start.
- Organize the tools in a tool box.
- Position your body securely while working with the tool.
- Wear eye protection.
- Always tie back long hair and tuck it out of the way.
- Make sure any loose clothing is tucked away or rolled back.
- Concentrate! No matter how trivial the task seems.

Hammer

- Use the correct hammer for the job (rubber, metal or wood) that is an appropriate size.
- Strike the hammer with the fact parallel to the surface being struck. Off center blows can throw can throw dangerous splinters into the air or catch fingers.
- Do not use a hammer to strike another hammer.
- Never use a striking tool with a loose or damaged handle.

Screwdrivers

- For fitting the Goblin floor panels, you will need to drill the holes first.
- The blade tip should fit the slot in the screw without hanging over the edge.
- Do not strike a screwdriver handle with a hammer – it may break/slide off.
- Never use the handle as a striking tool.
- Concentrate! If the blade slips, you could get hurt.

Electrical Equipment

- Make sure you use the correct size drill bit to drive in a screw. If you use the incorrect size, the bit may slip off.
- Make sure all wires are out of the way of not only your working area but also anyone who will be moving around in that area.
- Make sure all electrical tools are turned off after use and put on a bench that is out of the way and safe.
- Do not touch the drill bit immediately after operation – it may be extremely hot.

Formula Goblin Curriculum

Unit	Pre-Assembly: Greenpower Lead Teacher
Lesson Title	Team Building
Duration	1 hour
Lesson Focus	In this activity, team members will learn why it is beneficial to work in groups. They will also decide which group they want to join within the Greenpower team.
Lesson objective(s)	The students will: • Cooperate with others and work in a team • Explain what it means to work a s a team • Complete application for a position within the team
Materials	• Teamwork video from youtube • Team Resume
Vocabulary	Leadership, conflict, communicate, collaboration, responsibility, interdependence
Procedures	**ENGAGEMENT** • Watch one of the suggested videos on Teamwork: https://www.youtube.com/watch?v=fUXdrl9ch_Q https://www.youtube.com/watch?v=w9j3-ghRjBs https://www.youtube.com/watch?v=brrh4zqhf1s • Discuss the character traits of being a successful team member **EXPLORATION** • Discuss the various teams needed for creating a Goblin: o Design Team ✓ Select team name, motto, and design from entire 5th grade desig ✓ Responsible for building the exterior (shell) of the Goblin ✓ Create shirts for the team members o Build Team ✓ Assemble the car ✓ Students can break up into various teams within this group o Marketing Team ✓ Write letters requesting sponsorships ✓ Complete grant applications ✓ Fundraising Ideas **EVALUATION** • Students will complete application for a position within the team.
Extension	• Team building activity selected by the lead teacher • Teamwork Graphic Organizer • Teamwork Quiz • Create a realistic resume for applicant using Careerkids.com

Goblin Team Resume

Student Name: _____

Which team are you most interested in being a member?

_____ Design Team

_____ Build Team

_____ Marketing Team

Why do you think you should be hired for this position?

_____
_____
_____
_____
_____

Abilities and Talents:

List positive leadership skills and things you are good at that will make you success on this team. Example: Good in math

- _____
- _____
- _____

Achievements and Awards:

- _____
- _____
- _____

References:

List people who will say good things about you.

- _____
- _____
- _____

Greenpower USA

INSPIRING ENGINEERS

SIEMENS

Assembly Manual

Greenpower

INSPIRING ENGINEERS

The Institution of Engineering and Technology

FORMULA

INSTRUCTION MANUAL

Introduction to your Goblin Kit Car

- Welcome to your Goblin. We hope you enjoy the Greenpower experience!
- The key objective of building a Goblin is to encourage an appreciation and understanding of engineering and technology by the pupils involved.
- If you have a large number of pupils involved we suggest that you divide them into a number of teams of two or three pupils such as: Chassis Team, Drive System Team, Front Axle Team, Steering Team, Wiring Team and Bodywork Team.
- Each team can then operate separately from the others coming together for the final assembly.
- The method of assembly is clean and hence the project can take place in a classroom safely.
- Remember that the chassis will quickly become full size and will need to be stored in the dry.
- Please ensure that pupils are carefully introduced to the tools used (see over), and ensure they use the correct tools for the various jobs.
- Before any driving takes place, please read the Test Driving and Driver Training page.
- If you would like more copies of the manual, please e-mail becci@greenpower.co.uk

If you require any help whatsoever, please do contact us – we are here to help! Try asking a question on our online discussion forum at **www.greenpower.co.uk** - there are plenty of Goblin experts out there to help!

E-mail – becci@greenpower.co.uk **Phone** – 01243 552305

Goblin Components List

Part No.	Item	Located	Quantity
C1	5mm (M5) Button Head Screw	In Box	6
C3	M6 Nyloc Nut	In Box	20
C4	M6 Washer	In Box	24
C5	M6x12mm Allen Head Screw	In Box	3
C6	M6x20mm Screws	In Box	10
C7	M6x50mm Bolts	In Box	10
C8	M6 'U' Bolts	In Box	2
C9	8mm (M8) Nut	In Box	10
C10	M8 Nyloc Nut	In Box	16
C11	M8 Standard Washer	In Box	24
C12	M8 Penny Washer	In Box	10
C13	M8x25mm Screw	In Box	5
C14	M8x30mm Screw	In Box	8
C15	M8x50mm Bolt	In Box	10
C16	M8x60mm Bolt	In Box	2
C17	M8 Nylon Saddle Washer	In Box	18
C18	12mm (M12) Nyloc Nut	In Box	2
C19	M12 Standard Washer	In Box	6
C20	M12 Brass Washer	In Box	2
C21	M12 Penny Washer	In Box	4
C22	M12x25mm Bolt	In Box	3
C23	25mm Washer	In Box	6
C24	Roll Pin	In Box	4
C25	Rod End Bearing	In Box	4
C26	Small Self-Tapping Screw	In Box	25
C39	Main Chassis Screw	In Box	50
C30	Lynch Pin	In Box	2
C35	M8x50mm Dome Head Allen Screw	In Box	2
C43	M12 Spring Washers	In Box	4
C29	M12x80mm Bolt	Large Components Pack	2
C33	Q Clip	Large Components Pack	4
C34	Cable Tie	Large Components Pack	5

Spares of most Components Included in Component Box

C1	C6	C10	C14	C17	C21	C25	C39
C3	C7	C11	C15	C17	C22	C26	C39
C4	C8	C12	C15	C19	C23	C39	C30/ C35
C5	C9	C13	C16	C20/ C18	C24	C39	C43

Goblin Components List

Box 1 (x2)

Part No.	Item	Description	Quantity
A	Lower Frame Side Members	1550mm Aluminium Tube	2
B	Lower Cross Member (Front and Rear)	770mm Aluminium Tube	2
C	Lower Frame Cross Members (One Front)	700mm Aluminium Tube	4
D	Upper Frame Side Members	1350mm Aluminium Tube	2
E	Upper Frame Front Cross Member	525mm Aluminium Tube	1
F	Side Uprights	300mm Aluminium Tube	8
GA	Upper Frame Motor Mounting Members	450mm Aluminium Tube	2
GB	Upper Frame Steering Mounting Member	450mm Aluminium Tube	1
H	Diaganol Compression Members	646mm Aluminium Tube	2
J	Front Uprights	340mm Aluminium Tube	2
K	Battery Box for MRT35 battery	Folded Aluminium Sheet	1
L	Motor Mounting Plate	Punched and Folded Aluminium Sheet	1
M	Battery Isolator Mounting Plate	Punched and Folded Aluminium Sheet	2
N	Front Floors	Folded Aluminium Sheet	2
P	Central Floor	Folded Aluminium Sheet	1
E8	Battery Clamp	Sheet aluminium	1
S1	Front Axle	20mm Square Steel Tube (coated)	1
S2	Stub Axle Assemblies	Left and Right Handed (coated)	2
S4	Steering Column	Aluminium Welded Tube	1
A1	Roll Bar Brace	Aluminium Tube	1
A2	Roll Bar	U Shaped Aluminium Round Bar	1
D7	Rear Axle	25mm x 975mm Aluminium Bar	1
	Seat	Plastic (ABS) Seat with aluminium brackets.	1

Box 2 (x1)

D2	Drive Pulley	12 Toothed Pulley	1
D3	Driven Pulley (Large Diameter)	48 Toothed Pulley	1
D4	Taper-Lock Bush for Driven Pulley	Fixes Pulley to Axle	1
D5	Drive Belt	Part Number 322L050	2
D6	Axle Bearings	25mm 'Plumber Block' Bearings	2
D8	Free Wheels (with bearings)	25mm Roller Bearing Inserts	3
D9	Drive Wheel (with slot)	25mm Plain Bore with Drive Slot	1
E2	Electrical Connecting Block	50 amp Electrical Block	1
E3	Battery Isolator	Red Key Isolator	2
K1	Fuseholder	Holder for strip fuses	1
K2	Fuse strip link	Strip fuses, pack of ten	1
FS	Socket head screw	M5x20mm	2
FS6	Nyloc Nut	M5 Nyloc nut	2
E5	Switching Relay	100 amp (24 volt) Relay	1
E6	Push Button Switch	Throttle Button	1
E7	Electrical Cable Pack	All terminated cables labelled	1
S3	Plastic Steering Column Support	Including Fixings	1
S5	Steering Connecting Rods	350mm Lengths 8mm Studding	2
[redacted]			
A10	Component Box	All Small Fixings	1
A11	Instruction Manual	CD	1
A14	Large Component Pack	Labelled Pack of Fixings	1
A15	4 Point Harness	TRS Harness	1

Box 3 (x1)

D1	Motor (24 volts 240 watts)	Manufactured by Fracmo	1

Box 4 (x2)

E1	Batteries	SEC 12MRT 35	2

Tools Required for the Build

- Tools you will need:

  - Allen key selection. A 'T' bar type 4mm key is recommended for the chassis screws
  - Battery powered drill with drill bit selection (3mm and 6mm required)
  - Screwdriver selection
  - Assorted Metric spanners – 8mm, 10mm, 13mm and 19mm in particular
  - A small adjustable spanner may be useful!
  - Pliers
  - Small Hammer
  - Electrical sticky tape and cable ties
  - Fine flat file
  - Fine 'wet and dry' abrasive paper (800-1000 grade)
  - Masking Tape
  - Electrical Insulating Tape
  - *Recommended* - Light oil such as 3-in-1
  - *Recommended* – Thread Locking Compound such as Loctite Threadlock

- You will find the best general order of assembly is in the order of the following diagrams. Don't forget to contact us if you need any help or advice, or if you think any parts are missing.

- We recommend you do not open any packets until you need them so you reduce the risk of losing/misplacing parts

Safety First

Always wear goggles when drilling or using other hand tools. Keep long hair tied back.

Notes for the Chassis Team

- Start with the bottom frame of the chassis. Lay the two tube marks A on the floor (they are left and right handed so be careful here) and place the B and C tubes in place, make sure the C tube with a hole through it is placed at the front.

- Before screwing any on you can slide two of the C33 bracket (for the seatbelt) on to the A tubes between where the rear two C tubes will be (one on each A tube) and two onto the rear C tube. This is easier than forcing them on later!

- Now you can start inserting chassis screws, starting with the B tubes, followed by the C tubes. You may gently tighten them with an Allen key, careful not to tighten them right up at this point.

- Then lay out the top frame. The D tubes are left and right handed again. Make sure you have the GA tubes have the holes on the left hand side and the GB tube holes need to be on the right hand side. **Make sure the D tubes are the right way up, the 6th hole from the back should slant backwards for the roll bar to fit to later!** Add on the E tube too, with the holes facing upwards. Again screw in the chassis screws in loosely for now.

- Take the bottom frame, and fit the F tubes so they are on top of it, and all pointing inwards. **Don't tighten them up quite yet!**

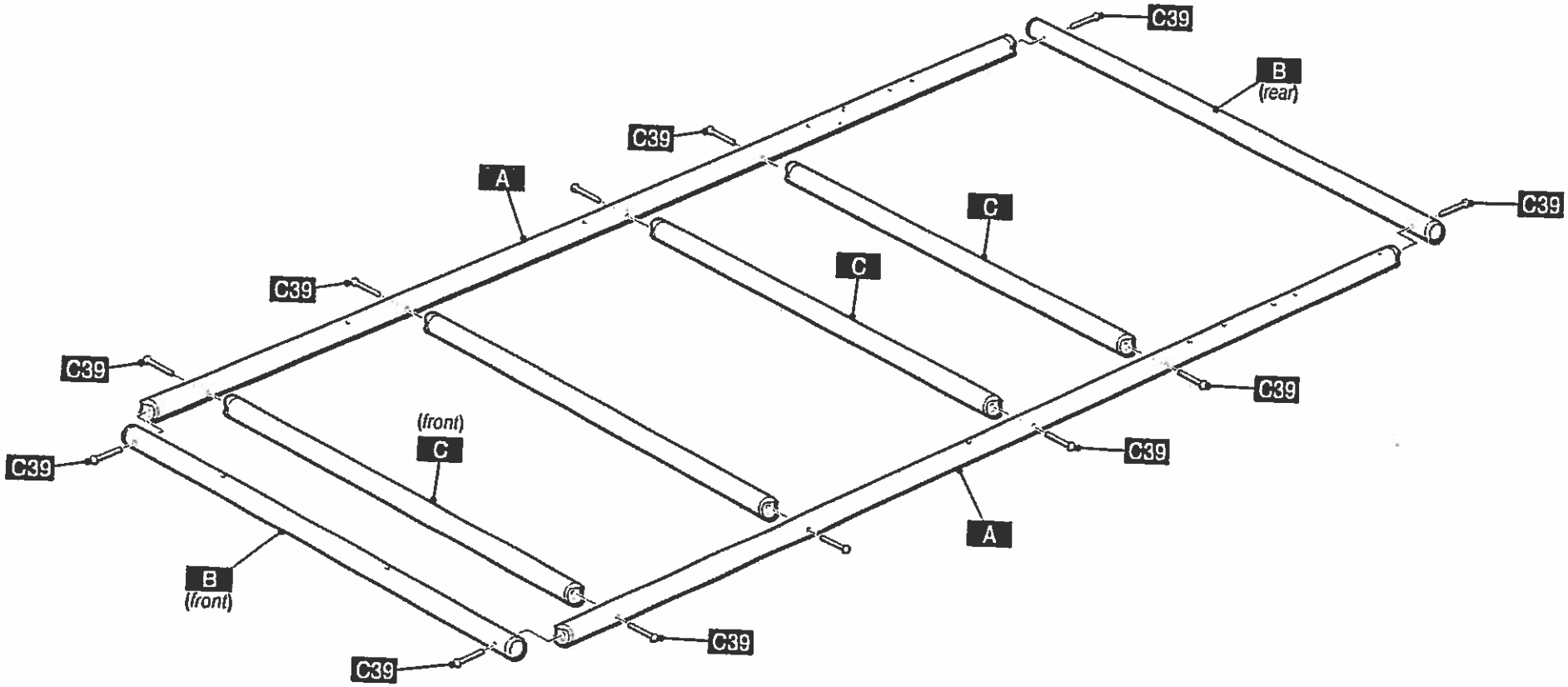
- Now put the top frame on top of the F tubes, and put the rest of the screws in. Add in the front J tubes.

- With the H tubes loosely in position you can start to tighten the screws on your chassis. **Don't tighten up any tubes with extra holes in too much; you want to be able to twist them to make lining things up later much easier!**

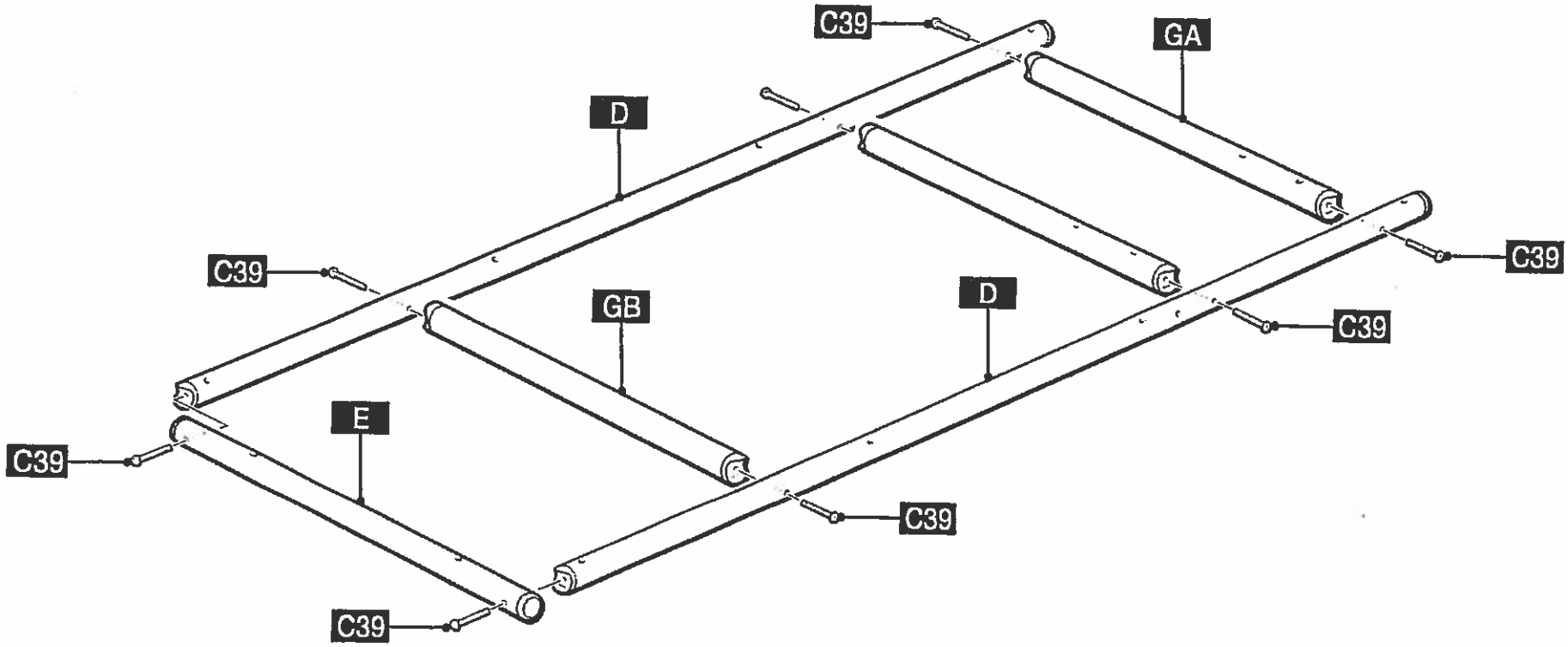
Handy tip

Once the chassis is together it may be much easier for it to be placed on some chairs, having it in the air will be much easier to work on and add parts to.

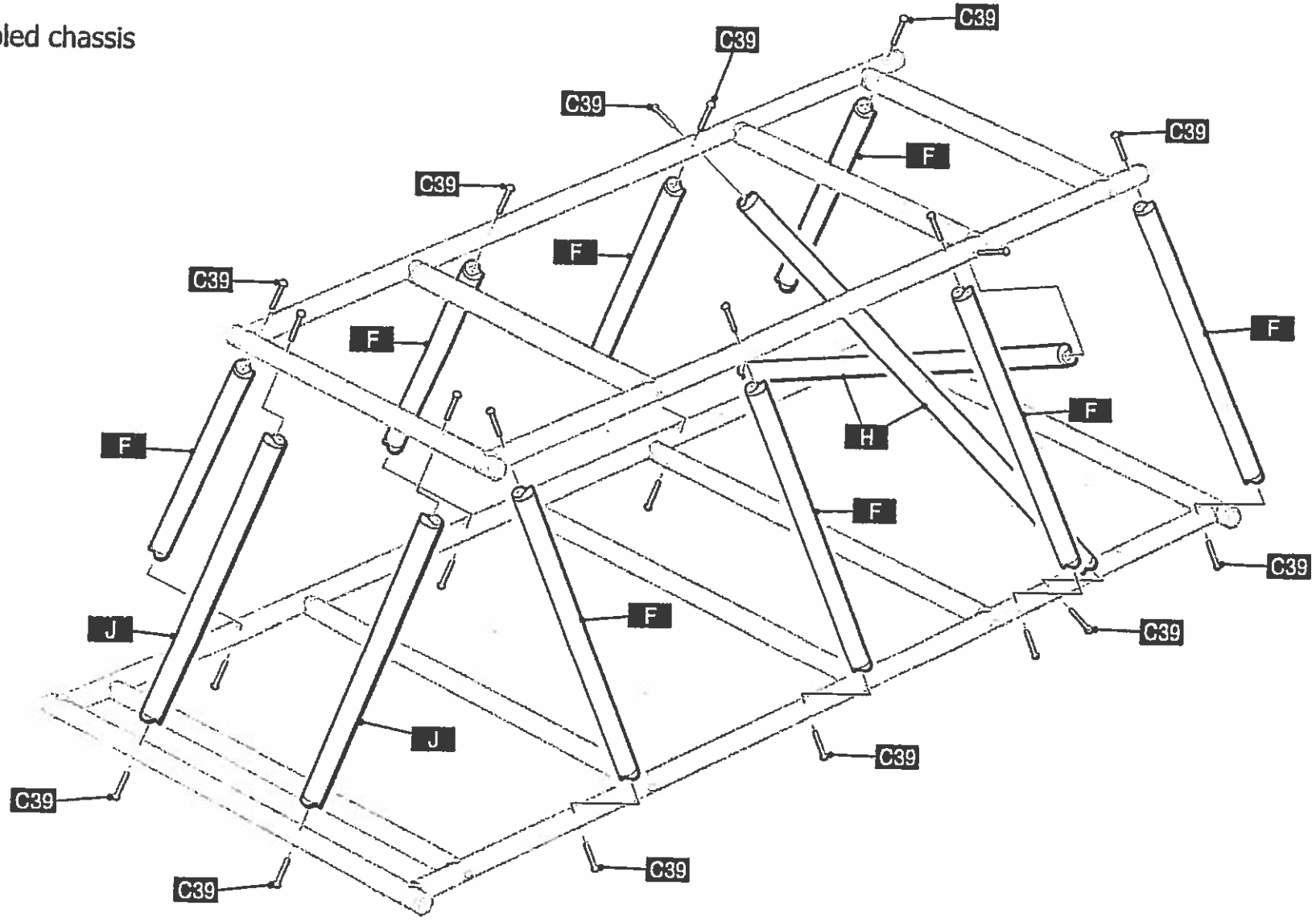
Bottom frame of chassis



Top frame of chassis



Assembled chassis



Notes for the Front Axle Team

- You can assemble most of the front axle off the car. Start by bolting the stub axles (Part S2) to the square axle tube (S1), as shown **(make sure you have the gold-coloured brass washer (C20) in place).**

- The diagram shows the front right hand wheel. The left hand side is assembled in the same way, but does have a part S2 to mirror the other side. Tighten the Bolt C29 until there is no movement up and down, but it can still turn from side to side easily.

- You may find it easiest to have the chassis upside down on a table to fit the axle or to hang the parts from the Chassis (if it is on chairs). The u-bolts (Component C8), as shown, clamp the axle to the A tubes. Only tighten the U-bolts up gently to start with, as you will not know exactly where it needs to be finally positioned yet.

- Your stub axle assemblies (Parts S2) should now have the flat strip part of them pointing towards the rear of the car on both sides. Do not fit Parts S5 quite yet...

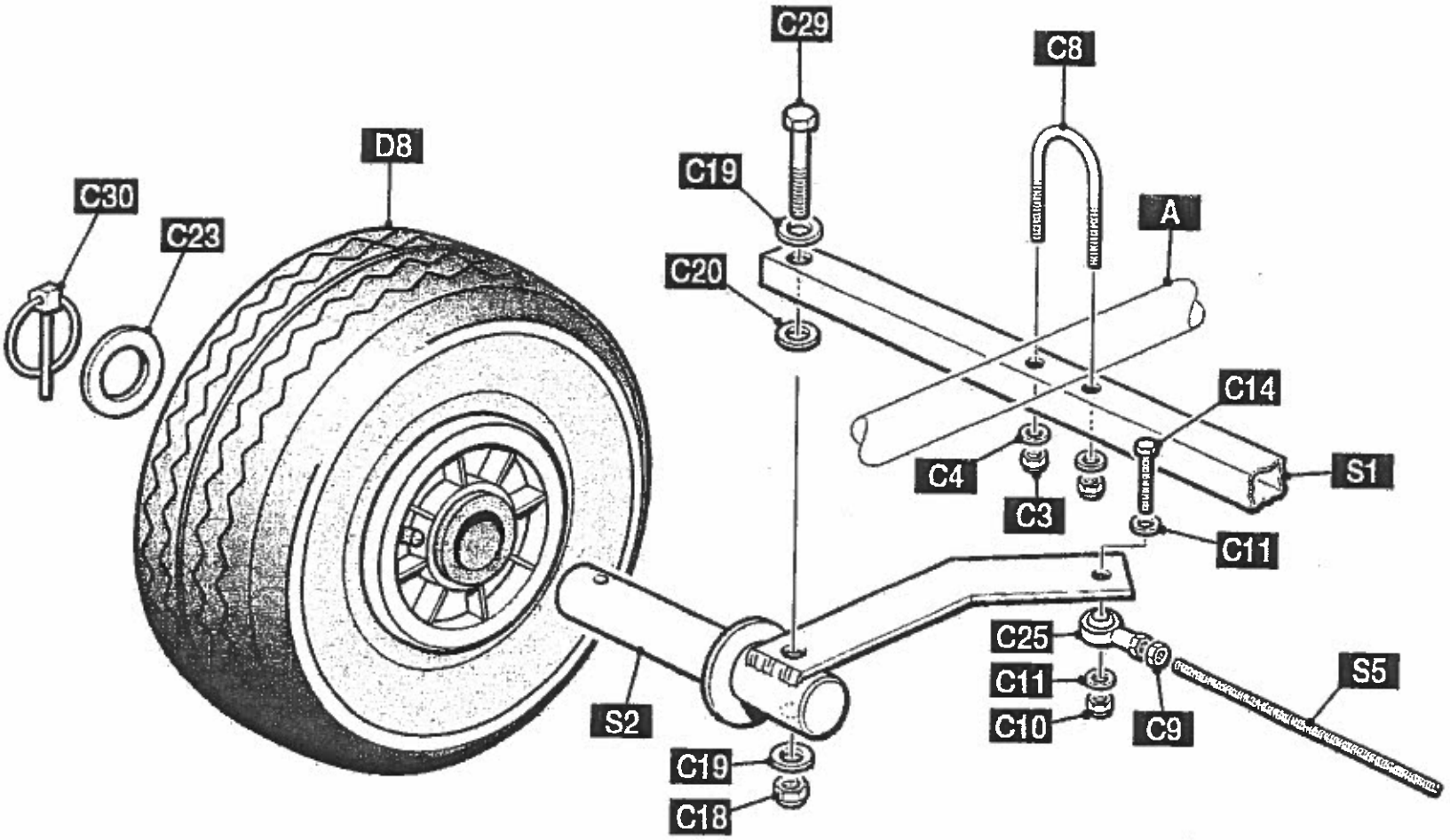
- Have a go at test fitting the wheels. Slide them onto the tube part of the stub axle and follow with C23/C30. Be sure to use the correct wheels as marked (D8 - not the driving wheel – which is different from the other three!)

Handy Tip

When you come to finally fit your wheels, put a small amount of oil inside the centre of the wheel to lubricate the bearings. **You will go much faster!!** You can also smear a little oil on the joints between S1, C20 and S2.

Did you know?

The axle parts of the Goblin have been powder coated. This is tougher than normal paint, and is applied as a dry powder, before being baked in a special oven. Motorbike frames and Rally car chassis' are often powder coated.

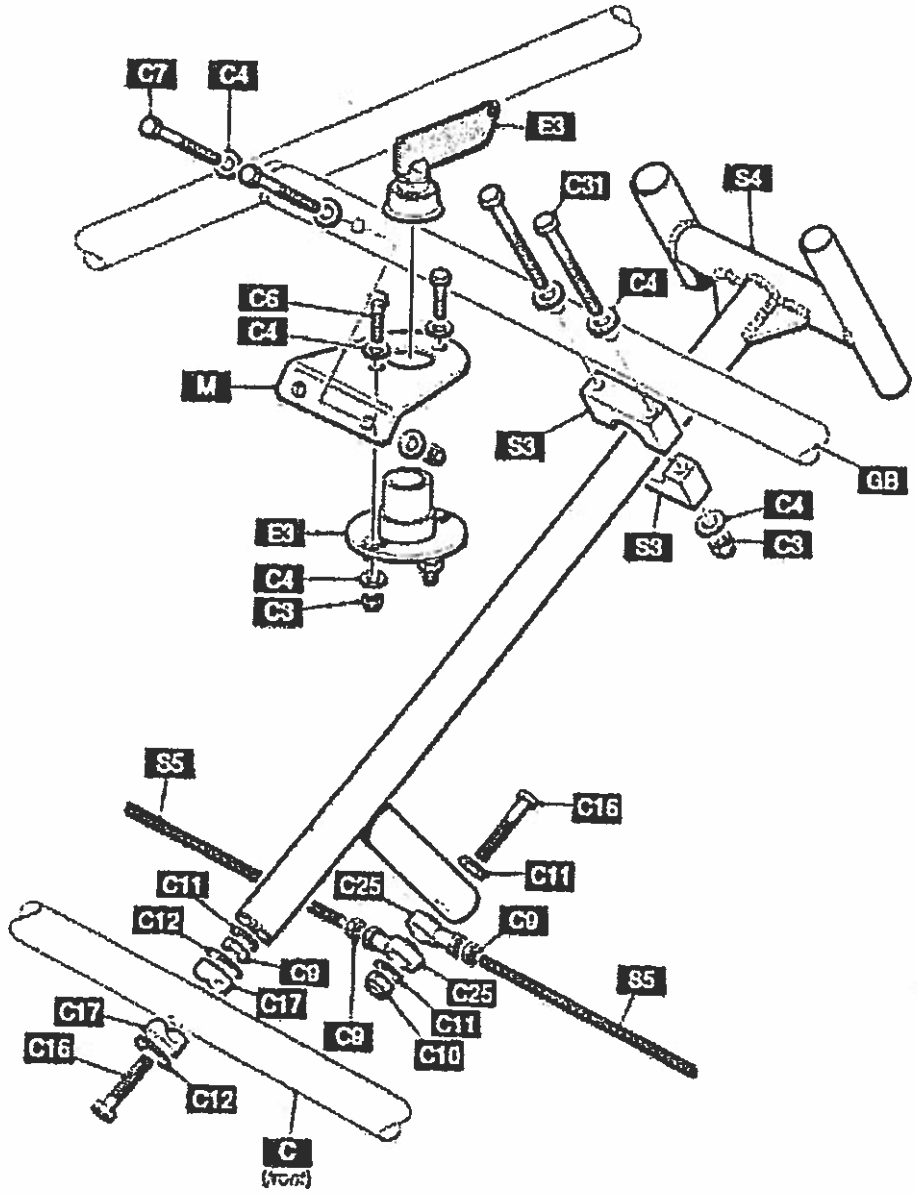

C29
C8
D8
C19
C30
C23
A
C20
C14
C4
S1
C3
C11
C25
S5
C11
C10
C9
S2
C19
C18

Notes for the Steering Assembly Team

- The steering column is also your steering wheel, and transfers your arm movement to the front wheels.
- Assemble the small components onto the front C tube as shown. Tighten the nut (C9) against the large washer (C12). Screw the whole steering column onto this bolt (C16), until it is close to the washer (C11) allowing not much more than 90 degrees movement left or right.
- Fit the plastic (nylon) column support block (S3) exactly as the diagram shows. If the steering column angle is not correct, carefully twist the front C tube using **both hands** until correct. You might like to put a drop of oil inside the plastic block. The steering should be smooth with no play in it. Tightening or loosening the mounting bolts on Part S3 can alter the resistance.
- Now you can take the two S5 parts – the steering linkages, screw a nut (C9) on both ends and then wind on the rod end bearings (part C25) to each end.
- Make sure the steering 'wheel' is in the central position, and both front wheels are pointing straight ahead. If they are not, adjustments can be made by winding the connecting rods S5, into or out of Parts C25. **However, at least 10mm of S5 must be inside Parts C25.**
- When satisfied, tighten up the fixing bolts at both ends of the steering rods, and the back nuts (C9).
- Fit the drivers isolator line M up with the two remaining holes. Slide a C7 in to each of the holes using a C4 washer either side and tighten using a C3 on each bolt.
- Then you can place the isolator in the larger diameter hole and bolt it to plate M using two C6 bolts, four C4 washers and two C3 nuts.

Handy Tip!

Friction is one of the biggest forces slowing your Goblin down. If your front wheels are not parallel to each other you are creating unnecessary friction which can sometimes feel as bad as driving through sand.


C7
C4
E3
C31
S4
C6
C4
C4
M
S3
GB
E3
C4
C3
S3
C4
C3
S5
C16
C11
C11
C25
C12
C9
C9
C25
S5
C17
C11
C9
C10
C17
C16
C12
C
(TOP)

Notes for the Rear Axle Team (Disc Brake Side)

- The rear axle on the Goblin is quite a long job to assemble, and it is important that it is correct, as everything must be aligned for the car to work at its best. Most of the axle can be assembled off the car. **It is a good idea to use a thread-locking compound such as 'Loctite Threadlock' on components like C1, C22 and C36.**

- The right hand side has a wheel the same as the front wheels (D8). The axle on this side has two small holes towards the end.

- Slide A7 on to the axle until it lines up with the inner most hole. Tap a roll pin (C24) through the holes, you could line them up with a small drill bit or similar, also try using something steady to hold the axle whilst you do so, a vice would be ideal, but even leaning on some wood would work to support it whilst you tap the pin in!

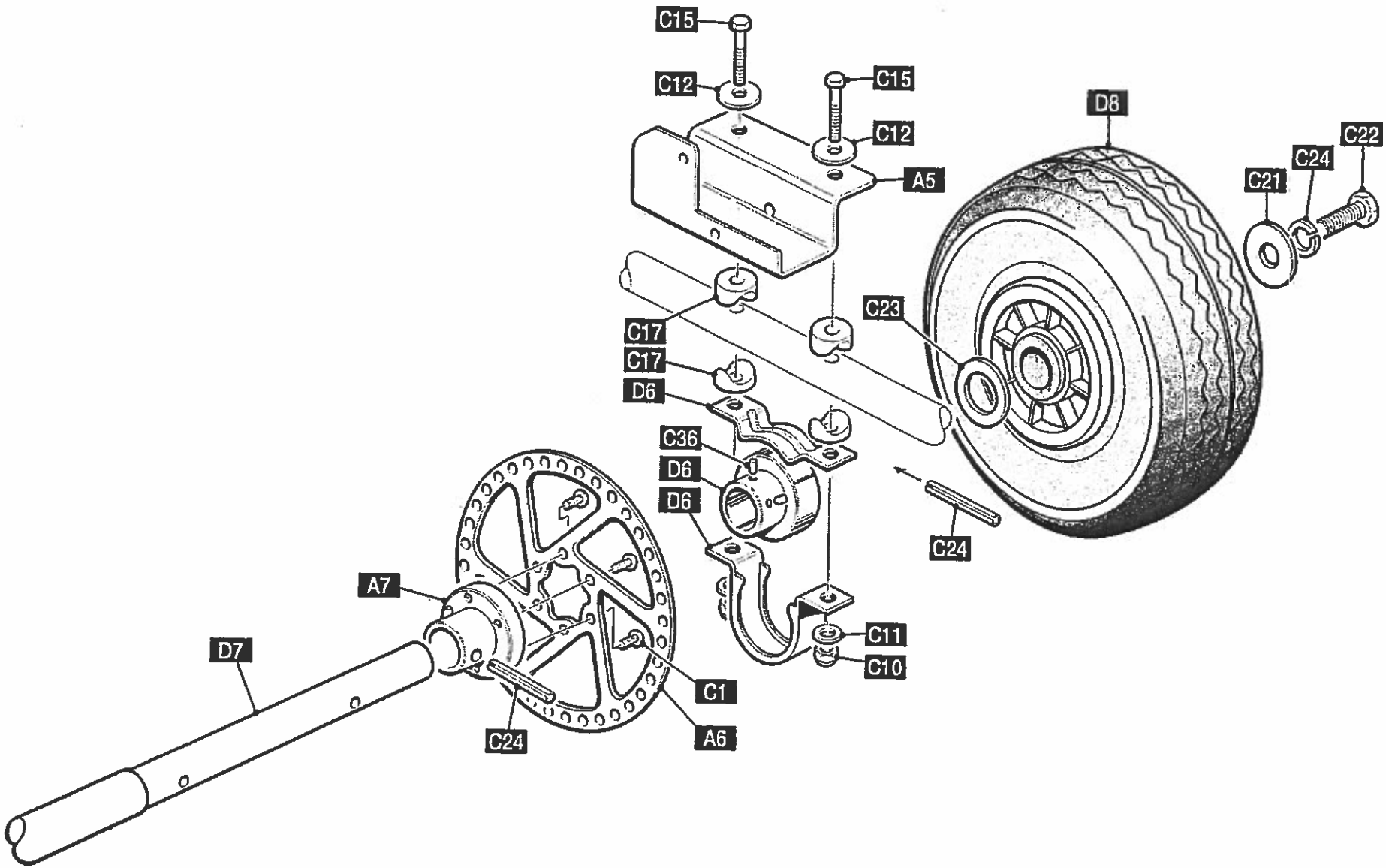
- Now attach the brake disc (A6) to A7 using the C1 screws, doing this after tapping the roll pin in will prevent you damaging the break disk! The disc will have a directional arrow, so make sure it is facing the right way, remember it will be turning with the wheels.

- Slide on the centre part of the bearing (D6). Don't tighten its small grubscrews (C36) onto the axle just yet.

- Tap another C24 pin through the outermost hole in the axle, until it protrudes an equal amount from both sides. Again try and support the axle whilst you do this.

Did you know?

The rear axle was made using solid Aluminium and has been shaped by a **C**omputer **A**ided **M**anufacturing (**CAM** or **CNC**) machine which is programmed by a person on a computer to create a more accurate product, but within a shorter space of time than it would possible to, by hand.


C15
C12
C15
C12
A5
D8
C22
C24
C21
C23
C17
C17
D6
C36
D6
D6
C24
A7
D7
C11
C10
C1
C24
A6

Notes for the Rear Axle Team (Driven Pulley & Wheel Side)

- As you will now have the disc of the disc brake on the axle, take care not to put much weight on the axle or you may bend the disc slightly.

- Working from the other end of the axle, slide on the taper lock bush (D4), with the smaller diameter end of the taper facing outwards. Very loosely place the large pulley (D3) over D4. The two 'half-holes' that are not threaded on D4 should correspond with the two threaded holes in D3. Loosely insert the grubscrews (C38) into the corresponding holes.

- Now make sure you put the drive belt (D5) around the axle as you will not get it on once the axle is fitted! It is always a good idea to pop a spare one on there too; you can tape it to the axle in between components so it is a ready spare!

- Slide on the bearing D6, exactly how you did it on the Disc Brake Side.

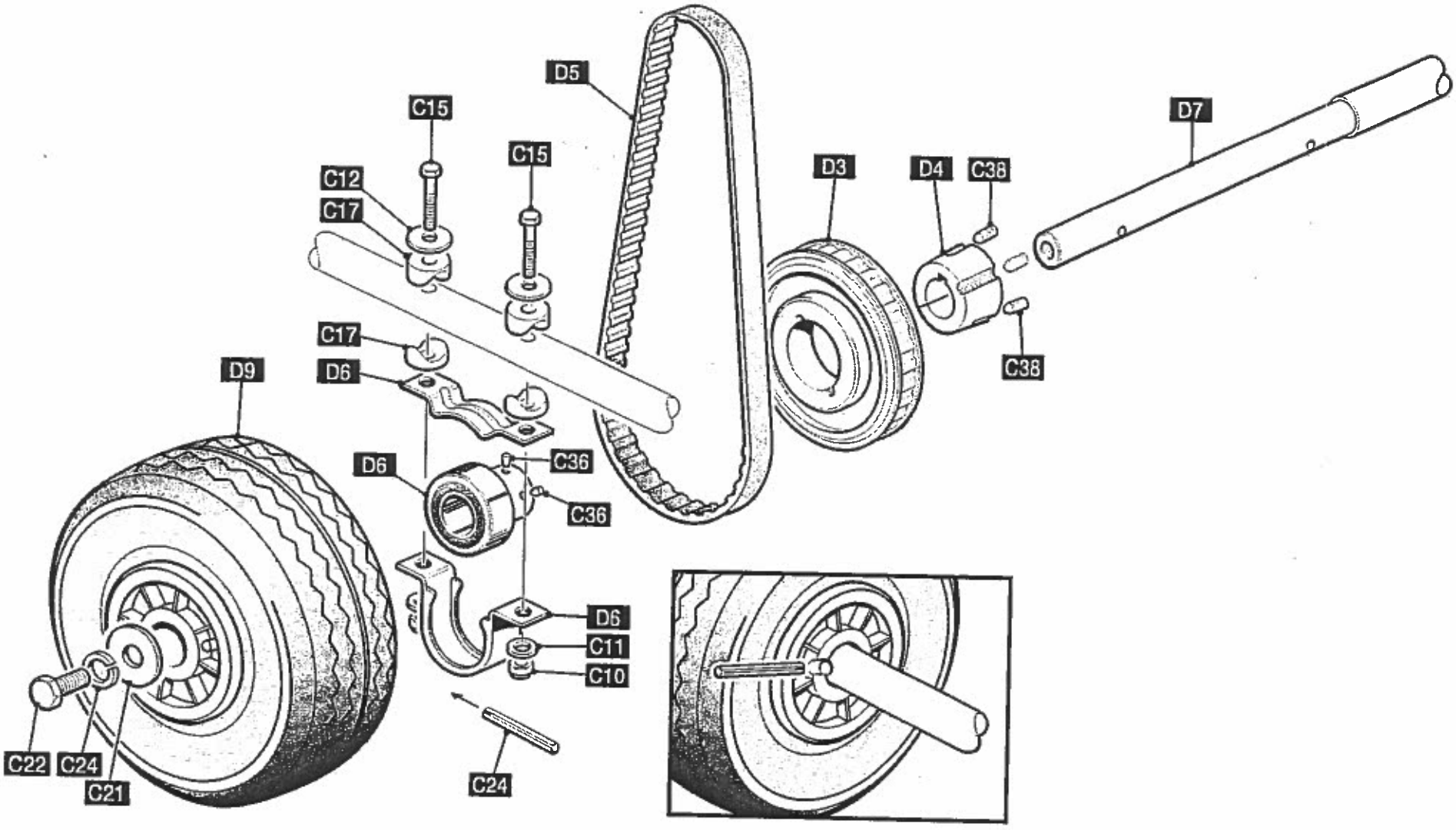
- Tap a roll-pin, C24, through the outer hole in the axle until it protrudes an equal amount each side. **This pin locates in the slot in your drive wheel (D9), and transmits the drive from the axle to the wheel.**

Handy Tip!

To loosen the taper lock bush, D4, remove the two grubscrews C38, and tighten one of them into the third hole (the threaded hole in the taper lock bush D4). This pushes off the pulley and should allow you to move D4.

Did you know?

Changing the D3 pulley for a larger pulley (with more teeth) would 'gear' your car down, and make it slower. A smaller pulley would make it go faster – just like the sprockets on a bicycle, or the gears in a car gearbox.
Remember though that changing any mechanical parts on the Goblin is banned!

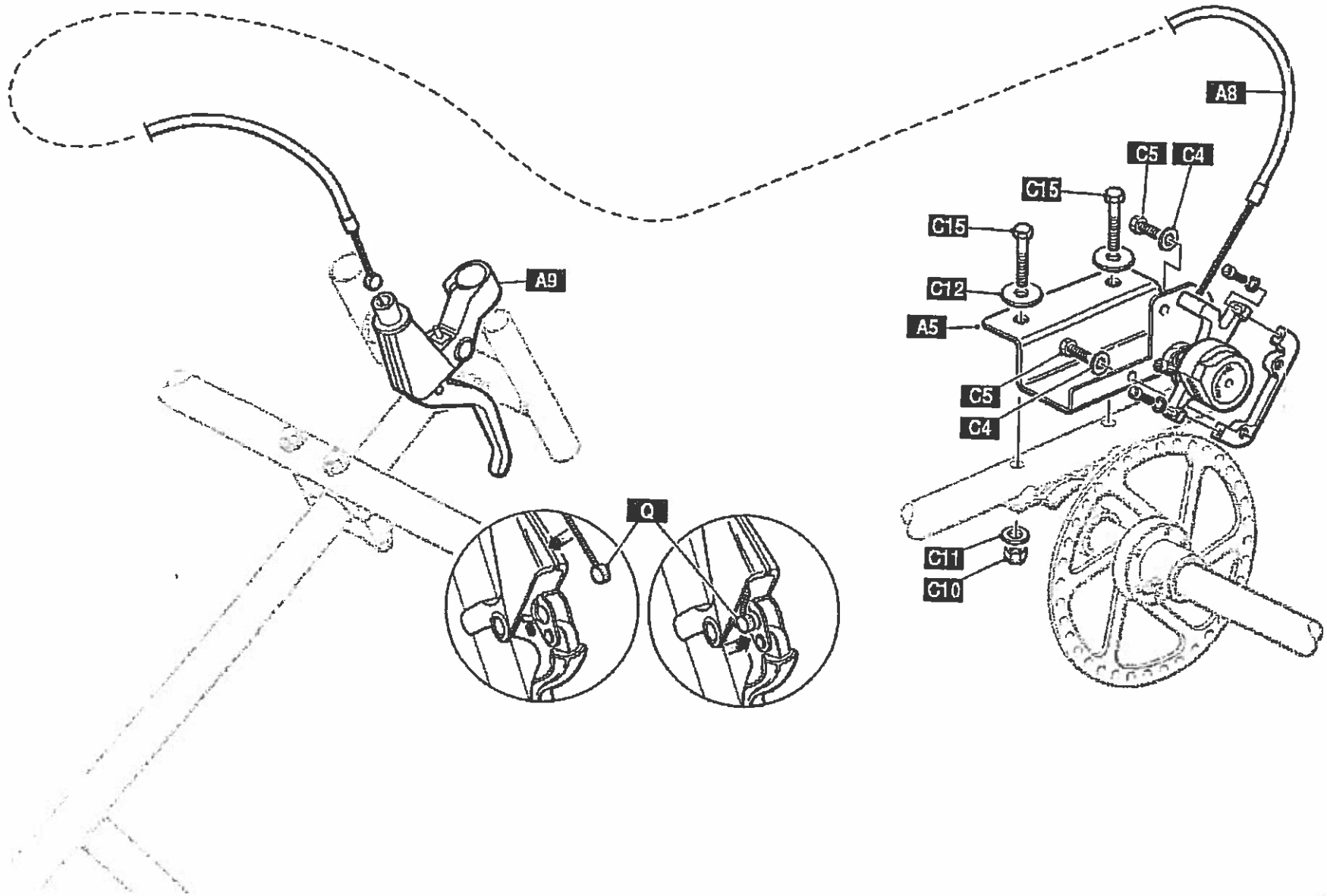

D5
C15
C15
D7
C12
C17
D3
D4
C38
C17
D9
D6
C38
D6
C36
C36
D6
C11
C10
C22
C24
C21
C24

More Notes for the Rear Axle Team (Fitting to Chassis)

- The brake calliper (A4) comes as two parts and will need to be fitted together as shown, using the screws also found in the same packet. Fit the completed brake calliper to its bracket (A5) exactly as shown in the drawing. The C5 front screw is best tightened through the hole in the opposite side of the bracket, and must be tightened now.
- Start on the drive (large pulley) side, pushing the C15 bolts through the chassis from the top, with components C12 and C17 in place. Place the flat part of the bearing (D6) housing onto the bolts. Then place the centre part of the bearing onto this (on the axle), and clamp in place with the final part of the bearing housing and then C11 and C10 underneath loosely – **do not tighten these yet.**
- Repeat on the disc brake side, ensuring that the brake caliper and bracket are fitted as shown; above the chassis tube A. **Locate the disc brake on the axle between the brake pads in the caliper. The bearings might need moving to be tightened in the correct position.**
- Now tighten up the bearing clamping bolts (C15). Move the axle side to the side gently until it is perfectly aligned in the centre of the brake caliper (A4). **Finally, tighten the bearing grubscrews (C36).**
- You can now fit the wheels as shown. Make sure the drive wheel (D9) has the slot in it **properly located** on the roll pin (C24) at this end of the axle, and you use the spring washer (C43). At the other end, **make sure you have a washer** (C23) between the roll pin and the wheel (D8) – this wheel must be free to rotate. Ensure that the screws C22 are tightened properly – you don't want the wheels falling off!

Handy Tips!

A race can be won or lost on the extra friction caused by a rubbing disc brake – spend time aligning it carefully!


A8
C5
C4
C15
C15
C12
A5
C5
C4
A9
Q
C11
C10

Notes for Connecting up the Brakes

- By now the brake disc and caliper should be in their final positions.
- Fit the Brake Lever (Part A9) to the steering column, and tighten in your preferred position.
- The brake cable fits to the lever just as it does on a bicycle. Place the end of the brake cable (Q) through the hole in the brake lever (A9). Continue feeding part Q down through the lever, squeezing the handle may make this process easier. Slot part Q into the small hole at the base of the handle for the brake lever. When squeezed, the brake should now pull on.
- Run the cable from the lever down the top right-hand chassis tube (A), keeping all bends open and gentle. Make sure the first bend is big enough to allow the steering to move fully both ways.
- Fix the cable inner at the caliper end using the small screw C42, trapping the cable under its washer. The outer should be located in the caliper body.
- If the cable needs shortening, use a pair of strong wire cutters to cut the inner and outer one at a time.
- Check the function and adjust to suit. When all is ok, tape or cable tie the cable to the chassis tube.

Handy Tip!

The most important thing to remember is that any friction will slow down the Goblin. If the brakes are rubbing on your bicycle, it makes it more difficult to pedal and you might not go as fast... and it is just the same on a Goblin – rubbing brakes will make the motor turn slower, and the car will then go slower!

Notes for the Motor Mounting Team

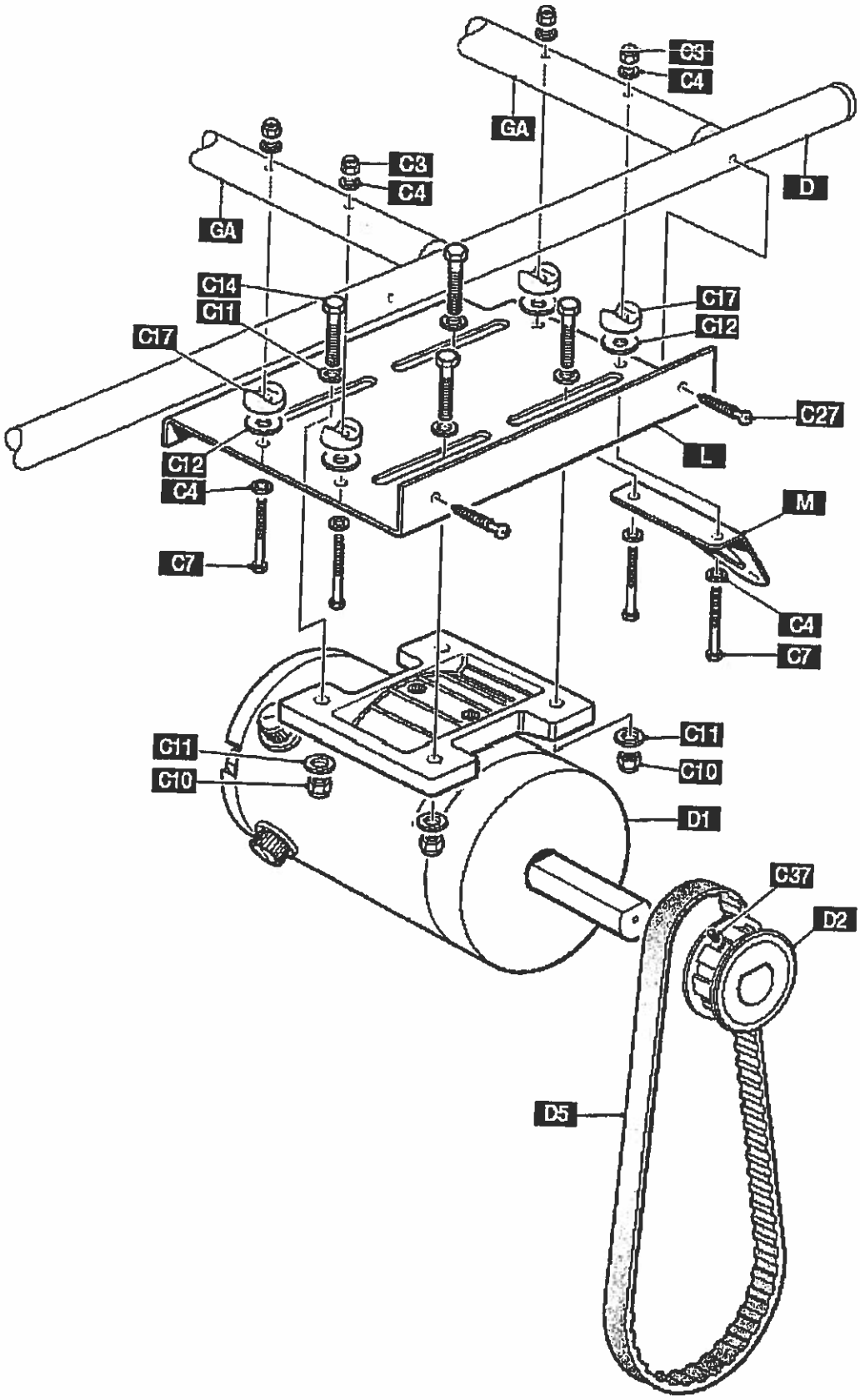
- First of all, bolt the motor mounting plate (Part L) to the GA tubes using the components shown. **Remember that the battery isolator mounting plate (Part M) uses the same fixings at the rear of the Part L.**
- Insert the long screws (C14) into the motor plate slits as shown, using washers (C11). Fix the motor to part L using the washers (C11) and bolts (C10) as shown.
- Slide the small pulley (Part D2) onto the motor shaft. This may take a bit of force and a bit more than sliding the part, be careful not to damage the pulley and use something softer than the part so not to damage it to 'tap' it in to place. Keep going until it is close to the main motor case. Lock the small grub screw onto the **flat part** of the motor shaft, the closer to the motor casing the better, but don't let them touch!
- When both pulleys are lined up perfectly (see the Handy Tip below), finally tighten the grub screws in the taper lock bush (Part D4), and stretch the belt (D5) on to the pulleys. Tension the belt by sliding the motor forwards or backwards on its screws (C14), until you can't squeeze it more than 10mm between thumb and first finger. **When viewed from the rear the belt should be vertical and the motor horizontal for best results!**

Handy Tip!

Line up the small pulley exactly above the large pulley, by using a straight edge. Move the pulleys on their shafts to find the best position. If the pulleys are out of line it could cause the belt to break, or extra friction, which will make your Goblin slower than some of the others.

Did you know?

The electric motor on the Goblin is usually used in an electric powered wheelchair! (Although the Goblin is of course a bit faster than a wheelchair!!)



Please Note that the motor shaft should be pointing towards the left side of the chassis.

Notes for Fitting the Battery Box

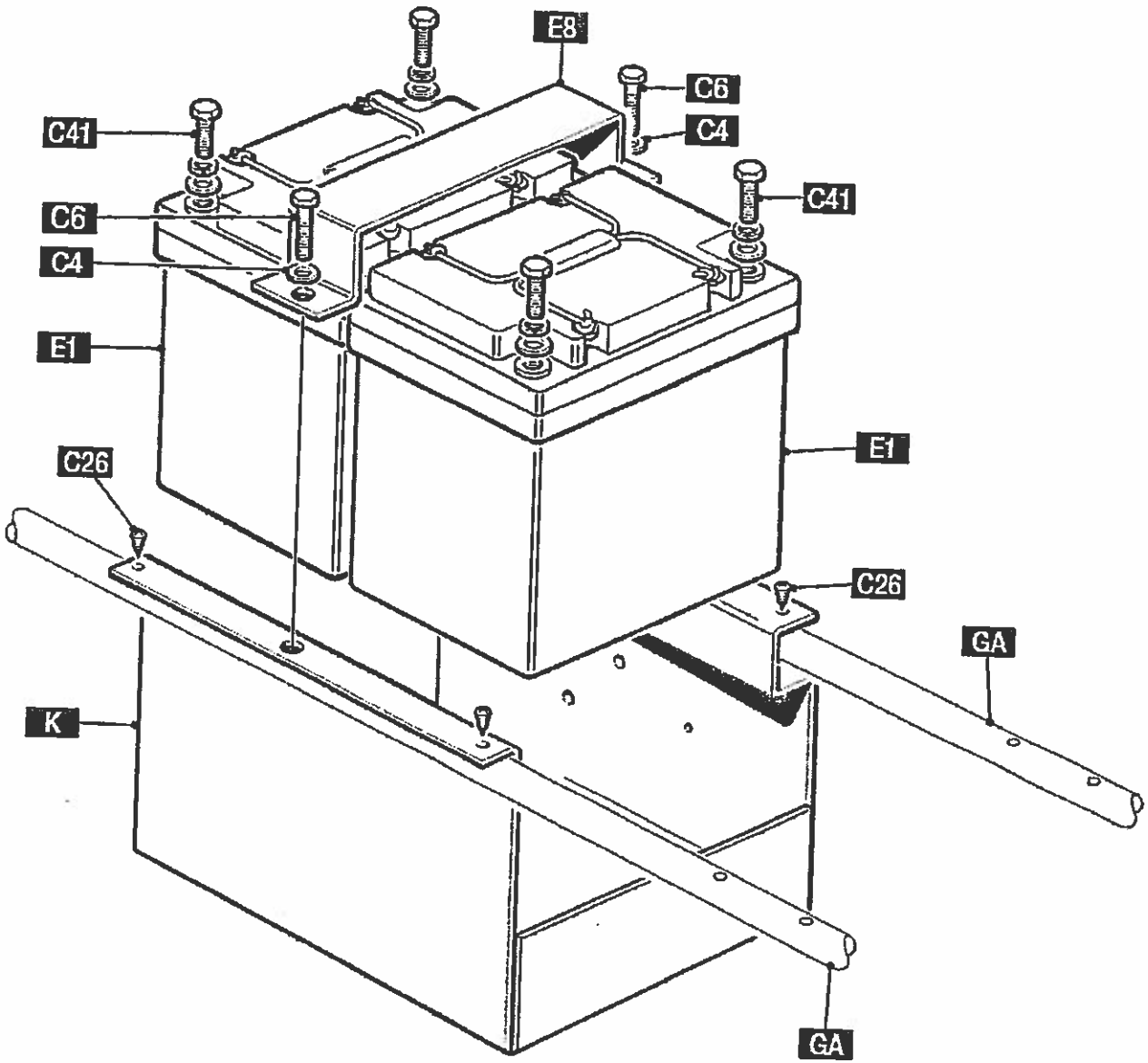
- The battery box (Part K) is easy to fit! You might like to fit the electrical components to it first as shown on the electrical diagram (after notes for wiring team); it will be less fiddly off of the car.
- Slide the box in from below the two rear GA tubes, squeezing the box slightly to allow it to hook over the top of the tubes. It should be positioned close to the right hand A tube.
- Carefully drill the fixing holes in the GA tubes, using a drill bit and the six holes in the battery box as guides. It may be a good idea to pop the battery clamp bolts in first (C6) loosely so the box stays still and your holes remain lined up, to be as accurate as possible screw each C26 screw in after drilling the hole, just loosely for now. **Safety First - Always wear goggles and gloves when drilling.**
- Once complete you can tighten each of the screws.
- Then you are ready to put the batteries in!

Handy Tip!

During a wet weather race, water may cause some of the electrical components to not function correctly. You might like to design a plastic cover to keep them dry – it could be part of your bodywork.

Did you know?

You must never place anything across the top of the batteries. Metal objects touching both battery terminals at the same time will 'short-circuit' the battery. Be especially careful when you are transporting your batteries.


E8
C6
C4
C41
C41
C6
C4
E1
E1
C26
C26
GA
K
GA

Notes for the Wiring Team

- Fix all the Parts to the back of the battery box (Part K) first, looking at the main drawings for positions. See wiring diagram which would have come with your instructions (on the CD).
- Connect the wires in order – start with the wire labelled *A*! The wiring diagram can be found in the documents you received with your Goblin!
- Secure the long wires *H, J, F and L* to the top chassis tube (Part D). To do this you can use cable ties or sticky tape.
- Make sure you leave enough wire for your steering wheel to turn both ways when the *H* and *J* wires are connected.
- When all the wires are connected, get your teacher to lift up the back of the car carefully, and press the button! If all your wires are connected correctly, and the Drive System is complete, the wheels should turn!

Handy Tip!

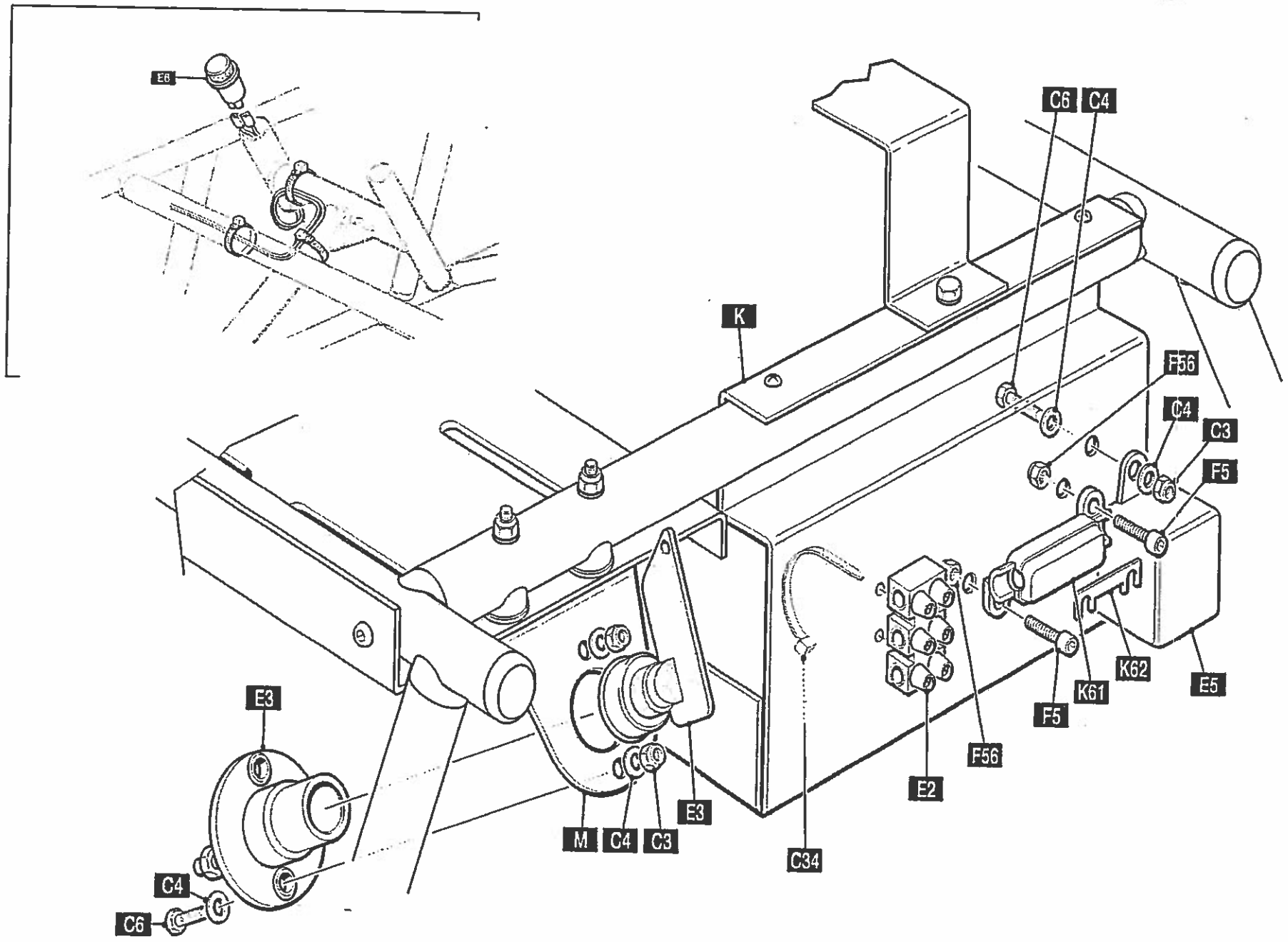
With your two **12 volt** batteries connected together as the wiring diagram shows, they are working in SERIES. This means that the wires coming out of them are using power from both, and you get **24 volts!**

Because your motor is designed to use **24 volts**, it works at full speed with the batteries connected like this.

If you only connect up one of the batteries you get **12 volts** and the motor works at **half the speed.** This makes the car move at half its usual speed, which can be great for test-driving!

Did you know?

Part E5 is called a relay. It is basically a clever switch which means only small wires need to go to your Push Button. Road cars have loads of relays in them – they switch on things like electric windows, sunroofs and locks.


E6
C6
C4
K
F56
C4
C3
F5
E3
C4
C6
M
C4
C3
E3
C34
E2
F56
F5
K61
K62
E5

24 Volt Battery Charger Suitable for Goblin Batteries

Available from Greenpower

Instructions:

Disconnect wires A and G from the batteries.

Leave wire F between the two batteries connected.

Do not plug charger in until you have:

- Clipped the black lead from the charger to the free negative terminal.
- Clipped the red lead from the charger to the free positive terminal.

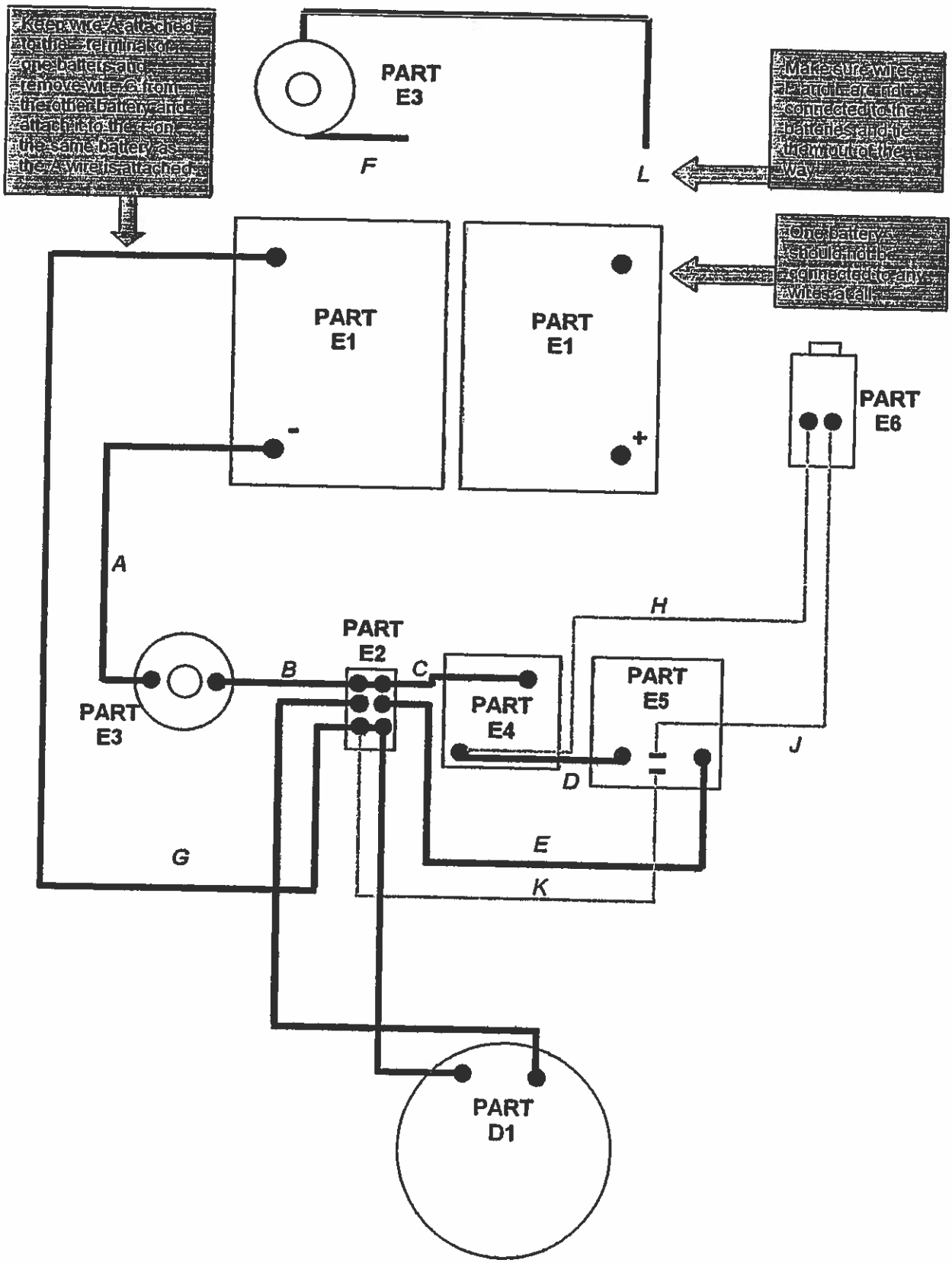
Plug in and switch on the charger.

When the light is green the batteries are fully charged. If you wish, the charger can be left on to switch itself on and off when the batteries require a top up. Alternatively plug in every few weeks to keep the batteries in perfect condition.

Any questions, please e-mail helpline@greenpower.co.uk

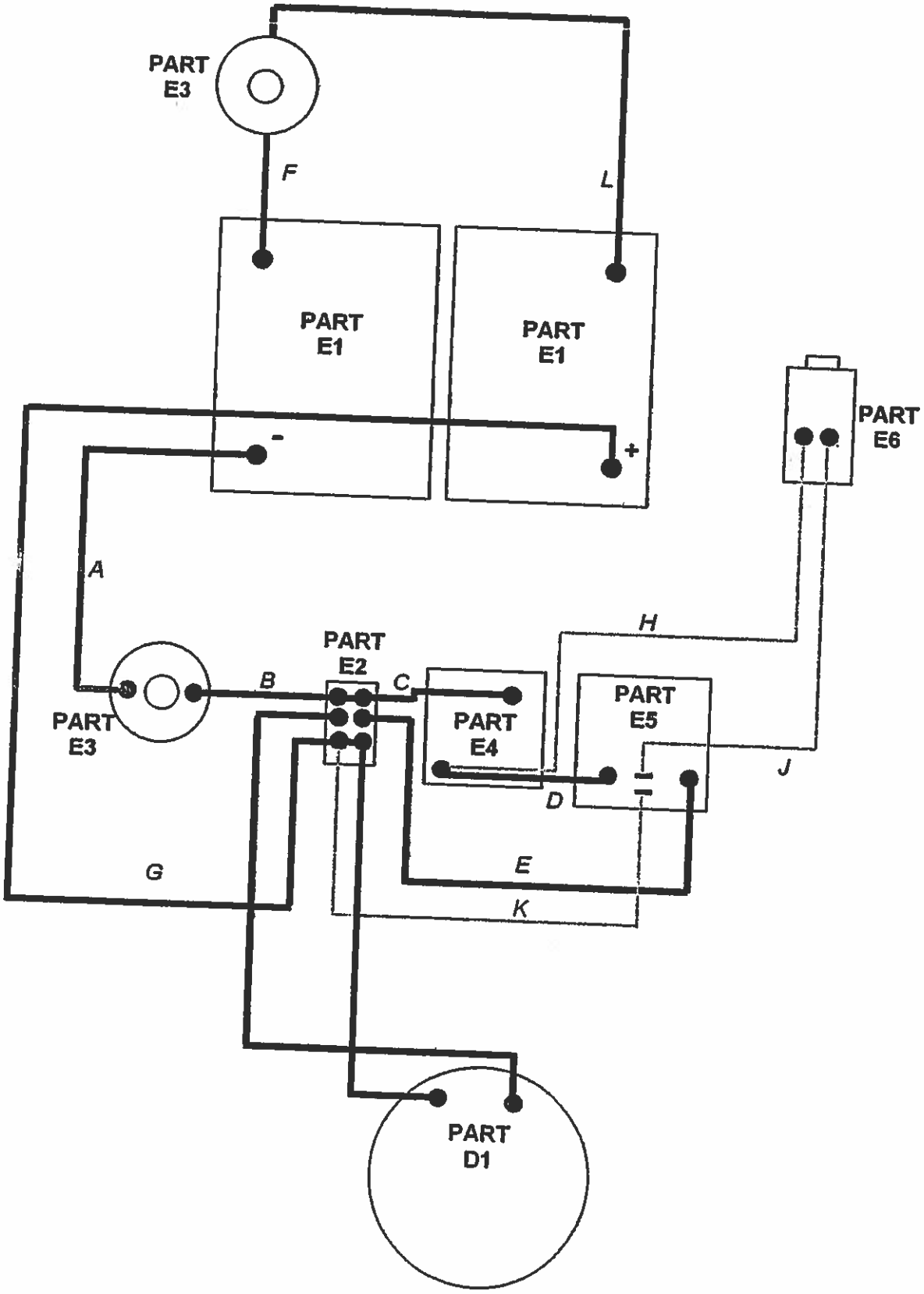
Greenpower
INSPIRING ENGINEERS

Goblin Wiring Diagram for single battery use



Greenpower
INSPIRING ENGINEERS

Goblin Wiring Diagram



Notes for Fitting the Floors

- The front floor panels (Parts N) also limit the amount of steering movement, so hold them in place before fixing them in place to check the steering is satisfactory. Attaching them against the F tubes is ideal.
- Then place the central floor panel (Part P) in position, with the front end of it overlapping the front floor panels.
- Carefully drill fixing holes in the C tubes, using a small drill bit, screw in the self-tapping screws loosely as you go.
- Tighten all the screws once all the holes have been drilled.
- Tape over the floor joints with duct tape or similar.

Handy Tip!

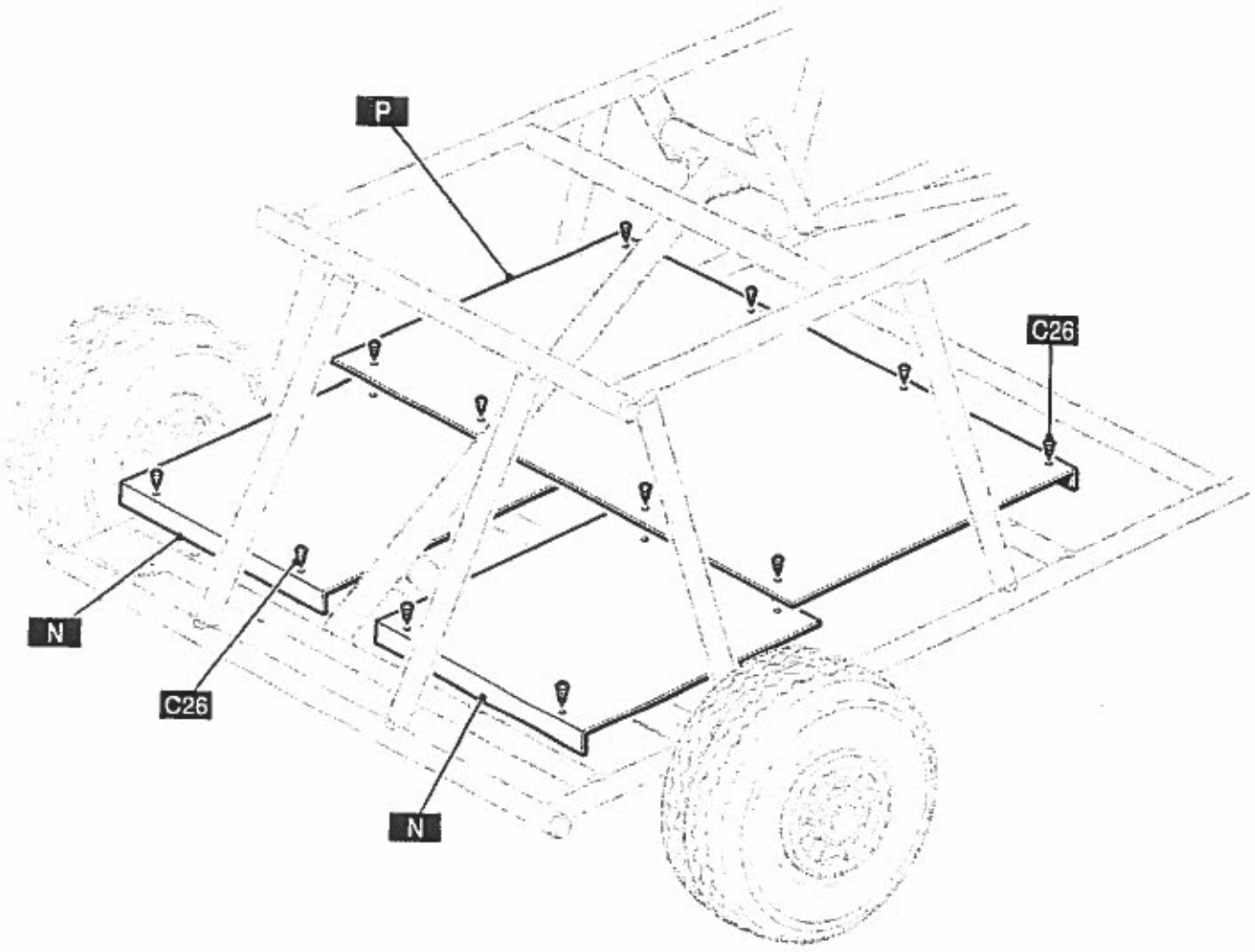
Carefully measure where you need to drill the holes for fixing down the floors – try and make them equally spaced, as it will look more professional! Also make sure they are central on the tube to provide a solid fixing.

If you find the drill bit slips across the floor panels when trying to start drilling the holes, put a bit of masking tape over the area where you will be drilling – this gives the drill bit some grip.

Did you know?

Although Goblins are limited to 15 miles per hour, they use the same motor that secondary schools use to power their own designs of Greenpower 'Formula 24' cars at over 40 miles per hour!

Will you be joining a secondary school that enters Greenpower Formula 24?! Check out **www.greenpower.co.uk** to see which schools are involved.


P
C26
N
C26
N

Notes for Fitting the Roll Bar

- The roll bar is a safety feature, which hopefully will never be tested in any car. (It also makes a very handy pushing point for starting the car!).
- To mount the roll bar place the roll bar on the D tubes near the back and push a C15 through each side of A2 (ensuring that C12 and C17 are present) as shown in the diagram on the next page.
- Tighten the C15 to secure the roll bar in place.
- The Roll Bar Brace (A1) is fixed using two chassis screws (C35), on in the top, and one at the bottom.

Handy Tip!

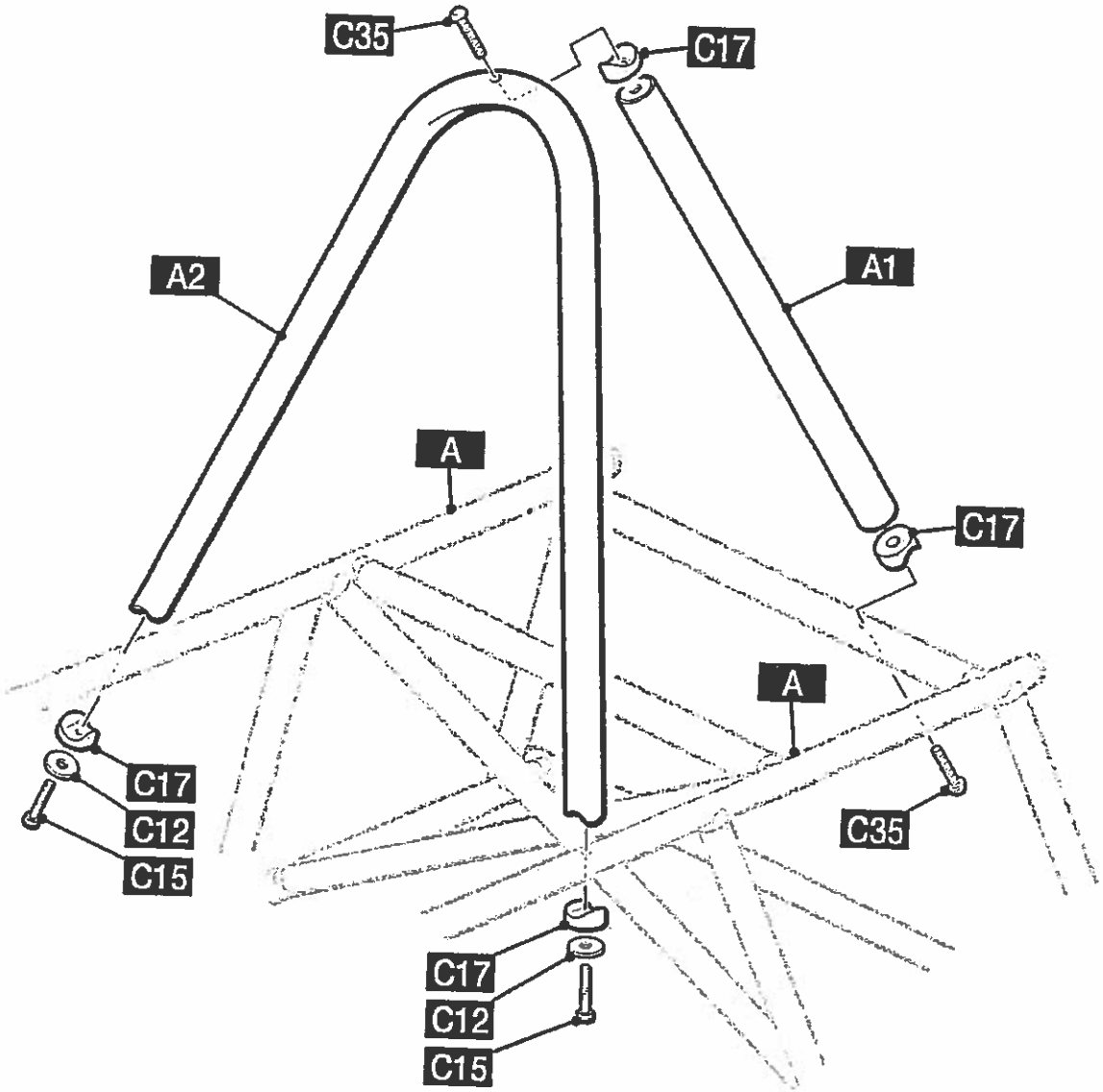
With the roll bar removed, you should find the Goblin will fit in the back of most estate cars.

Did you know?

Have you been wondering whilst building the car what a **nyloc nut** is?

Well, nyloc nuts are used in places where a normal nut might come undone by itself due to vibrations, or in places where it is extremely important that the nut doesn't come undone. An example would be on the steering mechanism of your Goblin, or anywhere in an aeroplane!

Have a look at one of the nyloc nuts on your Goblin, such as Component C10, and notice the small blue ring around the inside of the nut at the top. This is made of the plastic nylon, and grips the thread of the bolt you are using it on, preventing it from being undone without using tools.


C35
C17
A2
A1
A
C17
A
C17
C12
C15
C35
C17
C12
C15

Notes for Fitting a Seat

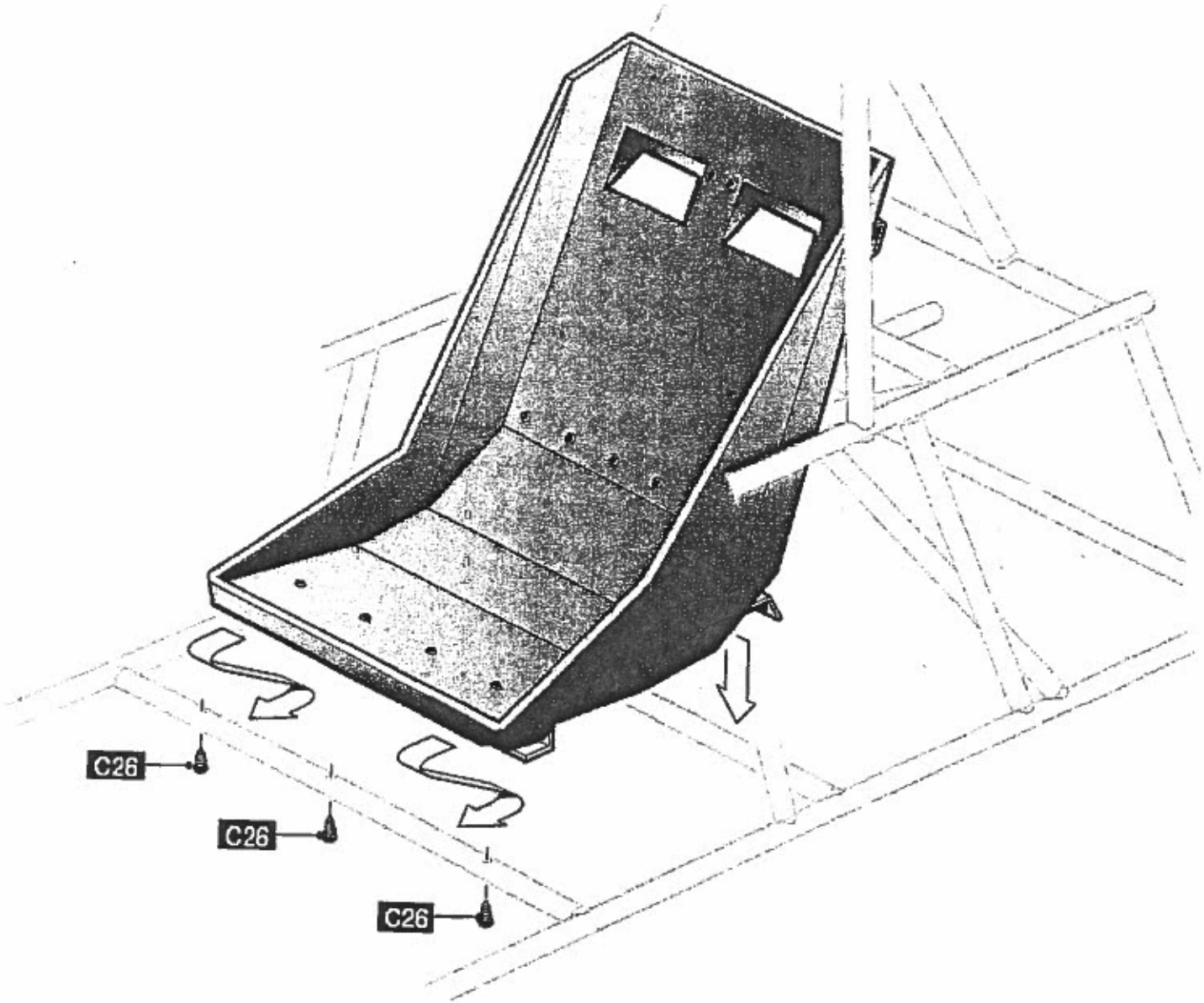
- The Goblin kit comes with black plastic seat which is very easy to fit. The two silver brackets underneath the seat fit over the C tube in front of the H bars and the front of the seat fixing to the 3rd C tube from the front.
- The seat should sit with the back resting against the diagonal H tubes and the base resting on the C tube below.
- Fix the front of the seat using 3 C26 screws. The C33 Q clips used to fix the rear straps of the 4 point harness prevent the seat from moving side to side.

Handy Tip!

Test all the potential drivers in the seat before finally fixing it down. Make sure they can all reach the controls safely. Smaller drivers may need a bit of padding behind their back.

Did you know?

Primary schools have been building and racing Goblins since 2001. There are now hundreds of them right around the country, from Aberdeen in Scotland to Kit Hill in Cornwall.


C26
C26
C26

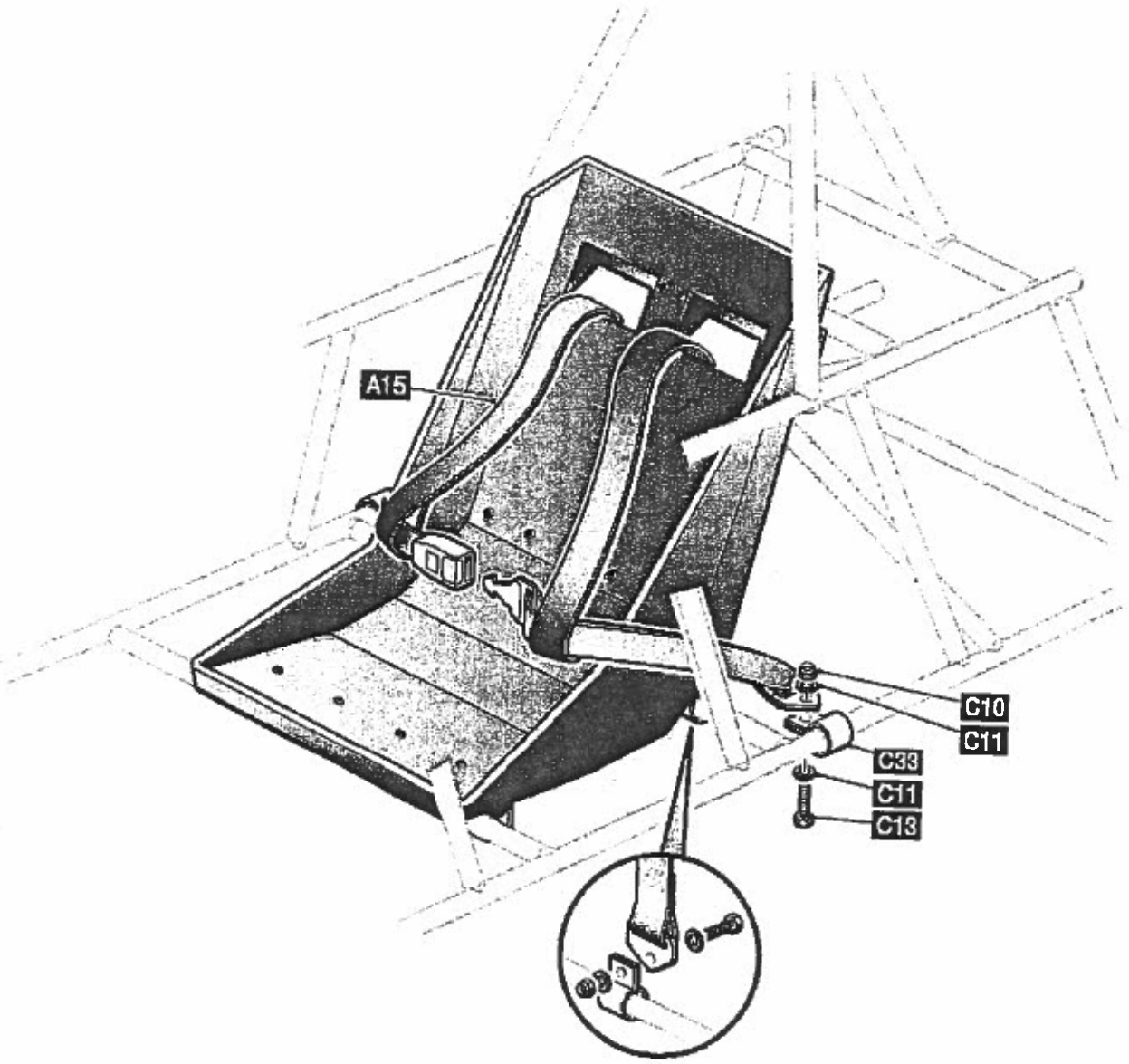
Fitting a Seatbelt

- The rear straps of the harness should run behind the H tubes, and thread over the C tube at the back of the seat.
- Component C33 is used to fix all four points, with the fixings as shown. C33 will need opening up with a pair of strong pliers, then closing back round the tubes if you didn't place it on earlier when building the chassis. **Do not drill holes in the tube to fix the seatbelt.**
- The clips supplied may not tighten up fully on the tube, but they will not move once the driver is strapped in.
- Each driver **must** have the straps adjusted to suit their size whilst driving.
- Please note the C33 on you're a tube will be in front of the C tube, this isn't clear in the diagram, on your Goblin there isn't space behind!!

Buying Spare Parts

You can order spare parts from us at Greenpower, either check out our website or send your order to:

E-mail – sales@greenpower.co.uk
Fax – 01243 553498
Post – The Greenpower Centre, Arundel Road, Fontwell, West Sussex, BN18 0SD
OR order some items online at www.greenpower.co.uk


A15
C10
C11
C33
C11
C13

Notes for the Bodywork Team

- The bodywork on a Goblin should be decorative, and we leave it to your imagination to do what you want with it!
- The most popular choice of bodywork is 'Correx' or 'Corroflute' (corrugated plastic) which is used to make estate agents For Sale signs etc. But think about alternatives such as foam board, cardboard, Papier-mâché, aluminium sheet or even very thin plywood. **Keep it as light as possible!**
- Try to fix your chosen bodywork on with duck tape or cable ties, as more holes in the chassis tubes will weaken them.
- Be creative and make something really different – you want to stand out on race day!
- If you have sponsors for your car, remember to incorporate their logos into the bodywork design.

Handy Tip!

Don't forget you will always need quick access to the big battery isolator switch, and don't make it difficult for the driver to get in and out – you will need to practise pitstops too.

Did you know?

We have seen Goblins with many different bodywork coverings... From flattened coke cans to toilet rolls!!! At our events we have prizes for the best bodywork and greenest bodywork, so be creative!

Test Driving and Driver Training

- If you are satisfied the car is fully set-up, try giving it a test drive! The bodywork need not be fully in place for this.
- To start, train each driver in the handling of the Goblin, by pushing the car around quickly with them in the car. Let the driver get used to the steering, and function of the brake. Put out some obstacles and practise turning in and out of them.
- When each driver has tried this, you can conduct the first powered runs. It is important that these take place on a large tarmac or very hard grass area.
- It is usually best to run the car on one battery at first, i.e. 12 volts, until the driver is used to the handling and brakes. This makes the car run at half its usual speed. To operate the car like this, simply disconnect wire F completely, and connect wire G to the positive (+) terminal on the same battery that A is connected to the negative terminal (-). Please see the diagram included with your Goblin documents!
- Ensure each driver is wearing helmet, gloves, goggles, and long sleeves and trousers. When the driver is comfortable and there is a clear open area, turn on the battery isolator and give the car a gentle push. It should pull away. If there is a prolonged rasping noise from the belt, it is slipping and requires a little tightening.
- The driver should now practise turning in and out of well-spaced cones or markers, freewheeling when turning. At first, practise using the power only in a straight line, and freewheeling in corners.

Important Safety Notice

As well as wearing all the clothing described above, drivers with long hair **must** tuck it into their helmet.

As we have said throughout this manual, unnecessary friction will slow you down! Go through some final checks before testing, races, and also after each race:

1. Ensure the brake disc **is not rubbing.** If it is, wind the brake pad adjusters in or out, or adjust axle position.
2. Tyre pressures. Inflate to around 30psi – never run the car on soft tyres.
3. Is the belt tension ok? It will loosen after the first few runs and will need re-tightening.
4. Are the front wheel bearings oiled with light oil?
   - Do not use very thin oils like WD40 as they will wash away all grease or oil and end up running dry.
5. Are the front wheels parallel? – check with a tape measure between them front and back.
6. Check the steering movement is free and smooth. Adjust immediately if not.
7. Is the brake functioning correctly? – It should be capable of locking the rear wheel.
8. Ensure all nuts and bolts are tightened correctly, including grub screws C36, C37 and C38.
9. Charge the batteries. Never leave them discharged. (See below).

Important Battery Notice

The batteries are AGM type batteries. This means they cannot leak or spill, and are therefore very safe.

They cannot however be charged like normal batteries. **Only use the slow or trickle charge setting on a battery charger, or acquire a battery charger that is limited to 14.1 volts charging rate.**

Never leave them discharged, and always remove from charge as soon as they are fully charged.

Fault Finding

The most common problem is the motor stopping because the circuit breaker (E4) has tripped. It allows you to re-set it after a few minutes using the red lever. It will trip if there is excessive friction, including running the car on soft ground, or on a very tight course.

If you have any other problems, please contact us:

E-mail - becci@greenpower.co.uk
T – 01243 552305
Ask questions on our forum at www.greenpower.co.uk

Formula Goblin Curriculum

Unit	Post-Assembly: Greenpower Lead Teacher
Lesson Title	Driving Prep/ Safety
Duration	1 hour
Lesson Focus	In this activity, students will prepare to drive the Goblin series car.
Lesson objective(s)	Students will… • identify safety expectations for driving the Goblin car. • adhere to safety expectations when test driving the Goblin car. • summarize the main ideas in an informational text.
Materials	• tally chart on graph paper (or on board) • "The Goblin Safety" from manual (one copy per student) • highlighters • Microsoft Word
Vocabulary	maneuvering, condoned, trousers, adhered, terminals, harness, marshal
Procedures	1. **Guiding Question**: How important is safety when operating a vehicle? 2. **Hook**: Survey students to see how many have driven a vehicle, such as a bike, go kart, golf cart, etc. Create a tally chart using the survey results. Ask your students to list some safety features for each vehicle and identify its purpose. 3. **Close Read Safety** – Provide each student with a copy of "The Goblin Safety" expectations and flag descriptions. Have the students close read the safety aspects of driving the car, such as safety clothing, moving vehicles, exit/entry of the vehicle, etc. Refer to the Goblin manual. Have students highlight and/or underline the key points to driving safety. Divide students into groups and have them create a safety checklist based on the close reading. As a team, compile a team safety checklist using Microsoft Word. **This checklist should be used during each test drive.** (Safety cannot be stressed enough!)
Extension	**1. Safety Equipment** – Begin by asking the students to list the sports equipment they use for an organized sport, such as football or soccer, and for individual sports, such as bicycling, skateboarding, or snowboarding. Ask the students to discuss why both athletes and race car drivers need safety equipment.

IET Formula Goblin
Safety

Building
The Goblin car is designed to be as safe as possible to build. However as with building anything, there are certain safety aspects which should be taken into account.

TOOLS Make sure all children know how to use each tool safely and correctly. They should be wearing the correct protective gear if using items such as drills and should be supervised at all times.

MOVING PARTS The Goblin does include moving parts. The car should never be worked on with the batteries connected. No one should be wearing baggy clothing that may get stuck in moving parts and long hair should always be tied back.

ELECTRICS The batteries are heavy and should not be moved by younger children. All should be made aware that electricity is dangerous and that touching both terminals of the batteries with anything metal will result in a burn.

WORKING TOGETHER The Goblin project encourages students to work as a team. Remember by working in groups or pairs, risk of injury is greatly reduced.

Getting in and out of the Goblin
Always make sure the Goblin is turned off before getting out. The driver should exit from the left hand side (the side without the wires running along the chassis). The next driver should get in from the same side. When exiting or entering the car, the driver should hold on the brake to stop the Goblin from moving. When the driver is in the Goblin, they are in control and no one else should be turning the car on or off.

Testing the car
Make sure the car is tested in a big enough space to allow easy maneuvering with plenty of run off. In order to understand the car better, it is sometimes beneficial for the teachers to test the car before the students do (in private). Please note; the Goblin should never be lifted from the back axle and the button pressed to test if it is working—This is a highly dangerous practice and is condoned by Greenpower.

Spectating
When people are not driving, it is important they are a safe distance away and do not approach the moving car.

Test Driving

Test driving is very important before you compete in an event. Giving everyone time to get used to how the Goblin handles and how to go and stop easily. When using the Goblin, it is important that a number of safety points are adhered to:

1. Always wear the correct safety clothes: Long sleeves and trousers, gloves, full faced helmet, goggles if the helmet doesn't have a visor.
2. Make sure all hair is tucked into either the hat or clothing (if long).
3. Make sure there are no items of clothing flapping which could get stuck in moving parts.
4. Make sure all those who are not driving the Goblin or pushing the Goblin at that point are out of the way, behind a line or barrier. At no point should any of them run towards the car when it is moving or alongside the car.
5. Make sure an appropriately large space is chosen for testing, which allows enough room for full cornering and plenty of runoff space.

Below are a number of stages you can take to ensure the test driving runs as smoothly as possible:

1. First, test drive with no batteries connected at all. Have one driver in the car and two others pushing the car around, start off at a walking pace and then getting quicker. Make sure the driver turns all directions and uses the brakes. Then swap around so all drivers get a turn.

2. Next use only one battery, this means the car will work at about half speed. One child driving and one child giving a 2 step push to get the car going. Make sure the Goblin is driven away from walls or dips and allow the children to turn corners and get used to using the brakes.

3. Finally, set up the Goblin to run on two batteries. Once all drivers have gotten used to the speed, some cones can be set out for the children to practice driving around.

Formula Goblin Curriculum

Unit	Post-Assembly: Greenpower Lead Teacher
Lesson Title	Using a Stopwatch
Duration	1 hour
Lesson Focus	In this activity, team members will learn how to properly use stopwatches and understand the place value of decimals on the stopwatch
Lesson objective(s)	The students will: • Relate a stopwatch to place value in decimals • Read and write decimals to the nearest hundredth • Observe and collect data • Compare and put decimals in numerical order
Materials	• Stopwatch • Student data collection sheet
Vocabulary	Stopwatch, decimals, tenths, hundredths
Procedures	**ENGAGEMENT** • Write 5 decimals to the hundredths place on the board and have students put them in order. Discuss the correct order based on place value and ordering. **EXPLORATION** • Ask the students "What type of career would require using a stopwatch?" Discuss possible careers that use stopwatches. • Make connection between a stopwatch and decimals. • Partner students up to explore a stopwatch. Distribute each team a stopwatch and allow them to examine the features of a stopwatch. **EVALUATION** • Students will practice using stopwatches by timing classmates doing various activities. Example: Allow students to time classmates running from point A to point B. • Have students write their time on a sticky note and submit to teacher • After everyone on the team has recorded their time and submitted to teacher, allow the students to order all the times based on the hundredths' value
Extension	• Video on how to use a stopwatch https://www.youtube.com/watch?v=G4S37csURSs&feature=player • Khan Academy – Place value and ordering of decimals • SoftSchools.com – Ordering decimals • Kidsmathgamesonline.com – Ordering decimals • Math-play.com – Jeopardy game on adding, subtracting, and multiplying decimals

Formula Goblin Curriculum

Unit	Post-Assembly: Greenpower Lead Teacher
Lesson Title	Driver Data Collection
Duration	Varies
Lesson Focus	In this activity, team members will begin collecting data and compare times.
Lesson objective(s)	The students will: • Observe and collect data • Compare and put times in numerical order
Materials	• Stopwatch • Student data collection sheet
Vocabulary	Stopwatch, decimals, tenths, hundredths

Procedures	**ENGAGEMENT**
	• Students will test drive the Goblin. Lead teacher will need to explain the role of the driver and the pusher. The pusher will only be allowed to take a **maximum** of 3 steps before being penalized for the run. The pusher will also need to communicate to the driver when to push the ON (red) button to start the car. The driver will listen for the cue to push the ON (red) button to accelerate. The driver should only push the ON (red) button when the acceleration process has begun in order to avoid grinding the gears.
	EXPLORATION
	• Distribute Data Collection Sheet to all team members. Each student will need to record time of each driver, pusher, event, etc.
	  ○ Due to the limited number of stopwatches, the team members may need to work in small groups.
	  ○ If the team only owns one stopwatch, then either the team can have a student at the start and finish then announce driver time to the team members to record on their data sheets.
	EVALUATION
	• Students will complete a driver data sheet for each event. After completing all the times, students will rank the performance of each driver. This can be used for the interpreting the data activity to determine drivers for the competition.

Extension	• Students will calculate speed of the car. Speed = distance/time

Formula Goblin Curriculum

Unit	Post-Assembly: Greenpower Lead Teacher
Lesson Title	Interpreting Data
Duration	1 hour
Lesson Focus	In this activity, students will use data collection to make improvements to overall car performance (mechanical, electrical, driver, etc.).
Lesson objective(s)	Students will… • determine cause and effect relationships. • analyze complex data and determine patterns. • identify variables.
Materials	• string • various coins • paper clips • index cards • chart paper • "Greenpower Car Depth and Complexity Questions" sheet
Vocabulary	variable, cause and effect relationships
Procedures	1. **Guiding Question**: Why is problem solving important? How do you determine the cause of a problem? What did you learn about problem solving while solving a problem? 2. **Hook**: The teacher will ask the students questions like, "Why would a defensive or offensive lineman on a football team not be an excellent running back? Why would you not select a basketball player to be a jockey in a horse race? Why would a NASCAR driver not put bicycle tires on their car?" 3. **Data Gallery Walk**— Get the data sheets for each event and compare times. Ask the students to walk around the classroom and discuss the data collected from trial runs. Give them time to record variables that may have affected the outcomes of the times displayed on their graphs. Determine the most common variable in relation to better times. Have students identity patterns with the collected data. (Suggested variables may be weight of driver, strength of the pusher, friction, battery voltage, weather, etc.) **NOTE: It is important to only change one variable when doing trial runs in order for students to make valid conclusions. Throughout the driving process, have students identify variables as they presented.**

	4. **Cause and Effect Activity**—Cause and effect relationships are very similar to variables when collecting data. Provide a list or have students list the problems (effects) that relate to the Goblin. List of effects can be placed on individual notecards, displayed around the room, or done independently. Students will work in groups or independently to brainstorm and record the various causes (variables) for each effect. Have students share out their relationships. **Here are example effects if needed:** a. The Goblin car would not start. b. The front right tire is wearing faster than the other tires. c. The Goblin car comes to an abrupt stop. d. The Goblin car is making a loud noise. e. The Goblin car is not running as fast as the day before. Example: The Goblin car would not start. What could have caused the problem? 5. **Greenpower Car Depth and Complexity Questions—**Have students pair with a partner to answer the questions.
Extension	**1. Swinger—**Students create a "swinger" using a piece of string 5 inches long, a paperclip, and a different type of coin per group. Place the coin inside the paperclip. Tie the string to a pencil and suspend the swinger off a student's desk with tape. On "GO", allow the students to count how many times their coin will swing in 15 seconds. Allow the students to try this activity multiple times. Then ask them why some groups are recording different data. At this point, it may be best to introduce the word "variable" and its meaning. (Suggested variables may be the release angle of the swinger, the length of the string, weight of the coin). They should write a conclusion based on their outcome in their notebook.