LearningSparks®
Education Services

Pre-IB Chemical Research Skills Programme

Chemical Research Skills

A Skills-Building Programme for Independent Chemical Investigation

Module 1 | Worksheets

Student Practice & Application

Module Focus

- Planning a Chemical Investigation
- Developing a Research Question
- Identifying Variables and Controls
- Designing a Fair and Reliable Experiment



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Module 1 Student Worksheets
From Topic to Research Question
1-Minute Chemical Research Skills — Pre-IB Chemistry
Student: _____ Date: _____
Module goal: By the end of these worksheets, you should be able to turn a broad chemical idea into a specific, measurable, controllable and feasible research question.

Worksheet 1 — Topic, Question or Researchable Question?
Part A — Classify the statements
For each statement, decide whether it is a Topic (T), Question (Q) or Researchable Question (RQ).

Statement	T / Q / RQ
1. Vitamin C	_____
2. Does temperature affect Vitamin C?	_____
3. Corrosion of iron	_____
4. Does pH affect corrosion?	_____
5. How does solution pH affect the percentage mass loss of an iron sample after 48 hours?	_____
6. Food colouring	_____
7. Does light destroy food colouring?	_____
8. How does UV exposure time affect the absorbance of a food dye solution at its λmax?	_____

Part B — What is missing?
Consider:
Does temperature affect Vitamin C?
Why is this not yet a strong research question?

Question to ask	Your answer
Temperature of what?	_____
What exactly will be measured?	_____
How could it be measured?	_____
What should remain constant?	_____
What units could be used?	_____

Now rewrite it as a researchable question:
How does _____
affect _____
when _____?

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Worksheet 2 — Meet the Variables

Part A — IV, DV or Controlled Variable?

A student investigates:

How does heating temperature affect the concentration of Vitamin C remaining in orange juice after 10 minutes of heating?

Complete the table.

Experimental factor	Type of variable	Unit, if applicable
Heating temperature	_____	_____
Vitamin C concentration	_____	_____
Heating time	_____	_____
Volume of orange juice	_____	_____
Source/batch of orange juice	_____	_____
Exposure to air	_____	_____

Part B — Identify the variables yourself

Investigation A

How does hydrochloric acid concentration affect the rate of reaction with magnesium at 25 °C?

Independent variable: _____

Dependent variable: _____

Three controlled variables: _____

Investigation B

How does pH affect the percentage mass loss of iron after 48 hours?

Independent variable: _____

Dependent variable: _____

Three controlled variables: _____

Part C — Think carefully

A student says:

"The independent variable is the thing that changes."

Why is this definition incomplete?

Write a better definition:

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Worksheet 3 — The Hidden Third Variable

Can we really make that conclusion?

Two experiments are performed.

	Experiment A	Experiment B
HCl concentration	**0.50 mol dm^{-3}**	**1.00 mol dm^{-3}**
Temperature	**20 °C**	**35 °C**
Reaction time	**68 s**	**24 s**

A student concludes:

"Increasing HCl concentration increases the reaction rate."

Question 1

What is the intended independent variable?

Question 2

What other important variable changed?

Question 3

Why does this make the conclusion unreliable?

Question 4

Redesign Experiment B so that concentration can be investigated fairly.

	Improved Experiment B
HCl concentration	_____
Temperature	_____
Other important controls	_____

Question 5 — The researcher's question

Whenever you design an experiment, ask:

What else could affect my result?

For the reaction above, identify four additional variables that could affect reaction rate.

Possible variable	How would you control it?
_____	_____
_____	_____
_____	_____
_____	_____

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Worksheet 4 — Observable or Measurable?

Part A

Classify each statement as predominantly qualitative/observable or quantitative/measurable.

Evidence	Observable	Measurable
The solution became lighter.	☐	☐
Absorbance decreased from 0.68 to 0.31.	☐	☐
More bubbles were produced.	☐	☐
42.5 cm^3 of gas was produced in 60 s.	☐	☐
The precipitate looked larger.	☐	☐
The dry precipitate had a mass of 1.26 g.	☐	☐
The reaction became faster.	☐	☐
Reaction time decreased from 74 s to 39 s.	☐	☐

Part B — Turn observations into measurements

Improve each weak dependent variable.

Weak measurement	Better quantitative measurement
"How dark the solution is"	_____
"How fast it reacts"	_____
"How much gas is produced"	_____
"How much corrosion occurs"	_____
"How acidic it becomes"	_____

Part C — Why numbers matter

Why is:

"Absorbance decreased from 0.68 to 0.31"

scientifically more useful than:

"The solution became lighter"?

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Worksheet 5 — Operationalising the Dependent Variable

The word "affect" is often hiding an incomplete research question.

Consider:

How does pH affect iron?

What could "affect iron" actually mean?

Possible dependent variable	How could it be measured?	Unit
Mass loss	Electronic balance	g
_____	_____	_____
_____	_____	_____
_____	_____	_____

Now improve:

How does pH affect iron?

into a measurable research question.

Challenge

Improve:

Does temperature affect orange juice?

Your improved question:

Identify the variables:

Component	Your answer
IV	_____
DV	_____
Measurement method	_____
Important controls	_____

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