1 Potassium sulfide is an ionic compound.

(a) Complete the table to show the arrangement of electrons in the ions formed when potassium and sulfur react to form potassium sulfide.

Give the charge on each of the ions.

(3)

| Element | Arrangement of electrons in atom | Arrangement of electrons in ion | Charge on ion |
|---|---|---|---|
| $_{19}K$ | ✓ 2.8.8.1 | 2.8.8 | $K^{1+}$ |
| $_{16}S$ | 2.8.6 | 2.8.8 | $S^{2-}$ |

(b) (i) Explain why potassium sulfide conducts electricity when molten.

Its ions are free to move

(1)

(ii) Explain why potassium sulfide has a high melting point.

(3)

KS — metal + non metal (ionic compounds)

Electrostatic force of attraction between oppositely charged particle exist

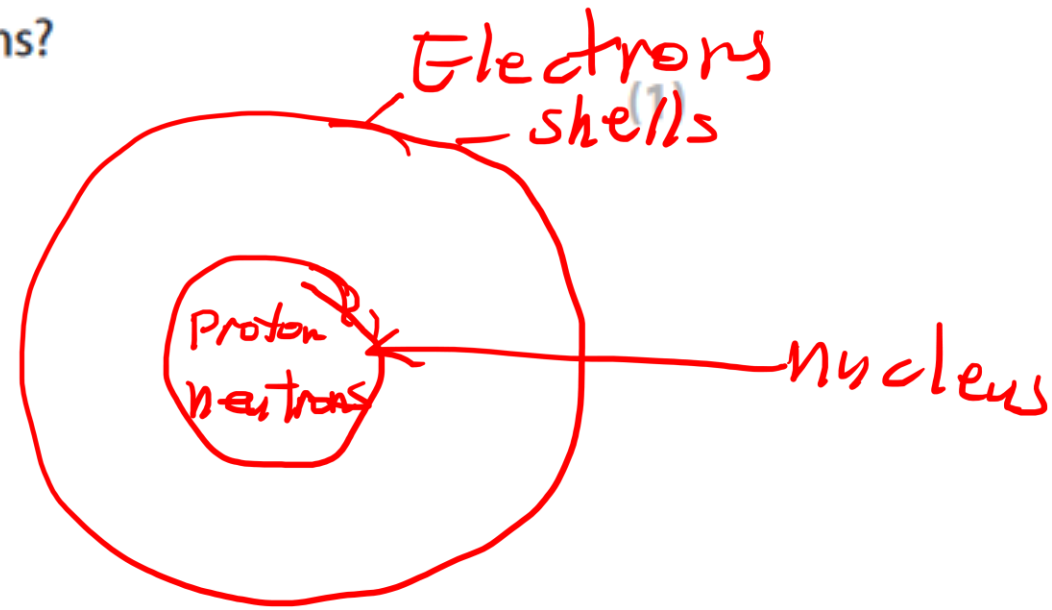
**(Total for Question 1 = 7 marks)**

**2** The table shows the numbers of particles in two atoms, L and M.

| | Atom L | Atom M |
|---|---|---|
| number of electrons | 6 | 6 |
| number of neutrons | 8 | 6 |
| number of protons | 6 | 6 |

(a) Which particles are present in the nuclei of both atoms?

- ☒ **A** electrons and neutrons
- ☒ **B** electrons and protons
- ☒ **C** neutrons and protons ✓
- ☒ **D** neutrons, protons and electrons




(1)

(b) (i) The atomic number of atom L is ..... 6 = number of protons ..... (1)

(ii) The mass number of atom L is ..... 14 = Protons + neutrons ..... (1)

(c) Atoms L and M are neutral because (1)

- ☒ **A** the numbers of electrons and neutrons are equal
- ☒ **B** the numbers of electrons and protons are equal ✓
- ☒ **C** the numbers of neutrons and protons are equal
- ☒ **D** the numbers of electrons, neutrons and protons are equal

(d) Use information from the table to explain why atoms L and M are isotopes of the same element.

(2)

number of protons are equal but number of neutrons are different. mass numbers of L and M are different but atomic number are same

(e) The electronic configuration of atom M is

(1)

$_6M$ => 2, 4

- ☒ **A** 2.2.2
- ☒ **B** 2.4
- ☒ **C** 2.4.6
- ☒ **D** 4.2

2, 4

**(Total for Question 2 = 7 marks)**

3 (a) Complete the table to show the relative mass and relative charge of a proton, a neutron and an electron.

(4)

| | Proton | Neutron | Electron |
|---|---|---|---|
| Relative mass | 1 | 1 | 1/1840 |
| Relative charge | 1+ | 0 | −1 |

(b) The symbol for an atom of one isotope of hydrogen is $^{3}_{1}H$

(i) State the number of protons, neutrons and electrons present in one atom of this isotope.

(2)

Number of protons ..... 1 .....

Number of neutrons ..... 3−1=2 .....

Number of electrons ..... 1 .....

(ii) What is meant by the term **isotopes**?

same number of protons but different number of neutrons

(2)

(c) Bromine has two naturally-occurring isotopes with mass numbers 79 and 81.
A sample of bromine contained the two isotopes in the following proportions:

bromine-79 50.7% and bromine-81 49.3%

Use this information to calculate the relative atomic mass of bromine.
Give your answer to **two** decimal places.

**(2)**

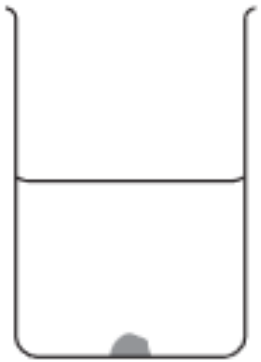
Relative atomic mass = Mass of isotope × % abundance + Mass of isotope × % abundance

= 79 × 0.507 + 81 × 0.493

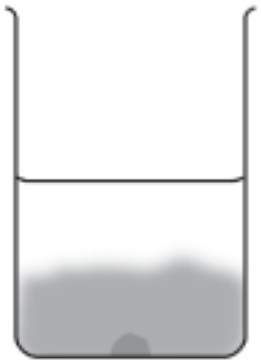
= 79.99

**4** Hydrated copper(II) sulfate is a soluble blue solid. A large crystal of this solid is placed at the bottom of a beaker of water.

The diagram shows the beaker immediately after placing the crystal in it, and after two days.



after placing the crystal



after two days

(a) After two days, the crystal becomes smaller and the liquid near the bottom of the beaker becomes blue.

Which statement explains these observations?

**(1)**

(1)

☒ **A** the crystal dissolves

☒ **B** the crystal freezes

☒ **C** the crystal melts

☒ **D** the crystal sublimes

(b) After two weeks, the crystal has disappeared.

Which statement best describes the appearance of the liquid in the beaker after two weeks?

(1)

☒ **A** it is all blue

☒ **B** it is all brown

☒ **C** only the lower part is blue

☒ **D** only the upper part is blue

(c) The formula of the compound in the crystal is $CuSO_4.5H_2O$

(i) How many different elements are shown in the formula?

(1)

4 (Cu, S, O, H) ← Elements in $CuSO_4.5H_2O$

(ii) How many atoms are shown in the formula?

(1)

Cu = 1 atom
S = 1 atom
O = 4 + 5 atoms
H = 10 atoms

2 + 9 + 10 = 21 total

Total Atoms 21

**5** Bromine and iodine are halogens.

(a) Complete the table by giving the colour and physical state of each of these halogens at room temperature.

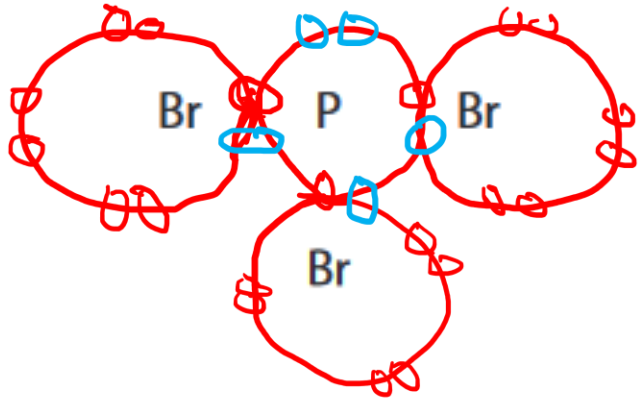
**(2)**

| Halogen | Colour | Physical state |
|---|---|---|
| bromine | red-brown | liquid |
| iodine | black | solid |

(b) Bromine reacts with phosphorus to form the covalent compound phosphorus tribromide.

Draw a dot and cross diagram to show the outer electrons in a molecule of phosphorus tribromide.

**(2)**




(c) Phosphorus tribromide reacts with water to form a mixture of two acids, HBr and $H_3PO_3$

Write a chemical equation for this reaction.

(2)

$$PBr_3 + 3H_2O \rightarrow 3HBr + H_3PO_3$$

**2** This is a recipe for making Irish soda bread.

- add 170 g of wholemeal flour, 170 g of plain flour, 10 g of salt and 10.5 g of bicarbonate of soda (sodium hydrogencarbonate, $NaHCO_3$) to a bowl and stir
- pour in 290 $cm^3$ of buttermilk and stir quickly to form a soft dough
- form the dough into a round ball and slightly flatten it
- cut a cross in the top and bake for 30 minutes in an oven at 200 °C

When sodium hydrogencarbonate is heated, it forms carbon dioxide gas.

$$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$$

(a) Calculate the mass, in grams, of carbon dioxide that would be produced by completely decomposing 10.5 g of sodium hydrogencarbonate.
[$M_r$ of $NaHCO_3$ = 84]

2 NaHCO3 → Na2CO3 + H2O + CO2 balanced
2 mol 1 mol 1 mol 1 mol

$n = \frac{m}{Mm} = \frac{10.5\,g}{84\,g/mol} = 0.125\,mol\ NaHCO_3$

mass of carbon dioxide = ..... g

$NaHCO_3$ — $CO_2$
2 — 1
0.125 mol — x

$2x = 0.125$
$x = 0.125/2 = 0.0625\,mol\ CO_2$

(2)

(b) Use your answer from part (a) to calculate the volume, in $cm^3$, at room temperature and pressure, of carbon dioxide that would be produced by completely decomposing 10.5 g of sodium hydrogencarbonate.

Assume one mole of carbon dioxide has a volume of 24000 $cm^3$ at room temperature and pressure.

(2)

1 mol → 24 000 $cm^3$

0.0625 mol $CO_2$ → x

x = 24 000 × 0.0625 = 1500 $cm^3$

**3** This question is about the reactions of compounds of antimony and phosphorus.

(a) Antimony (Sb) can be obtained from its oxide ($Sb_2O_4$) by heating it with carbon.

The equation for this reaction is

$$Sb_2O_4(s) + 4C(s) \rightarrow 2Sb(s) + 4CO(g)$$

(i) Give the name of the gas produced in this reaction.

(1)

Carbon monoxide

(ii) State why this gas is poisonous to humans.

(1)

→ decreases the capacity of blood cells to carry oxygen

→ IE uses up oxygen

(b) Phosphorus sulfide ($P_4S_3$) is one of the reactants used in match heads.

When a match is struck, energy is transferred to the reactants in the match head, starting a reaction.

(i) Balance the equation that represents this reaction.

**(2)**

$$6KClO_3(s) + \ldots\ldots S(s) + \ldots\ldots P_4S_3(s) \rightarrow \ldots\ldots 6 KCl(s) + \ldots\ldots 4 SO_2(g) + \ldots\ldots P_4O_{10}(s)$$

(ii) What term is used to describe the energy required to start a reaction?

**(1)**

*activation Energy

**(Total for Question 3 = 5 marks)**

**4** Sodium azide ($NaN_3$) is a stable compound at room temperature but decomposes when heated to 300 °C. The equation for the decomposition is:

$$2NaN_3(s) \rightarrow 2Na(l) + 3N_2(g)$$

Sodium azide is used to produce nitrogen gas to inflate car airbags.

If a car is involved in a collision, the sodium azide decomposes.

The nitrogen gas is produced very rapidly and the airbag inflates almost immediately.

(a) (i) A fully-inflated airbag has a total volume of 108 $dm^3$.
Calculate the amount of nitrogen, in moles, in a fully-inflated airbag.
[You should assume that the volume of one mole of nitrogen inside the airbag is 24 $dm^3$]

1 mol ∝ 24 $dm^3$
x ∝ 108 $dm^3$

$24x = 1 \times 108$
$x = 108/24 = 4.5$ moles of nitrogen

(2)

(ii) Use your answer to (a)(i) to calculate the mass, in grams, of sodium azide required to produce 108 $dm^3$ of nitrogen.

(3)

$2NaN_3 \rightarrow 2Na + 3N_2$

2 mol 2 mol 3 mol

$NaN_3$ : $N_2$

2 mol 3 mol

x 4·5 mol

$3x = 2 \times 4{\cdot}5$

$x = \frac{2 \times 4{\cdot}5}{3} = 3$ mols of $NaN_3$

$n = \frac{m}{Mr}$

$3 = \frac{m}{23 + 14 \times 3}$

$3 = \frac{m}{65}$

$m = 3 \times 65$

Mass of sodium azide required = $m = 195$ g of $NaN_3$