| | |
|---|---|
| Forename | |
| Surname | |
| Candidate Signature | |

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| Centre Number | | | | | | Candidate Number | | | | |

# GCSE
# CHEMISTRY

## Higher Tier 1H

Study Hack

Practice Paper 2022

Time allowed: 1 hour 45 minutes

**Materials**
For this paper you must have:
- a ruler
- a calculator
- the periodic table

**Instructions**
- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outsidethe box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end ofthis book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

| For Examiner's Use | |
|---|---|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| **TOTAL** | |

**Information**
- The maximum mark for this paper is 103.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.

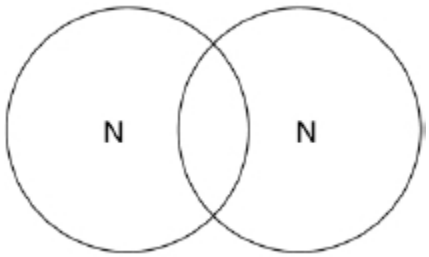
You are reminded of the need for good English and clear presentation

**Q1.**

This question is about structure and bonding.

(a) Complete the dot and cross diagram to show the covalent bonding in a nitrogen molecule, $N_2$

Show only the electrons in the outer shell.




**(2)**

(b) Explain why nitrogen is a gas at room temperature.

Answer in terms of nitrogen's structure.

_____

_____

_____

_____

_____

_____

**(3)**

(c) Graphite and fullerenes are forms of carbon.

Graphite is soft and is a good conductor of electricity.

Explain why graphite has these properties.

Answer in terms of structure and bonding.

_____

_____

_____

_____

_____

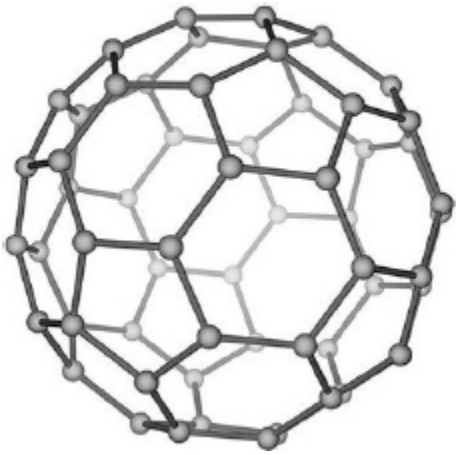
_____

_____

**(4)**

(d) **Figure 1** shows a model of a Buckminsterfullerene molecule.

Figure 1



A lubricant is a substance that allows materials to move over each other easily.

Suggest why Buckminsterfullerene is a good lubricant.

Use **Figure 1**.

_____

_____

_____

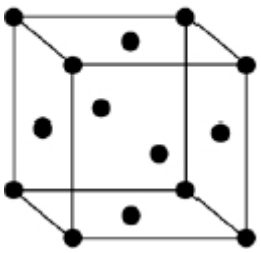
_____

**(2)**

Silver can form cubic nanocrystals.

**Figure 2** represents a silver nanocrystal.

Figure 2



(e) A silver nanocrystal is a cube of side 20 nm

Calculate the surface area to volume ratio of the nanocrystal.

_____

_____

_____

_____

_____

Surface area to volume ratio = _____

**(3)**

(f) Silver nanoparticles are sometimes used in socks to prevent foot odour.

Suggest why it is cheaper to use nanoparticles of silver rather than coarse particles of silver.

_____

_____

_____

_____

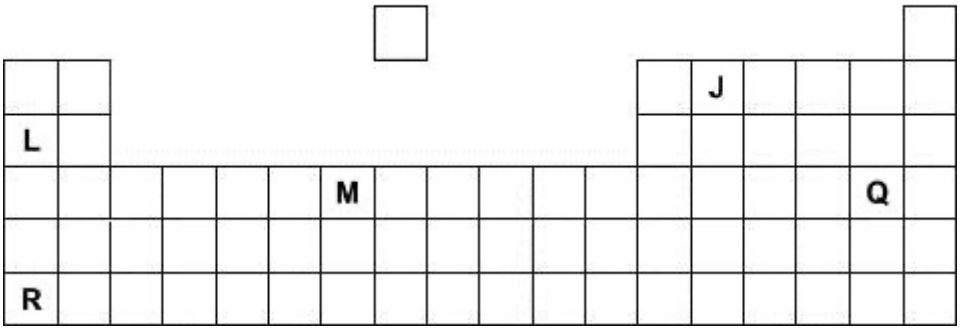
**(2)**

**(Total 16 marks)**

## Q2.

**Figure 1** shows an outline of the modern periodic table.

**Figure 1**




**J**, **L**, **M**, **Q** and **R** represent elements in the periodic table.

(a) Which element has four electrons in its outer shell?

Tick (✓) **one** box.

**J** ☐ **L** ☐ **M** ☐ **Q** ☐ **R** ☐

**(1)**

(b) Which **two** elements in **Figure 1** are in the same period?

_____ and _____

**(1)**

(c) Which element reacts with potassium to form an ionic compound?

Tick (✓) **one** box.

J ☐ L ☐ M ☐ Q ☐ R ☐

**(1)**

(d) Which element forms ions with different charges?

Tick (✓) **one** box.

J ☐ L ☐ M ☐ Q ☐ R ☐

**(1)**

(e) Which element has three electron shells?

Tick (✓) **one** box.

J ☐ L ☐ M ☐ Q ☐ R ☐

**(1)**

(f) In the 1860s scientists were trying to organise elements.

**Figure 2** shows the table published by John Newlands in 1865.
The elements are arranged in order of their atomic weights.

**Figure 2**

| | | | | | | |
|---|---|---|---|---|---|---|
| H | Li | Be | B | C | N | O |
| F | Na | Mg | Al | Si | P | S |
| Cl | K | Ca | Cr | Ti | Mn | Fe |
| Co,Ni | Cu | Zn | Y | In | As | Se |
| Br | Rb | Sr | Ce,La | Zr | Di,Mo | Ro,Ru |
| Pd | Ag | Cd | U | Sn | Sb | Te |

**Figure 3** shows the periodic table published by Dmitri Mendeleev in 1869.

**Figure 3**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| H | | | | | | | |
| Li | Be | B | C | N | O | F | |
| Na | Mg | Al | Si | P | S | Cl | |
| K Cu | Ca Zn | ? ? | Ti ? | V As | Cr Se | Mn Br | Fe Co Ni |
| Rb Ag | Sr Cd | Y In | Zr Sn | Nb Sb | Mo Te | ? I | Ru Rh Pd |

Mendeleev's table became accepted by other scientists whereas Newlands' table was not.

Evaluate Newlands' and Mendeleev's tables.

You should include:

- a comparison of the tables
- reasons why Mendeleev's table was more acceptable.

Use **Figure 2** and **Figure 3** and your own knowledge.

**(6)**
**(Total 11 marks)**

**Q3.**

Oil rigs are used to drill for crude oil.



(a) Drill heads are made from steel. Steel is an alloy.

Explain why alloys are harder than pure metals.

**(3)**

(b) Drill heads also contain diamonds.

Describe, as fully as you can, the structure and bonding in diamond.

**(4)**

(c) Polymers are produced from crude oil.

Describe the structure and bonding in a thermosoftening polymer and explain why

thermosoftening polymers melt when heated.

**(4)**

**(Total 11 marks)**

## Q4.

A student investigated the temperature change in the reaction between dilute sulfuric acid and potassium hydroxide solution.

This is the method used.

1. Measure 25.0 $cm^3$ potassium hydroxide solution into a polystyrene cup.

2. Record the temperature of the solution.

3. Add 2.0 $cm^3$ dilute sulfuric acid.

4. Stir the solution.

5. Record the temperature of the solution.

6. Repeat steps 3 to 5 until a total of 20.0 $cm^3$ dilute sulfuric acid has been added.

(a) Suggest why the student used a polystyrene cup rather than a glass beaker for the reaction.

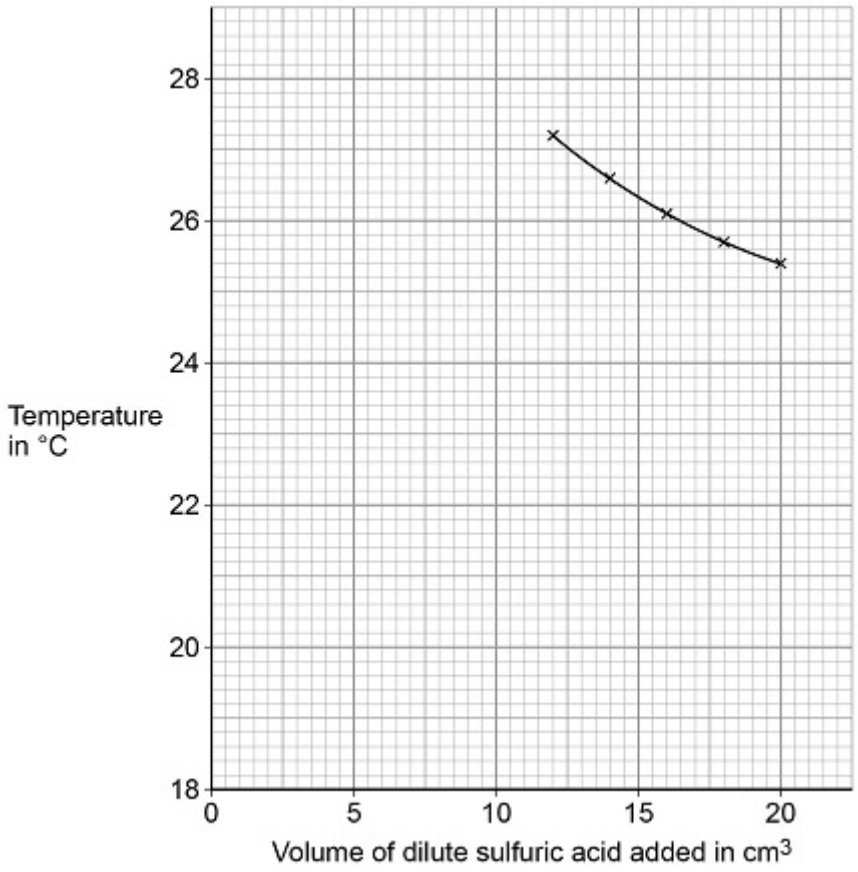
**(2)**

The following table shows some of the student's results.

| Volume of dilute sulfuric acid added in $cm^3$ | Temperature in °C |
|---|---|
| 0.0 | 18.9 |

| | |
|---|---|
| 2.0 | 21.7 |
| 4.0 | 23.6 |
| 6.0 | 25.0 |
| 8.0 | 26.1 |
| 10.0 | 27.1 |

The figure below shows some of the data from the investigation.




(b) Complete the figure:

- plot the data from the table
- draw a line of best fit through these points
- extend the lines of best fit until they cross.

**(4)**

(c) Determine the volume of dilute sulfuric acid needed to react completely with 25.0 $cm^3$ of the potassium hydroxide solution.

Use the figure above.

Volume of dilute sulfuric acid to react completely = _____ $cm^3$

**(1)**

(d) Determine the overall temperature change when the reaction is complete.

Use the figure above.

Overall temperature change = _____ °C

**(1)**

(e) The student repeated the investigation.

The student used solutions that had different concentrations from the first investigation.

The student found that 15.5 $cm^3$ of 0.500 $mol/dm^3$ dilute sulfuric acid completely reacted with 25.0 $cm^3$ of potassium hydroxide solution.

The equation for the reaction is:

$$2\ KOH + H_2SO_4 \rightarrow K_2SO_4 + 2\ H_2O$$

Calculate the concentration of the potassium hydroxide solution in $mol/dm^3$ and in $g/dm^3$

Relative atomic masses ($A_r$): H = 1 O = 16 K = 39

Concentration in $mol/dm^3$ = _____ $mol/dm^3$

Concentration in $g/dm^3$ = _____ $g/dm^3$

**(6)**

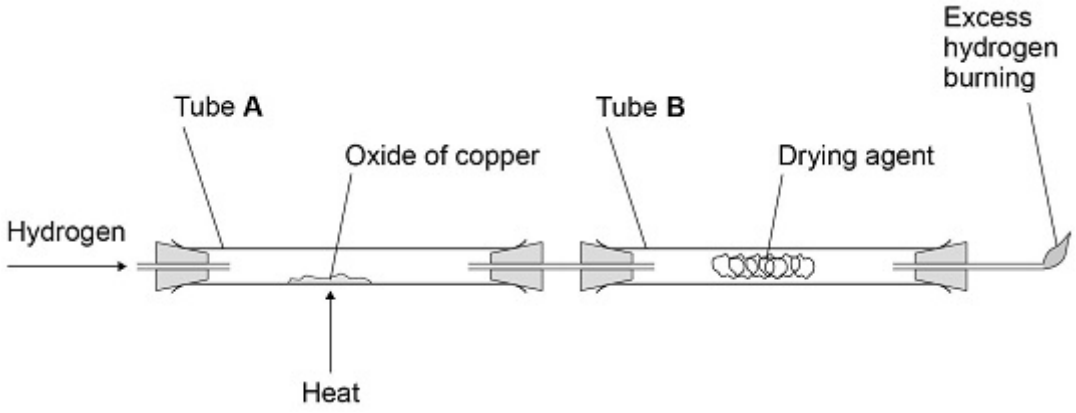
**(Total 14 marks)**

## Q5.

Copper forms two oxides, $Cu_2O$ and CuO

A teacher investigated an oxide of copper.

The following figure shows the apparatus.




This is the method used.

1. Weigh empty tube **A**.

2. Add some of the oxide of copper to tube **A**.

3. Weigh tube **A** and the oxide of copper.

4. Weigh tube **B** and drying agent.

5. Pass hydrogen through the apparatus and light the flame at the end.

6. Heat tube **A** for 2 minutes.

7. Reweigh tube **A** and contents.

8. Repeat steps 5 to 7 until the mass no longer changes.

9. Reweigh tube **B** and contents.

10. Repeat steps 1 to 9 with different masses of the oxide of copper.

(a) Suggest **one** reason why step 8 is needed.

_____

_____

**(1)**

(b) Explain why the excess hydrogen must be burned off.

_____

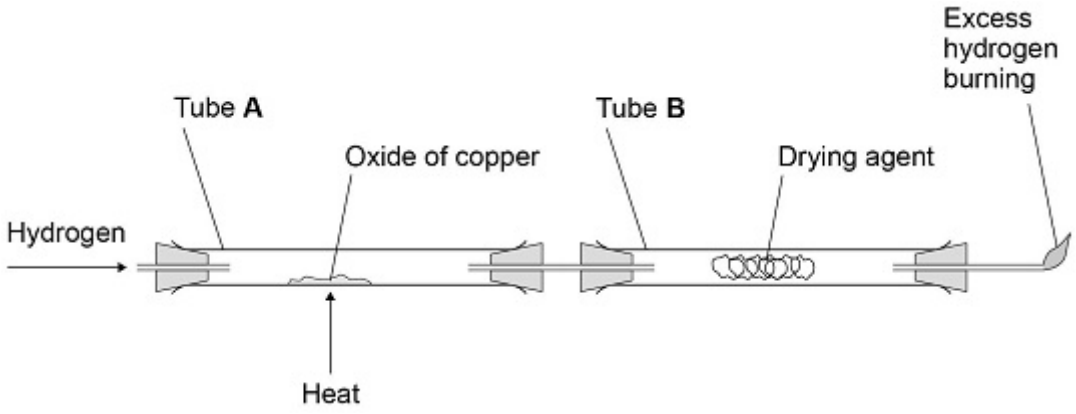
_____

_____

_____

**(2)**

The figure above is repeated here.




The table below shows the teacher's results.

| | **Mass in g** |
|---|---|
| Tube **A** empty | 105.72 |
| Tube **A** and oxide of copper before heating | 115.47 |
| Tube **A** and contents after 2 minutes | 114.62 |
| Tube **A** and contents after 4 minutes | 114.38 |
| Tube **A** and contents after 6 minutes | 114.38 |
| Tube **B** and contents at start | 120.93 |
| Tube **B** and contents at end | 123.38 |

When an oxide of copper is heated in a stream of hydrogen, the word equation for the reaction is:

copper oxide + hydrogen → copper + water

(c) Determine the mass of copper and the mass of water produced in this experiment.

Use the table.

_____

_____

_____

_____

Mass of copper = _____ g

Mass of water = _____ g

**(2)**

(d) The teacher repeated the experiment with a different sample of the oxide of copper.

The teacher found that the oxide of copper produced 2.54 g of copper and 0.72 g of water.

Two possible equations for the reaction are:

**Equation 1:** $Cu_2O + H_2 \rightarrow 2\ Cu + H_2O$

**Equation 2:** $CuO + H_2 \rightarrow Cu + H_2O$

Determine which is the correct equation for the reaction in the teacher's experiment.

Relative atomic masses ($A_r$): H = 1 O = 16 Cu = 63.5

**(3)**

**(Total 8 marks)**

## Q6.

This question is about electrolysis.

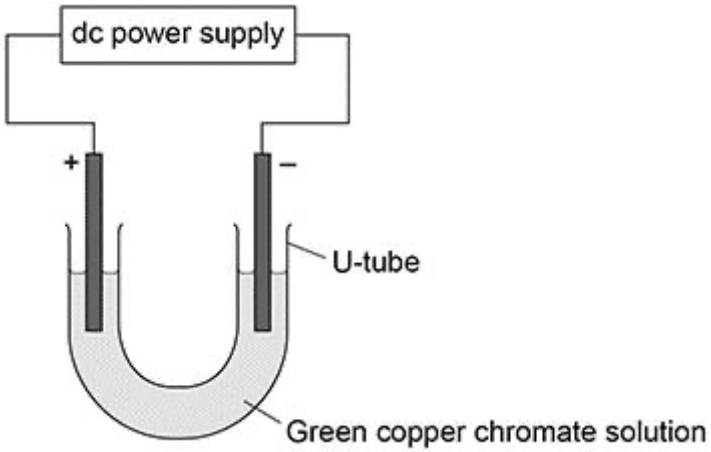
A student investigated the electrolysis of copper chromate solution.

Copper chromate solution is green.

Copper chromate contains:

- blue coloured $Cu^{2+}$ ions
- yellow coloured $CrO_4^{2-}$ ions.

The diagram below shows the apparatus used.




The student switched the power supply on.

The student observed the changes at each electrode.

The table below shows the student's observations.

| Changes at positive electrode | Changes at negative electrode |
|---|---|
| Solution turned yellow<br>Bubbles formed at the electrode | Solution turned blue<br>Solid formed on the electrode |

(a) Explain why the colour changed at the positive electrode.

_____

_____

_____

_____

**(2)**

(b) The gas produced at the positive electrode was oxygen.

The oxygen was produced from hydroxide ions.

Name the substance in the solution that provides the hydroxide ions.

_____

**(1)**

(c) Describe how the solid forms at the negative electrode.

_____

_____

_____

_____

_____

_____

**(3)**

(d) The student repeated the investigation using potassium iodide solution instead of copper chromate solution.

Name the product at each electrode when potassium iodide solution is electrolysed.

Negative electrode

_____

Positive electrode

_____

**(2)**

**(Total 8 marks)**

## Q7.

This question is about acids and alkalis.

(a) Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

_____

_____

_____

_____

**(2)**

(b) A $1.0 \times 10^{-3}$ mol/dm$^3$ solution of hydrochloric acid has a pH of 3.0

What is the pH of a $1.0 \times 10^{-5}$ mol/dm$^3$ solution of hydrochloric acid?

pH = _____

**(1)**

A student titrated 25.0 cm$^3$ portions of dilute sulfuric acid with a 0.105 mol/dm$^3$ sodium hydroxide solution.

(c) The table below shows the student's results.

| | **Titration 1** | **Titration 2** | **Titration 3** | **Titration 4** | **Titration 5** |
|---|---|---|---|---|---|
| Volume of sodium hydroxide solution in cm$^3$ | 23.50 | 21.10 | 22.10 | 22.15 | 22.15 |

The equation for the reaction is:

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

Calculate the concentration of the sulfuric acid in mol/dm$^3$

Use only the student's concordant results.

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

Concentration of sulfuric acid = _____ mol/dm$^3$

**(5)**

(d) Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

**(2)**

(e) Calculate the mass of sodium hydroxide in 30.0 cm$^3$ of a 0.105 mol/dm$^3$ solution.

Relative formula mass ($M_r$): NaOH = 40

Mass of sodium hydroxide = _____ g

**(2)**
**(Total 12 marks)**

## Q8.

Soluble salts are formed by reacting metal oxides with acids.

(a) Give **one** other type of substance that can react with an acid to form a soluble salt.

_____

**(1)**

(b) Calcium nitrate contains the ions $Ca^{2+}$ and $NO_3^-$

Give the formula of calcium nitrate.

_____

**(1)**

(c) Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

_____

_____

_____

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_____

_____

_____

**(6)**

**(Total 8 marks)**

## Q9.

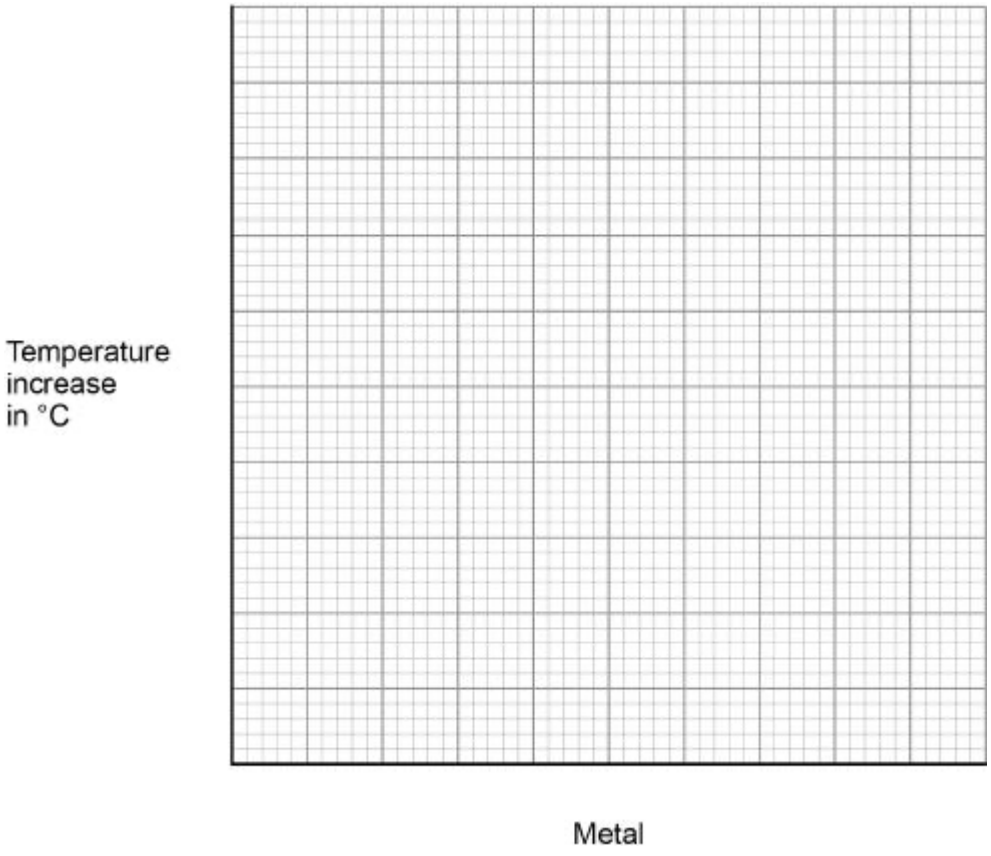
A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

The table below shows the student's results.

| **Metal** | **Temperature increase in °C** |
|---|---|
| Copper | 0 |
| Iron | 13 |
| Magnesium | 43 |
| Zinc | 17 |

(a) Plot the data from the table above on **Figure 1** as a bar chart.

**Figure 1**




**(2)**

(b) The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give **one** reason why this conclusion is **not** correct.

_____

_____

**(1)**

(c) The temperature change depends on the reactivity of the metal.

The student's results are used to place copper, iron, magnesium and zinc in order of their reactivity.

Describe a method to find the position of an unknown metal in this reactivity series.

Your method should give valid results.

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(d) Draw a fully labelled reaction profile for the reaction between zinc and copper sulfate solution on **Figure 2**.

**Figure 2**


**(3)**

**(Total 10 marks)**

## Q1.

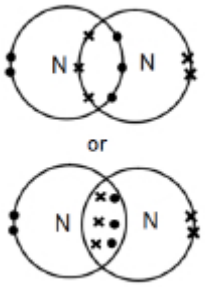
(a) six electrons in the overlap

*allow dots, crosses or $e^{(-)}$ for electrons*

1

2 non-bonding electrons on each nitrogen atom

***2** marks for an answer of:*




1

(b) weak forces

1

between molecules
**or**
intermolecular

*do not allow references to covalent bonding between molecules*

1

(which) need little energy to overcome

1

(c) each (carbon) atom forms three covalent bonds

1

forming layers (of hexagonal rings)

1

(soft)
(because) layers can slide over each other

1

(conducts electricity)
(because of) delocalised electrons

1

(d) molecules are spherical

1

(so molecules) will roll

1

(e) surface area (= 20 × 20 × 6) = 2400 ($nm^2$)

1

volume (= $20^3$) = 8000 ($nm^3$)

1

ratio = 0.3 ($nm^3$): 1 ($nm^3$)
ratio = 0.3 ($nm^3$): 1 ($nm^3$)
**or**
1 ($nm^3$): 3.33 ($nm^3$)

**1**

(f) (nanoparticles) have a larger surface area to volume ratio

**1**

so less can be used for the same effect

**1**

**[16]**

## Q2.

(a) **J**

**1**

(b) **M** and **Q**

*either order*

**1**

(c) **Q**

**1**

(d) **M**

**1**

(e) **L**

**1**

(f) **Level 3 (5-6 marks):**
A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

**Level 2 (3-4 marks):**
Some logically linked reasons are given. There may also be a simple judgement.

**Level 1 (1-2 marks):**
Relevant points are made. They are not logically linked.

**Level 0**
No relevant content

**Indicative content**

**comparative points**
- both tables have more than one element in a box
- both have similar elements in the same column
- both are missing the noble gases
- both arranged elements in order of atomic weight

**advantages of Mendeleev / disadvantages of Newlands**
- Newlands did not leave gaps for undiscovered elements
- Newlands had many more dissimilar elements in a column
- Mendeleev left gaps for undiscovered elements
- Mendeleev changed the order of some elements (e.g. Te and I)

**points which led to the acceptance of Mendeleev's table**

- Mendeleev predicted properties of missing elements
- elements with properties predicted by Mendeleev were discovered
- Mendeleev's predictions turned out to be correct
- elements were discovered which fitted the gaps

**6**

**[11]**

## Q3.

(a) because atoms / ions / particles in alloy are different (sizes)

*do **not** allow reference to molecules*

*ignore reference to compounds*

**1**

so layers distorted

(and layers / atoms / ions / particles) don't slide **or** slide less easily

*accept all marking points in a suitably labelled or annotated diagram*

**1**

*if no other mark awarded accept an alloy is a mixture **or** contains different metals / elements for **1** mark*

**1**

(b) giant structure **or** lattice **or** macromolecule

*max **3** marks if incorrect bonding*

**1**

strong bonds (between carbon / atoms)

**1**

covalent (bonds)

**1**

each carbon / atom forms 4 bonds

*accept tetrahedral*

*if no other marks awarded, allow carbon (atoms) for **1** mark*

**1**

(c) *reference to incorrect bonding = max **3***

*reference to 'weak covalent bonds' = max **2***

*allow correctly drawn diagram for first two marking points eg. (tangled) lines with no cross-links*

chains **or** large molecules

*ignore layers*

**1**

with intermolecular forces **or** forces between chains

*allow bonds for forces accept no cross-links*

**1**

that are weak

*must relate to 2 $^{nd}$ marking point*

**1**

and are easily overcome/ broken (when heated)

*accept molecules / chains can flow / move*

1

**[11]**

## Q4.

(a) polystyrene is a better (thermal) insulator

*allow polystyrene is a poorer (thermal) conductor*

1

(so) reduces energy exchange (with the surroundings)

*allow (so) reduces energy / heat loss (to the surroundings)*

1

(b) all six points plotted correctly

*allow a tolerance of ± ½ a small square*
*allow **1** mark for at least 3 points plotted correctly*

2

line of best fit through points plotted from the table

1

both lines of best fit extrapolated correctly until they cross

1

(c) 11 ($cm^3$)

*allow ecf from part (b)*
*allow answers in the range 10.75 to 11.25 ($cm^3$)*
*allow a tolerance of ± ½ a small square*

1

(d) (27.5 − 18.9) = 8.6 (°C)

*allow ecf from part (b)*
*allow answers in the range 8.5 to 8.7 (°C)*
*allow a tolerance of ± ½ a small square*

1

(e)

*an answer of 0.62 ($mol/dm^3$) for concentration in $mol/dm^3$ scores **4** marks*
*an answer of 0.31 ($mol/dm^3$) for concentration in $mol/dm^3$ scores **3** marks*

(moles $H_2SO_4$ = 0.500 × $\frac{15.5}{1000}$) = 0.00775

1

(moles KOH = 2 x moles $H_2SO_4$ = 2 x 0.00775) = 0.0155

*allow correct calculation using incorrectly calculated value of moles of $H_2SO_4$*

1

(conc KOH = moles KOH x $\frac{1000}{25.0}$ ) = 0.0155 x $\frac{1000}{25.0}$)

*allow correct calculation using incorrectly calculated value of moles of KOH*

1

= 0.62 ($mol/dm^3$)

*allow correct answer using incorrectly calculated value of moles of KOH*

1

($M_r$ KOH =) 56

1

(conc = $M_r$ x conc in $mol/dm^3$ = 56 x 0.62) = 34.7 ($g/dm^3$)

*allow 35 or 34.72 ($g/dm^3$)*

*allow correct answer using incorrectly calculated value of concentration in $mol/dm^3$ and/or incorrect $M_r$*

1

**alternative approach for step 1 to step 4**

$$\frac{2}{1} = \frac{25 \times \text{conc KOH}}{15.5 \times 0.500} \quad (2)$$

$$(\text{conc KOH}) = \frac{2 \times 15.5 \times 0.500}{25.0} \quad (1)$$

= 0.62 ($mol/dm^3$) (1)

*allow 1 mark if mole ratio is incorrect*

1

**[14]**

## Q5.

(a) to make sure all of the oxide (of copper) has reacted

**or**

to make sure all water (produced) is removed

*ignore to ensure complete reaction unqualified*
*ignore to make sure all of the hydrogen has reacted*

1

(b) to prevent hydrogen escaping (into the air)

1

(because) hydrogen is explosive

*ignore hydrogen is flammable*

1

(c) (mass of copper) 8.66 (g)

1

(mass of water) 2.45 (g)

1

(d) moles Cu = 0.04

**or**

$\frac{2.54}{63.5} = 0.04$

1

moles $H_2O$ = 0.04

**or**

$\frac{0.72}{18} = 0.04$

1

ratio = 1:1 so equation 2 is correct

1

**alternative approach A**
(calculating mass of water from copper)

moles Cu= 0.04 **or** $\frac{2.54}{63.5} = 0.04(1)$

0.02 x 18 = 0.36 (g of water for equation 1) (1)

0.04 x 18 = 0.72 (g of water) so equation 2 is correct (1)

**alternative approach B**
calculating mass of copper from water)

moles $H_2O$=0.04 **or** $\frac{0.72}{18}$=0.04 (1)

0.08 x 63.5 = 5.08 (g of copper for equation 1) (1)

0.04 x 63.5 = 2.54 (g of copper) so equation 2 is correct (1)

***alternative approach C***
*(mass ratio)*
*(copper : water for equation 1)*
*127 : 18 = 7.06 : 1 (1)*
*(copper : water for equation 2)*
*63.5 : 18 = 3.53 : 1 (1)*
*2.54 : 0.72 = 3.53 : 1 = 63.5 : 18*
*so equation 2 is correct (1)*

**[8]**

## Q6.

(a) $CrO_4^{2-}$ / chromate ions moved to the positive electrode

*allow anode for positive electrode*

*allow yellow (coloured) ions moved to the positive electrode*

1

(because) opposite charges attract

*allow (because) negative ions are attracted to the positive electrode*

1

(b) water

*ignore copper chromate solution*

1

(c) copper ions gain two electrons

*allow $Cu^{2+}$ for copper ions*

*allow **1** mark for copper ions gain electrons*

***or***

*allow **1** mark for copper ions are reduced*
*do **not** accept copper ions are oxidised*

**2**

(to) form copper (atoms)

*allow Cu for copper (atoms)*

*the equation:*
*$Cu^{2+} + 2e^- \rightarrow Cu$*
*scores **3** marks*

**1**

(d) (negative electrode) hydrogen

*allow $H_2$*

**1**

(positive electrode) iodine

*allow $I_2$*

**1**

**[8]**

## Q7.

(a) (strong because) completely ionised (in aqueous solution)

*ignore pH*

*allow dissociated for ionised*

*do **not** accept hydrogen is ionising*
*do **not** accept $H^+$ are ionised*

**1**

(dilute because) small amount of acid per unit volume

*ignore low concentration*

**1**

(b) 5.0

*allow 5*

**1**

(c) (titre):
chooses titrations 3, 4, 5

**1**

average titre = 22.13 ($cm^3$)

*allow average titre = 22.13(3…) ($cm^3$)*
*allow a correctly calculated average from an incorrect choice of titrations*

**1**

(calculation):
(moles NaOH =

$$\frac{22.13}{1000} \times 0.105 = 0.002324)$$

*allow use of incorrect average titre from step 2*

**1**

(moles $H_2SO_4$ =
½ × 0.002324 =) 0.001162

*allow use of incorrect number of moles from step 3*

1

(concentration = $\frac{0.001162}{25} \times 1000$)

= 0.0465 (mol/dm$^3$)

*allow use of incorrect number of moles from step 4*

1

*alternative approach for step 3, step 4 and step 5*

$\frac{2}{1} = \frac{22.13 \times 0.105}{25.0 \times conc.\ H_2SO_4}$ *(1)*

*(concentration $H_2SO_4$ =)*

$\frac{22.13 \times 0.105}{25.0 \times 2}$

*= 0.0465 (mol/dm$^3$) (1)*

*an answer of 0.046473* ***or*** *0.04648 correctly rounded to at least 2 sig figs scores marking points 3, 4 and 5*

*an answer of 0.092946* ***or*** *0.09296* ***or*** *0.185892* ***or*** *0.18592 correctly rounded to at least 2 sig figs scores marking points 3 and 5*

*an incorrect answer for one step does* ***not*** *prevent allocation of marks for subsequent steps*

(d) pipette measures a fixed volume (accurately)

1

(but) burette measures variable volume

*allow can measure drop by drop*

1

(e) $(moles =) \frac{30}{1000} \times 0.105$

**or** 0.00315 (mol)

**or**

(mass per dm$^3$ =) 0.105 × 40

**or** 4.2 (g)

1

$(mass = \frac{30}{1000} \times 0.105 \times 40)$

= 0.126 (g)

1

*an answer of 0.126 (g) scores* ***2*** *marks*

*an answer of 126(g) scores* ***1*** *mark*

*an incorrect answer for one step does* ***not*** *prevent allocation of marks for subsequent steps*

**[12]**

## Q8.

(a) any **one** from:

- metal

- (metal) hydroxide
  *allow ammonium hydroxide*

- (metal) carbonate
  *allow ammonium carbonate*

- alkali
  *allow soluble base*
  *allow ammonia*

  *allow named example*
  *allow correct formula*
  *ignore base*

**1**

(b) $Ca(NO_3)_2$

*allow* $Ca^{2+}(NO_3^-)_2$

**1**

(c) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

**5–6**

**Level 2:** The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

**3–4**

**Level 1:** The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

**1–2**

**No relevant content**

**0**

**Indicative content**

- use magnesium oxide and sulfuric acid
- add sulfuric acid to a beaker
- warm sulfuric acid
- add magnesium oxide
- stir
- continue adding until magnesium oxide is in excess

- filter
- using a filter paper and funnel
- to remove excess magnesium oxide

- heat solution in an evaporating basin
- to crystallisation point
- leave to crystallise
- pat dry with filter paper

credit may be given for diagrams

**[8]**

## Q9.

(a) all 4 metals labelled and suitable scale on *y*-axis

*magnesium value must be at least half the height of the grid*

**1**

all bars correctly plotted

*allow a tolerance of ±½ a small square*

*ignore width and spacing of bars*

*allow **1** mark if copper not included and other 3 bars plotted correctly*

**1**

(b) temperature increases

*allow (because) energy / 'heat' is transferred to the surroundings*
*allow energy / 'heat' is given out*

**or**

temperature does not decrease

*allow energy / 'heat' is not taken in (from the surroundings)*
*allow the energy of the products is less than the energy of the reactants*

**1**

*ignore because it is exothermic*
*ignore references to copper*

(c) suitable method described

**1**

the observations / measurements required to place in order

*dependent on a suitable method*

**1**

an indication of how results would be used to place the unknown metal in the reactivity series

**1**

a control variable to give a valid result

**1**

**approaches that could be used**

**approach 1:**
add the unknown metal to copper sulfate solution (1)

measure temperature change (1)

place the metals in order of temperature change (1)

any **one** from (1):
- same volume of solution
- same concentration of solution
- same mass / moles of metal
- same state of division of metal

**approach 2:**
add the metal to salt solutions of the other metals

**or**
heat the metal with oxides of the other metals (1)

measure temperature change (only if salt solutions used)
**or**
observe whether a chemical change occurs (1)

place the metals in order of temperature change **or**
compare whether there is a reaction to place in correct order (1)

any **one** from (1):
- same volume of salt solutions
- same concentration of salt solutions
- same (initial) temperature of salt solutions
- same mass / moles of metal **or** metal oxide
- same state of division of metal **or** metal oxide

**approach 3:**
add all of the metals to an acid (1)

measure temperature change or means of comparing rate of reaction (1)

place the metals in order of temperature change or rate of reaction (1)

any **one** from (1):
- same volume of acid
- same concentration of acid
- same (initial) temperature of acid
- same mass / moles of metal
- same state of division of metal

**approach 4:**
set up electrochemical cells with the unknown metal as one electrode and each of the other metals as the other electrode (1)

measure the voltage of the cell (1)

place the metals in order of voltage (1)

any **one** from (1):
- same electrolyte
- same concentration of electrolyte
- same (initial) temperature of acid
- same temperature of electrolyte

(d) correct shape for exothermic reaction

*the reactant and product lines needed not be labelled*

*do **not** accept incorrectly labelled reactant and product lines*

**1**

labelled activation energy

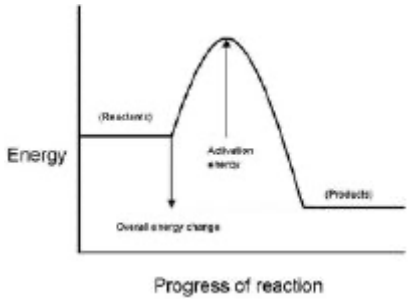
**1**

labelled (overall) energy change

**1**

*ignore arrow heads*

*an answer of:*




*scores **3** marks*

**[10]**