



SeaHawk Tutors

AQA Chemistry GCSE Topic 4.1 - Atomic Structure and Periodic Table

Topic 4.1 only

1.

a. Give the symbols of the following elements:

i. Carbon _____

ii. Sodium _____ [2]

Atoms of element X have 18 protons and 23 neutrons.

b. State X's:

i. Atomic number _____

ii. Mass number _____ [2]

c. State element X's electron structure. [1]

d. State which group X is in. [1]

e. Explain the difference between a compound and a mixture. [2]

Total Marks – 8

2. Calcium is a group II element.

a. Define the term 'element.' [1]

b. Is Calcium a metal or a non-metal? Explain how you know. [2]

c. What is Calcium's atomic number? _____ [1]

Calcium forms ions by losing the electrons in its outer shell.

d. State the charge on a Calcium ion. _____ [2]

The charge on a Fluoride ion is -1.

e. What will be the chemical formula of Calcium Fluoride? [1]

f. Calcium has several different isotopes. The most abundant by far is Calcium-40. 97% of all naturally occurring Calcium is Calcium-40. All the other isotopes have atomic masses between 42 and 48. Which of the following can you predict must be true?

☐

The relative atomic mass of Calcium is less than 40

☐

The relative atomic mass of Calcium is more than 40

☐

The relative atomic mass of Calcium is very close to 40

☐

The relative atomic mass of Calcium is between 42 and 48

[2]

Total Marks - 9

3. This question is about group I elements.

a. What is the name given to the group I elements? [1]

b. State two **physical** properties of group I elements. [2]

Group I elements are highly reactive. This can be observed in their reaction (i) with oxygen and (ii) with water.

c. Describe what you would observe if a clean sample of a Sodium was exposed to the air. [2]

A small sample of Potassium is placed carefully in a beaker of water.

d. Describe what you would observe. [3]

e. When the activity in the beaker has ended, the pH of the liquid in the beaker is tested. Suggest the pH of the liquid. [1]

f. Write the chemical formula and state symbol of the substance in the beaker when the reaction has ended. [2]

g. Explain the change in reactivity of the elements in Group I as you go down the group. [4]

Total Marks - 15

4. This question is about group 7 elements.

a. What is the name given to the group VII elements? [1]

b. Write the state (solid, liquid or gas) at room temperature of the first four elements in the group. [2]

Fluorine	
Chlorine	
Bromine	
Iodine	

c. Draw an electron configuration diagram for an atom of Chlorine. Show **all** the electron shells. [2]

d. Explain one use of Chlorine in modern life. [2]

- e. Explain the change in reactivity of the elements in Group VII as you go down the group. [4]

Total Marks - 11

5. This question is about transition metals.

- a. Which of the following are transition metals? [2]

Zinc

Copper

Magnesium

Cobalt

- b. Shade the area of the periodic table where the transition metals are located.

[1]

- c. State one common **chemical** use of transition metals. [1]

- d. State two **physical** properties of transition metals when compared to group I metals. [2]

- e. Compare the reactivity of transition metals to group I metals. [1]

- f. Iron is a transition metal. It has two different oxides, with the formulae:
 Fe_2O_3 and Fe_3O_4

What chemical property of transition metals is shown by the existence of more than one oxide? [1]

Total Marks – 8

6. This question is about electron configurations.

- a. Name the 20th century scientist whose work proposed the existence of electron shells of different energy levels. [1]

- b. An element X is in period Y of the periodic table. How many electron shells must it have? [1]

☐ X

☐ Y

☐ X + Y

☐ There is no way to know from the information provided

- c. Draw a dot-cross diagram showing the electron configuration of an **ion** of Sulphur. Show **all** electron shells and clearly identify any electrons that are not originally from the Sulphur atom. [2]

- d. Write the electron configuration of a Sulphur ion in numerical form. [1]
-

- e. Which of these other atoms or ions have the same electron configuration as a Sulphur ion? [2]

☐

An Argon atom

☐

A Chlorine atom

☐

A Potassium ion

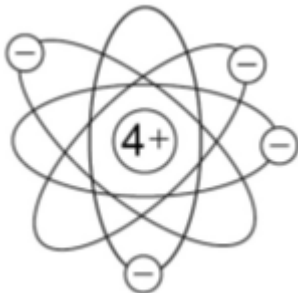
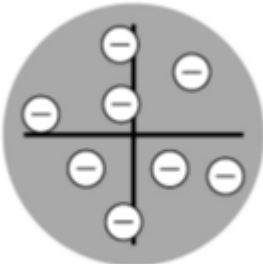
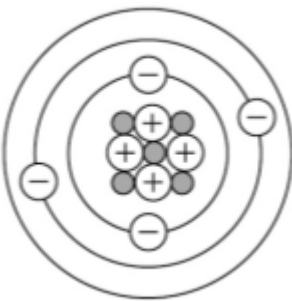
☐

An Oxygen ion

Total Marks – 7

7. This question is about the histories of the model of the atom and the Periodic Table.

The three diagrams represent three different models of the atom that have been the accepted understanding of the nature of the atom at different points in history.

A	B	C
		

a. Put these three models in time order, the earliest first. [1]

b. Describe the experiment that demonstrated that model B could not be correct. You may use a diagram to help you explain. [4]

c. Complete the following sentence:

All elements in the same period have the same number of _____
 _____; all elements in the same group have the same number
 of _____. [2]

d. The image shows a mid-19th century periodic table of the elements.

No.	No.	No.	No.	No.	No.	No.	No.
H 1	F 8	Cl 15	Co & Ni 22	Br 29	Pd 36	I 42	Pt & Ir 50
Li 2	Na 9	K 16	Cu 23	Rb 30	Ag 37	Cs 44	Os 51
G 3	Mg 10	Ca 17	Zn 24	Sr 31	Cd 38	Ba & V 45	Hg 52
Bo 4	Al 11	Cr 19	Y 25	Ce & La 33	U 40	Ta 46	Tl 53
C 5	Si 12	Ti 18	In 26	Zr 32	Sn 39	W 47	Pb 54
N 6	P 13	Mn 20	As 27	Di & Mo 34	Sb 41	Nb 48	Bi 55
O 7	S 14	Fe 21	Se 28	Ro & Ru 35	Te 43	Au 49	Th 56

When Dmitri Mendeleev produced his new version of the periodic table in 1869, he did several things that differed from the way other scientists were working at the time. Describe two of the different approaches that he used.

[2]

e. An element X has two isotopes, A and B.

i. What is meant by the term 'isotope'?

[2]

ii. Isotopes A and B have atomic mass of 102 and 105 respectively. The abundances of the two isotopes are 60% and 40% respectively. Calculate the atomic mass of element X.

[3]

Synoptic Questions including Topic 4.1

8. This question is about mixtures.

- a. Circle those of the following substances that are a mixture. [1]

Crude oil	Pure water	Graphene	Steel
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- b. A formulation is a type of mixture. Explain how a formulation differs from a mixture. [1]

- c. Match the separation method to the relevant mixture. Draw a line from each box in the left column to the appropriate one in the right column. [3]

Salt (sodium chloride) and water;
retaining the water

Salt (sodium chloride) and water;
retaining the salt

Ethanol and water

Sand and water

Chromatography

Simple distillation

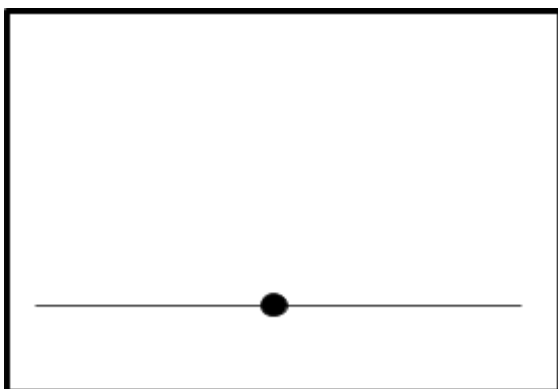
Filtration

Crystallisation

Fractional distillation

- d. Chromatography is a technique used to separate different dissolved substances such as dyes. Four students set up an experiment to investigate the different dyes in a black felt tip pen. Each of them starts with a piece of filter

paper, draws a horizontal line on the paper and puts a dot of the black felt tip on the line. They then put the paper in a clamp and placed it so that some of the paper was in a liquid in a beaker. They each did these steps slightly differently. The table below shows the detail of what each student did.



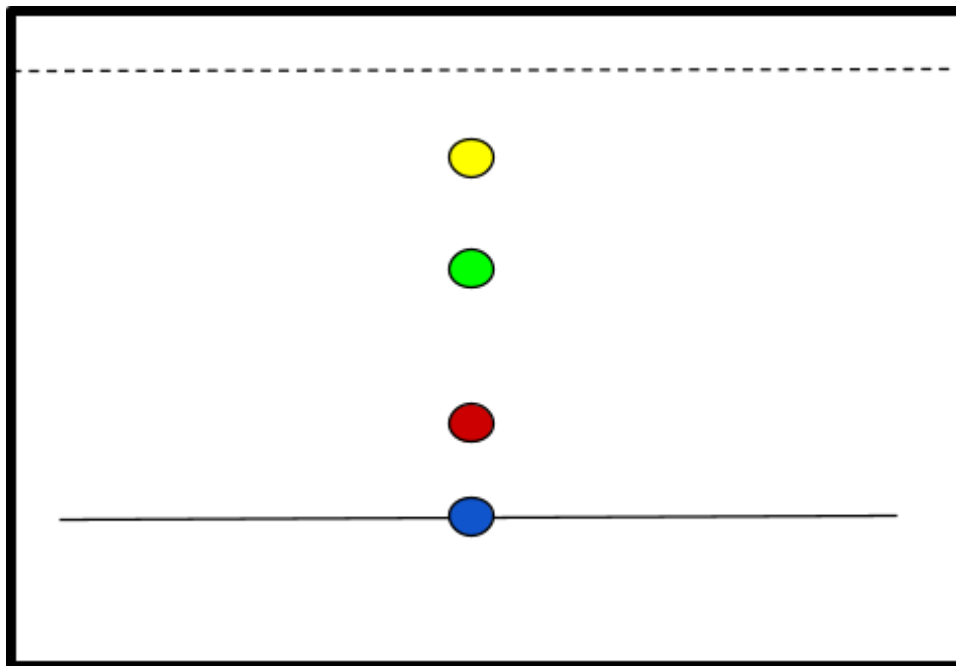
Student A	Student B	Student C	Student D
Drew the line in pencil.	Drew the line in black felt tip.	Drew the line in pencil.	Drew the line in pencil.
Used ethanol as the liquid in the beaker.	Used water as the liquid in the beaker.	Used water as the liquid in the beaker.	Used water as the liquid in the beaker.
Put the paper in so that the line was above the level of the liquid.	Put the paper in so that the line was above the level of the liquid.	Put the paper in so that the line was below the level of the liquid.	Put the paper in so that the line was above the level of the liquid.

i. In this experiment, what is the stationary phase? [1]

ii. Two of the students have made clear mistakes in how they set up the experiment. Identify the students and explain the error that they each made. [4]

- iii. Student A's experiment did not seem to do anything. The state of the paper after 30 minutes was the same as at the start. What can you deduce about the dyes in the black felt tip from this observation? [1]

The student with the correct set up had results that look like the diagram below, which is reproduced actual size.



The dotted line represents the level that the water has reached in the filter paper.

- iv. Calculate the R_f value of green ink in water. [3]

Answers

1.
 - a.
 - i. C
 - ii. Na
 - b.
 - i. 18
 - ii. 41
 - c. 2, 8, 8
 - d. Group 0 (Group 8 / VIII allowed)
 - e. A compound is a substance composed of more than one **type of atom** (allow element) chemically bonded. A mixture is a substance composed of two or more substances that are **not chemically bonded**.
2.
 - a. A substance composed of **only one type of atom**. The word 'type' must be there. Ignore 'pure.'
 - b. Metal. Any explanation such as: it is on the left side of the periodic table; it is in group II; it forms ions with a positive charge. Do not allow physical properties (shiny, conducts electricity)
 - c. 20
 - d. 2+ / +2. Must have plus sign.
 - e. CaF_2 . Allow F_2Ca
 - f. Boxes 2 and 3 ticked. Subtract one mark for any additional boxes ticked.
3.
 - a. The alkali metals
 - b. Any suitable properties: soft, low density, conduct electricity. Ignore chemical properties.
 - c. Initially it would be **shiny / bright silver**. It would quickly start to turn **dull / grey**. Ignore explanations of oxidation/reaction (command is describe not explain).
 - d. Any three from: float on surface; move / zip around; become a sphere / ball; bubbles / gas / effervescence; burn with lilac (allow purple) flame
 - e. Any number 10 - 14.
 - f. KOH (aq)
 - g. Reactivity **increases** down the group because atoms are **larger** / outer shell is further from nucleus. Results in **weaker force of (electrostatic) attraction** between nucleus and outer shell electron. Therefore **easier/ less energy required for outer shell electron to be lost**.
4.
 - a. Halogens
 - b. Gas; gas; liquid; solid
 - c. Diagram showing 2, 8, 7
 - d. Water purification / disinfectant / bleach; because it kills / destroys microbes / germs
OE
 - e. Reactivity **decreases** down the group because atoms are **larger** / outer shell is further from nucleus. Results in **weaker force of (electrostatic) attraction** between nucleus and outer shell electron. Therefore **harder/ more energy required for extra electron to be attracted into outer shell**.

5.
 - a. Boxes 1, 2, 4 checked. Deduct mark if box 3 checked.
 - b. Middle area shaded
 - c. As catalysts
 - d. Any two from harder; higher melting points; more dense; stronger
 - e. Transition metals are less reactive than group I. Allow unreactive / (very) reactive respectively.
 - f. The ability of transition metals to form ions of different charges / to behave as if in more than one group.

6.
 - a. (Nils) Bohr
 - b. Box 2 (Y) checked
 - c. Diagram showing 2, 8, 8 with outer shell having 6 Xs and 2 Os (or vice versa where the 6 must match what is shown on other shells)
 - d. 2, 8, 8
 - e. Boxes 1 & 3 checked. Deduct mark for checks in 2 or 4.

7.
 - a. B, C, A
 - b. **Gold leaf experiment; fire alpha particles at very thin sheet of gold; alpha particles scattered;** detectors in various positions; most alpha particles **pass straight through;** a few are slightly deflected; very few bounce back; showing that atoms are **mostly empty space**. 1-2 marks for some of these points in some order; 3 marks for most key points in correct order. For 4th mark must include conclusion of mostly empty space.
 - c. Electron **shells** ; **outer shell** electrons
 - d. Group by elements with similar properties; left gaps for elements not discovered at the time
 - e.
 - i. An atom of an element with **same number of protons** (and electrons) but **different number of neutrons**. Ignore references to atomic number or mass number.
 - ii. M1 for either $0.6 \times 10^2 = 61.2$ or $0.4 \times 10^5 = 42$
M1 for adding [61.2] and [42]
A1 103.2

8.
 - a. Crude oil, steel. Must be both and no others for the mark.
 - b. A mixture with a specific '**recipe**' or **ratio** of component substances.
 - c. In order: simple distillation; crysallisation; fractional distillation; filtration. Subtract 1 mark for each incorrect or missing line.
 - d.
 - i. The (filter) paper
 - ii. B put the line under the level of the liquid. This will mean that the dyes disappear in the liquid. C used felt tip for the line. This will mean that the line is affected by the process as well as the dot. 1 mark for identifying both of B and C. 2 marks for identifying the errors. 1 mark for an explanation of why this is a problem, can be for either student.
 - iii. **None** of the dyes in the black felt tip are **soluble in ethanol** OE.
 - iv. M1 Shows measurements (can be on diagram): 5.7cm for solvent front; 3.2cm for green dye (both +/- 2mm)

M1 shows dividing $[3.2] / [5.7]$

A1 = 0.56[14] Allow 0.6 if correct working shown.