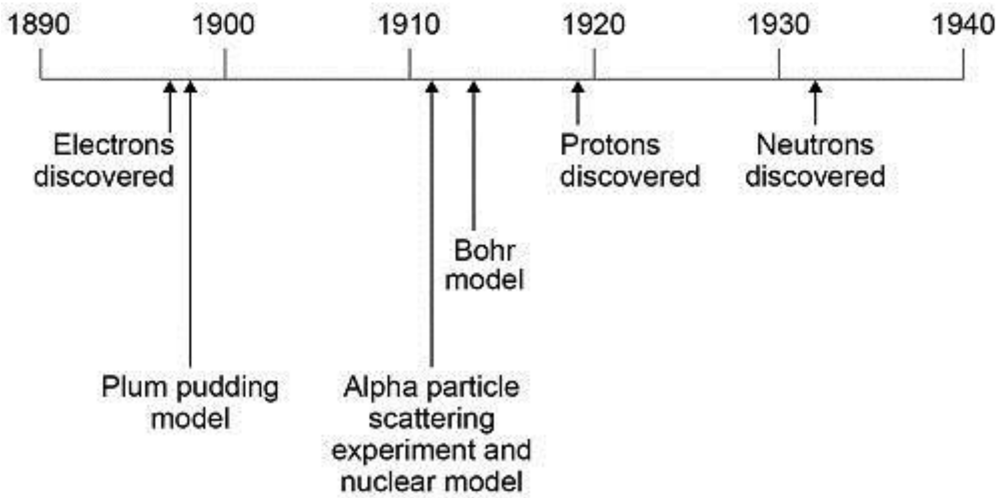
A Level Bridging Work – Chemistry

Please complete these questions – use your revision guide/GCSE Factfiles to help. Once completed, green pen using the mark scheme at the end of this document.

Q1.

This question is about the development of scientific theories.

The diagram below shows a timeline of some important steps in the development of the model of the atom.



(a) The plum pudding model did not have a nucleus.

Describe **three** other differences between the nuclear model of the atom and the plum pudding model.

1 ____

____

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2 ____

____

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3 ____

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____

(3)

(b) Niels Bohr adapted the nuclear model.

Describe the change that Bohr made to the nuclear model.

(2)

(c) Mendeleev published his periodic table in 1869.

Mendeleev arranged the elements in order of atomic weight.

Mendeleev then reversed the order of some pairs of elements.

A student suggested Mendeleev's reason for reversing the order was to arrange the elements in order of atomic number.

Explain why the student's suggestion **cannot** be correct.

Use the diagram above.

(2)

(d) Give the correct reason why Mendeleev reversed the order of some pairs of elements.

(1)

(Total 8 marks)

Q2.

This question is about displacement reactions.

(a) The displacement reaction between aluminium and iron oxide has a high activation energy.

What is meant by 'activation energy'?

(1)

(b) A mixture contains 1.00 kg of aluminium and 3.00 kg of iron oxide.

The equation for the reaction is:

$$2\ Al + Fe_2O_3 \rightarrow 2\ Fe + Al_2O_3$$

Show that aluminium is the limiting reactant.

Relative atomic masses (A_r): O = 16 Al = 27 Fe = 56

(4)

Magnesium displaces zinc from zinc sulfate solution.

(c) Complete the ionic equation for the reaction.

You should include state symbols.

$$Mg(s) + Zn^{2+}(aq) \rightarrow \_\_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_\_$$

(2)

(d) Explain why the reaction between magnesium atoms and zinc ions is both oxidation and reduction.

(2)

(Total 9 marks)

Q3.

This question is about the halogens.

Table 1 shows the melting points and boiling points of some halogens.

Table 1

Element	**Melting point in °C**	**Boiling point in °C**
Fluorine	–220	–188
Chlorine	–101	–35
Bromine	–7	59

(a) What is the state of bromine at 0 °C **and** at 100 °C?

Tick (✓) **one** box.

State at 0 °C	**State at 100 °C**	
Gas	Gas	☐
Gas	Liquid	☐
Liquid	Gas	☐
Liquid	Liquid	☐
Solid	Gas	☐
Solid	Liquid	☐

(1)

(b) Explain the trend in boiling points of the halogens shown in **Table 1**.

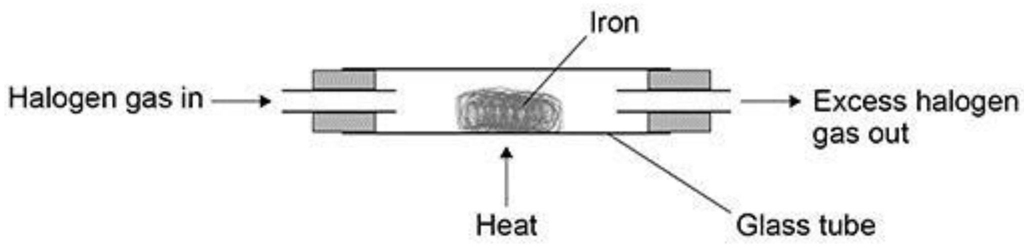
(4)

(c) Why is it **not** correct to say that the boiling point of a single bromine molecule is 59 °C?

(1)

Iron reacts with each of the halogens in their gaseous form.

The diagram below shows the apparatus used.



(d) Give **one** reason why this experiment should be done in a fume cupboard.

(1)

(e) Explain why the reactivity of the halogens decreases going down the group.

____

____

____

____

____

____

(3)

(f) A teacher investigated the reaction of iron with chlorine using the apparatus in the above diagram.

The word equation for the reaction is:

iron + chlorine → iron chloride

The teacher weighed:

- the glass tube
- the glass tube and iron before the reaction
- the glass tube and iron chloride after the reaction.

Table 2 shows the teacher's results.

Table 2

	Mass in g
Glass tube	51.56
Glass tube and iron	56.04
Glass tube and iron chloride	64.56

Calculate the simplest whole number ratio of:

moles of iron atoms : moles of chlorine atoms

Determine the balanced equation for the reaction.

Relative atomic masses (A_r): Cl = 35.5 Fe = 56

____

____

Moles of iron atoms : moles of chlorine atoms = __________ **:** __________

Equation for the reaction

____

(6)

(Total 16 marks)

Q4.

Sodium hydroxide neutralises sulfuric acid.

The equation for the reaction is:

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

(a) Sulfuric acid is a strong acid.

What is meant by a strong acid?

(2)

(b) Write the ionic equation for this neutralisation reaction. Include state symbols.

(2)

(c) A student used a pipette to add 25.0 cm^3 of sodium hydroxide of unknown concentration to a conical flask.

The student carried out a titration to find out the volume of 0.100 mol / dm^3 sulfuric acid needed to neutralise the sodium hydroxide.

Describe how the student would complete the titration.

You should name a suitable indicator and give the colour change that would be seen.

(4)

(d) The student carried out five titrations. Her results are shown in the table below.

	Titration 1	Titration 2	Titration 3	Titration 4	Titration 5
Volume of 0.100 mol / dm^3 sulfuric acid in cm^3	27.40	28.15	27.05	27.15	27.15

Concordant results are within 0.10 cm^3 of each other.

Use the student's concordant results to work out the mean volume of 0.100 mol / dm^3 sulfuric acid added.

Mean volume = ______________________________ cm^3

(2)

(e) The equation for the reaction is:

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of the sodium hydroxide.

Give your answer to three significant figures.

Concentration = ______________________ mol / dm³

(4)

(f) The student did another experiment using 20 cm^3 of sodium hydroxide solution with a concentration of 0.18 mol / dm^3.

Relative formula mass (M_r) of NaOH = 40

Calculate the mass of sodium hydroxide in 20 cm^3 of this solution.

___

___

___

___

Mass = ________________ g

(2)

(Total 16 marks)

Q5.

This question is about polymers.

(a) Name the monomer used to form poly(chloroethene).

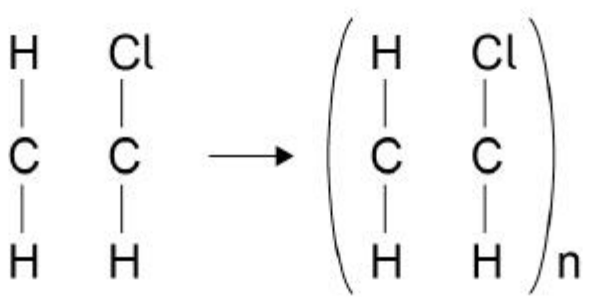
___

(1)

(b) **Figure 1** shows the equation for the formation of poly(chloroethene).

Complete **Figure 1**.

Figure 1



(3)

(c) Poly(chloroethene) is the only product.

What type of polymer is poly(chloroethene)?

___

(1)

Ethanediol reacts with butanedioic acid to produce a polyester and a small molecule.

(d) **Figure 2** shows the structural formula of ethanediol.

Figure 2

$HO–CH_2–CH_2–OH$

Name the functional group present in ethanediol.

____

(1)

(e) **Figure 3** shows the structural formula of butanedioic acid.

Figure 3

$HOOC–CH_2–CH_2–COOH$

Which formula represents the carboxylic acid functional group?

Tick (✓) **one** box.

$–CH_2–$ ☐

$–CH_2–CH_2–$ ☐

$–CH_2–COOH$ ☐

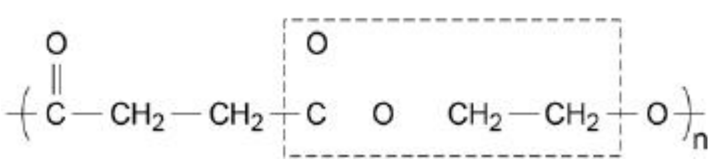
$–COOH$ ☐

(1)

(f) **Figure 4** shows part of the structure of the polyester.

Complete the box in **Figure 4**.

Figure 4



(2)

(g) Name the small molecule produced when ethanediol reacts with butanedioic acid.

____

(1)

Starch, proteins and DNA are naturally occurring polymers.

(h) Name the monomers from which starch and proteins are produced.

Starch ____________________________

Proteins ____________________________

(2)

(i) Describe the structure of DNA.

____

____

____

____

(2)

(Total 14 marks)

Mark schemes

Q1.

(a) any **three** from: (nuclear model)

- mostly empty space

  allow the plum pudding model has no empty space

  allow the plum pudding model is solid

- the positive charge is (all) in the nucleus

  allow in the plum pudding model the atom is a ball of positive charge (with embedded electrons)
  *do **not** accept reference to protons*

- the mass is concentrated in the nucleus

  allow in the plum pudding model the mass is spread out
  *do **not** accept reference to neutrons*

- the electrons and the nucleus are separate

  allow in the plum pudding model the electrons are embedded

  allow in the nuclear model the electrons are in orbits

3

(b) electrons orbit the nucleus

*do **not** accept reference to protons / neutrons*
allow electrons are in energy levels around the nucleus
or
allow electrons are in shells around the nucleus

1

electrons are at specific distances from the nucleus

1

(c) atomic number is the number of protons

1

(and) protons were not discovered until later

ignore electrons / neutrons were not discovered until later

1

(d) so their properties matched the rest of the group

allow converse

1

[8]

Q2.

(a) the (minimum) energy needed for particles to react
or
the (minimum) energy needed for a reaction to occur

allow the (minimum) energy needed to start a reaction

1

(b) (M_r of Fe_2O_3 =) 160

1

(moles Fe_2O_3 = $\frac{3000}{160}$ =)
18.75 (mol)

allow correct use of incorrectly calculated M_r

1

(moles Al = $\frac{1000}{27}$ =) 37.0 (mol)

allow 37.037037 (mol) correctly rounded to at least 2 significant figures

if both MP2 and MP3 are not awarded allow ***1*** *mark for 0.01875 mol Fe_2O_3* ***and*** *0.037 mol Al*

1

(aluminium is limiting because)
37.0 mol is less than the (2 x 18.75 =) 37.5 mol (aluminium needed)
or

iron oxide is in excess because 18.75 mol is more than the ($\frac{37.0}{2}$ =) 18.5 mol (iron oxide needed)

allow correct use of incorrect number of moles from steps 2 and/or 3

alternative approaches:

approach 1:

(finding required mass of aluminium by moles method)

(M_r of Fe_2O_3 =) 160 (1)

(moles Fe_2O_3 = $\frac{3000}{160}$ =)
18.75 (mol) (1)

allow correct use of incorrectly calculated M_r

(moles Al needed =18.75 × 2 =) 37.5 (mol)
and

(mass Al needed = 37.5 × 27 =) 1012.5 (g) **or** 1.0125 kg (1)

allow correct use of incorrectly calculated moles of iron oxide

allow correct use of incorrectly calculated moles of aluminium needed

(so) 1.00 kg of aluminium is not enough (1)

dependent on calculated mass of aluminium needed being greater than 1.00 (kg)

approach 2:

(finding required mass of aluminium by proportion method)

(M_r of Fe_2O_3 =) 160 (1)

(3.00 kg Fe_2O_3 needs)
$\frac{3.00}{160} \times 2 \times 27$ (kg Al) (1)

allow correct use of incorrectly calculated M_r

(=) 1.0125 (kg) (1)

(so) 1.00 kg of aluminium is not enough (1)

dependent on calculated mass of aluminium needed being greater than 1.00 (kg)

alternative approaches:

approach 3:
(finding required mass of iron oxide by moles method)

M_r of Fe_2O_3 =) 160 (1)

(moles Al = $\frac{1000}{27}$ =) 37.0 (mol) (1)

allow 37.037037 (mol) correctly rounded to at least 2 significant figures

(moles Fe_2O_3 needed) = $\frac{37.0}{2}$) = 18.5 (mol)
and
(mass Fe_2O_3 needed = 18.5 × 160 =) 2960 (g) **or** 2.96 (kg) (1)

allow correct use of incorrectly calculated moles of aluminium

allow correct use of incorrectly calculated moles of iron oxide needed
allow correct use of incorrectly calculated M_r

(so) 3.00 kg of iron oxide is an excess (1)

dependent on calculated mass of iron oxide needed being less than 3.00 (kg)

approach 4:
(finding required mass of iron oxide by proportion method)

(M_r of Fe_2O_3 =) 160 (1)

(1.00 kg Al needs) $\frac{1.00}{2 \times 27}$ (kg Fe_2O_3) (1)

allow correct use of incorrectly calculated M_r

(=) 2.96 (kg) (1)

(so) 3.00 kg of iron oxide is an excess (1)

dependent on calculated mass of iron oxide needed being less than 3.00 (kg)

1

(c) $Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$

allow multiples

*allow **1** mark for Mg^{2+} + Zn with missing or incorrect state symbols*

2

(d) magnesium (atoms) are oxidised because they lose electrons

1

(and) zinc (ions) are reduced because they gain electrons

*if no other marks awarded allow **1** mark for magnesium (atoms) lose electrons and zinc (ions) gain electrons 1*

1

[9]

Q3.

(a) liquid gas

1

(b) (boiling point) increases (down the table / group)

1

(because) the relative formula / molecular mass increases
or
(because) the size of the molecule increases

1

(so) the intermolecular forces increase (in strength)

allow (so) the forces between molecules increase (in strength)

1

(so) more energy is needed to overcome the intermolecular forces

allow (so) more energy is needed to separate the molecules

*do **not** accept a reference to breaking bonds unless specifically between molecules*

1

(c) boiling point is a bulk property

allow boiling point is related to intermolecular forces (so more than one molecule is involved)

1

(d) the gas / halogen is toxic

allow the gas / halogen is poisonous / harmful
allow to prevent inhalation of the gas / halogen

ignore deadly / lethal

1

(e) (going down the group) the outer electrons / shell become further from the nucleus

allow energy level for shell throughout

allow the atoms become larger

allow the number of shells increases

ignore the number of outer shells increases

1

(so) the nucleus has less attraction for the outer electrons / shell

allow (so) the nucleus has less attraction for the incoming electron

allow (so) increased shielding between the nucleus and the outer electrons / shell

allow (so) increased shielding between the nucleus and the incoming electron

1

(so) an electron is gained less easily

1

(f) 4.48 (g iron) **and** 8.52 (g chlorine)

1

(moles Fe = $\frac{4.48}{56}$ =) 0.08

allow correct calculation using incorrectly calculated mass of iron

1

(moles Cl = $\frac{8.52}{35.5}$ =) 0.24

allow correct calculation using incorrectly calculated mass of chlorine

allow (moles Cl_2 = $\frac{8.52}{71}$ =) 0.12

1

(Fe : Cl = 0.08 : 0.24 =) 1 : 3

allow correct calculation using incorrectly calculated moles of iron and / or chlorine

$2\ Fe + 3\ Cl_2 \rightarrow 2\ FeCl_3$

allow multiples / fractions

allow a correctly balanced equation including Fe and Cl_2 from an incorrect ratio of Fe : Cl

*allow **1** mark for Fe **and** Cl_2 (reactants) **and** $FeCl_3$ (product)*
or
*allow **1** mark for Fe **and** Cl_2 (reactants) **and** a formula for iron chloride correctly derived from an incorrect ratio of Fe : Cl (product)*

2

[16]

Q4.

(a) (sulfuric acid is) completely / fully ionised

1

In aqueous solution **or** when dissolved in water

1

(b) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

allow multiples

***1** mark for equation*

***1** mark for state symbols*

2

(c) adds indicator, eg phenolpthalein / methyl orange / litmus added to the sodium hydroxide
(in the conical flask)

*do **not** accept universal indicator*

1

(adds the acid from a) burette

1

with swirling **or** dropwise towards the end point **or** until the indicator just changes colour

1

until the indicator changes from pink to colourless (for phenolphthalein) or yellow to red
(for methyl orange) or blue to red (for litmus)

1

(d) titrations 3, 4 and 5

or

$$\frac{27.05 + 27.15 + 27.15}{3}$$

1

27.12 cm^3

*accept 27.12 with no working shown for **2** marks*

1

*allow 27.1166 with no working shown for **2** marks*

(e) Moles H_2SO_4 = conc × vol = 0.00271

allow ecf from 8.4

1

Ratio H_2SO_4:NaOH is 1:2

or

Moles NaOH = Moles H_2SO_4 × 2 = 0.00542

1

Concentration NaOH = mol / vol = 0.00542 / 0.025 = 0.2168

1

0.217 (mol / dm^3)

*accept 0.217 with no working for **4** marks*

1

*accept 0.2168 with no working for **3** marks*

(f) $\frac{20}{1000} \times 0.18$ = no of moles

or

0.15 × 40 g 1

0.144 (g) 1

*accept 0.144g with no working for **2** marks*

[16]

Q5.

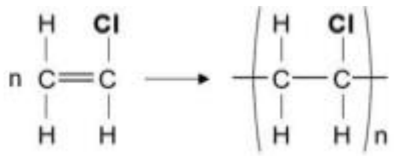
(a) chloroethene 1

(b) double bond in monomer 1

in polymer one C–C bond **and** two open ended bonds 1

‘n’ in front of monomer 1

an answer of:



*scores **3** marks*

(c) addition 1

(d) −OH

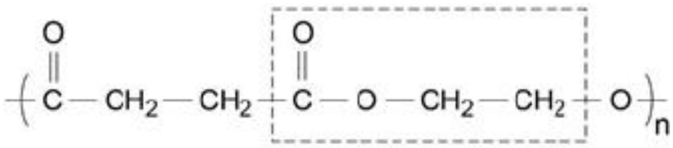
allow alcohol 1

(e) –COOH 1

(f) C=O bond 1

2 × C−O bonds 1

an answer of:



scores **2** marks

(g) water 1

(h) glucose

1

amino acids

1

(i) any **two** from:

- two polymer chains
- double helix
- four different monomers / nucleotides

2

[14]