Killara High School

**2024** **Year 11 Examination**

# Chemistry

**General Instructions**

- Reading time – 5 minutes
- Working time – 2 hours
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used
- A formulae sheet, data sheet and Periodic Table are provided at the back of this paper

**Total marks: 75**

**Section I – 15 marks** (pages 2-7)

- Attempt Questions 1-15
- Allow about 20 minutes for this section

**Section II – 60 marks** (pages 11-23)

- Attempt questions 16-32
- Allow about 1 hour and 40 minutes for this section

**Section I**

**15 marks**
**Attempt Question 1-15**
**Allow 20 minutes for this section**

Use the multiple-choice answer sheet for Questions 1-15.

**1** A soil sample containing sand and leaf litter was dried. What technique would be most appropriate to separate the sand from the leaf litter?

A. Decanting

B. Evaporating

C. Sieving

D. Filtering

**2** An atom has the orbital notation of:

$$1s^2 2s^2 2p^6$$

Which atom is this?

A. Ne

B. Na

C. K

D. Cl

**3** Which atoms are listed in the order of increasing electronegativity?

A. Ti, Zr, Hf, Rf

B. Br, Se, As, Ge

C. I, Br, Cl, F

D. F, O, N, C

**4** Which of the following lists only allotropes of carbon?

A. carbon-12, carbon-13, carbon-14

B. diamond, graphite, carbon nanotubes

C. carbonates, carbon dioxides, carbonic acid

D. carbon monoxide, carbon dioxide, carbon tetrachloride

**5** What is the IUPAC systematic name for $MnO_2$?

A. magnesium oxide

B. manganese(IV) oxide

C. manganese(II) oxide

D. manganese oxide

**6** According to Boyle's Law, if the pressure of a gas is doubled while keeping the temperature constant, what happens to the volume of the gas?

A. The volume is halved.

B. The volume is doubled.

C. The volume remains the same.

D. The volume is quadrupled.

**7** What does an empirical formula represent?

A. The total mass of a compound.

B. The molecular structure of a compound.

C. The exact number of each type of atom in a molecule.

D. The simplest whole-number ratio of atoms in a compound.

**8** When measuring the mass of a solid reactant before and after a chemical reaction, which principle is used to ensure accurate measurement of the reaction's yield?

A. The law of conservation of energy

B. The law of conservation of mass

C. The principle of equilibrium

D. All of the above

**9** Which piece of equipment is essential for accurately measuring and mixing a precise volume of solvent when preparing a standard solution?

A. Beaker

B. Burette

C. Volumetric flask

D. Measuring cylinder

**10** A 75.0 g sample of an iron oxide contains 22.5 g of iron. How many grams of oxygen is present in the sample?

A. 22.5 g

B. 52.5 g

C. 37.5 g

D. 50.0 g

Refer to the information and table to answer **Questions 11 and 12**.

In an investigation to determine how a factor affects the rate of chemical reaction, the following data was collected.

| Initial reactant concentration (mol $L^{-1}$) | Temperature (°C) | Surface area ($cm^2$) | Rate of reaction (mol $s^{-1}$) |
|---|---|---|---|
| 2.0 | 20 | 0.8 | 3.2 |
| 2.0 | 40 | 0.8 | 3.8 |
| 2.0 | 60 | 0.8 | 4.0 |
| 2.0 | 80 | 0.8 | 4.2 |

**11** Which row is correct?

| | *Variables* | | |
|---|---|---|---|
| | *Independent* | *Dependent* | *Controlled* |
| A. | Temperature | Rate of reaction | Initial reactant concentration; Surface area |
| B. | Surface area | Temperature | Rate of reaction; Initial reactant concentration |
| C. | Initial reactant concentration | Surface area | Temperature; Rate of reaction |
| D. | Rate of reaction | Initial reactant concentration | Temperature; Surface area |

**12** Using the data shown, what would occur when the temperature is increased to 100°C?

A. The reaction will stop.

B. The rate of reaction would decrease.

C. There will be no change in the rate of reaction.

D. The rate of reaction would increase.

**13** Predict the outcome of mixing barium nitrate with magnesium sulfate.

**Solubility of common ionic compounds**

| COMPOUNDS THAT ARE SOLUBLE | COMPOUNDS THAT ARE INSOLUBLE |
|---|---|
| • Group 1 and $NH_4^+$ compounds<br>• Nitrates<br>• Chlorides (except $Ag^+$ and $Pb^{2+}$)<br>• Sulfates (except $Ag^+$, $Pb^{2+}$, $Ba^{2+}$, $Sr^{2+}$, $Ca^{2+}$) | • Carbonates (except group 1 and $NH_4^+$)<br>• Hydroxides, Oxides } (except group 1, $NH_4^+$, $Ba^{2+}$, $Sr^{2+}$ $Ca^{2+}$) |

A. There is no reaction.

B. A gas is formed.

C. The reaction goes on fire.

D. A precipitate is formed.

**14** Hydrogen iodide is formed from its elements:

$$I_2(g) + H_2(g) \rightarrow 2HI\ (g) \qquad \Delta H = +52.90\ kJ/mol$$

Which of the following is closest to the enthalpy change for the decomposition of one mole of hydrogen iodide?

A. -52.90 kJ/mol

B. +52.90 kJ/mol

C. -26.45 kJ/mol

D. -7.27 kJ/mol

**15** A student made the following statements about enthalpy changes in reactions:

*i. Hess' law works because energy is not created or destroyed in chemical reactions*

*ii. Breaking bonds requires an energy input*

*iii. When the enthalpy change for a reaction is positive, the chemical bonds in the products are higher in energy than those of the reactants.*

*iv. The enthalpy change for an exothermic reaction must be greater than the activation energy*

Which statements are true?

A. i only

B. i and ii only

C. i, ii and iii only

D. i, ii, iii, iv

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Student number

**2024** **Year 11 Examination**

**Multiple Choice Answer Sheet**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **1.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **2.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **3.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **4.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **5.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **6.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **7.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **8.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **9.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **10.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **11.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **12.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **13.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **14.** | A | ◯ | B | ◯ | C | ◯ | D ◯ |
| **15** | A | ◯ | B | ◯ | C | ◯ | D ◯ |

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**2024** **Year 11 Examination**

# Chemistry

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Student Number

# Section II Answer Booklet

**60 marks**
**Attempt Questions 16 - 33**
**Allow about 1 hour and 40 minutes for this section**

**Instructions**

- Write your student number at the top of this page.
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing booklets are available on request.

**Question 16** (5 marks)

Two students are arguing over whether a salad dressing made from white vinegar (ethanoic acid + water) and olive oil (oil) is a homogenous or heterogeneous mixture.

| | Ethanoic acid | Water | Oil |
|---|---|---|---|
| Boiling point (°C) | 117 | 100 | 180 |
| Miscible in water | yes | - | no |
| Colour | colourless | colourless | yellow |

The students want to separate the mixture into its components.

a) State a method of separate that could be used to remove the oil. **1**

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b) Explain why the separation of water and ethanoic acid would be different to Part (a) **2**

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**Question 17** (2 marks)

Sulfur has 4 common isotopes as shown in the table below.

| Mass number | 32 | 33 | 34 | 36 |
|---|---|---|---|---|
| Relative abundance (%) | 94.99 | 0.75 | 4.25 | 0.01 |

Calculate the relative atomic mass of a sulfur atom. (Show all working) **2**

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**Question 18** (2 marks)

Ammonium chloride ($NH_4Cl$) decomposes upon heating to form ammonia gas ($NH_3$) and hydrogen chloride gas (HCl). The balanced chemical reaction is as follows:

$$NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$$

How many grams of $NH_4Cl$ is required to produce 20 g of $NH_3$? **2**

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**Question 19** (5 marks)

Magnesium oxide can be produced by reacting magnesium and oxygen gas together.

a. Write a balanced chemical equation for this reaction. **1**

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b. Determine how many moles of magnesium oxide can be produced when 0.75 moles of magnesium and 0.50 moles of oxygen are reacted together. **2**

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c. Identify the substance that is in excess. Then, calculate the mass remaining once the limiting reagent is consumed. **2**

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**Question 20** (4 marks)

Four metals (W, X, Y and Z) are tested with steam, dilute hydrochloric acid and a blue copper (II) sulfate solution. After a short time, the following observations were recorded.

| *Metals* | *Test and observations* | | |
|---|---|---|---|
| | *Steam* | *Dilute HCl* | *$CuSO_4$ (aq)* |
| W | No gas | Slight bubbling | Colourless |
| X | No gas | No change | Remains blue |
| Y | No gas | No change | Colourless |
| Z | Small bubbles of gas | Vigorous bubbling | White |

(a) Use these observations to rank the metals from most reactive to least reactive. **1**

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Another Metal (Q) is tested in the same way and is observed to produce the same results as metal W.

b) Outline a test, which includes expected observations, that would more accurately compare the reactivities of metals Q and W. **3**

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Student Number

**Question 21** (6 marks)

An investigation was performed to measure the volume of hydrogen gas produced when a 5.0 g piece of magnesium metal reacted with 0.1 mol $L^{-1}$ nitric acid solution. The data collected was recorded in the table below.

| *Time (s)* | *Volume of $H_2$ (mL)* |
|---|---|
| 0 | 0 |
| 10 | 29 |
| 20 | 41 |
| 30 | 44 |
| 40 | 45 |
| 50 | 46 |
| 60 | 46 |
| 70 | 46 |
| 80 | 46 |
| 90 | 46 |

(a) Write a balanced chemical equation for the reaction. **1**

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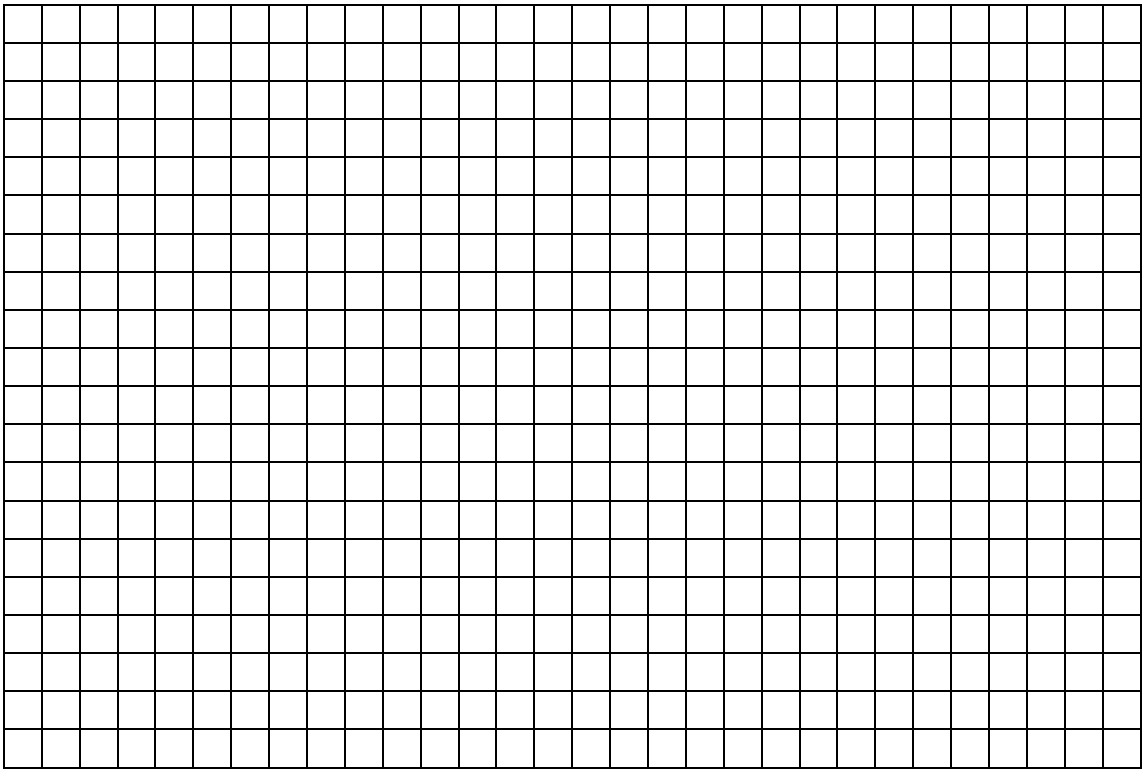
**Question 21 continues on the next page**

(b) Graph the results on the grid below. **3**



Time (s)

(c) Use Collision theory to explain how the shape of the graph would change if 5.0 g of magnesium metal was divided into smaller fragments before its addition to nitric acid solution. **2**

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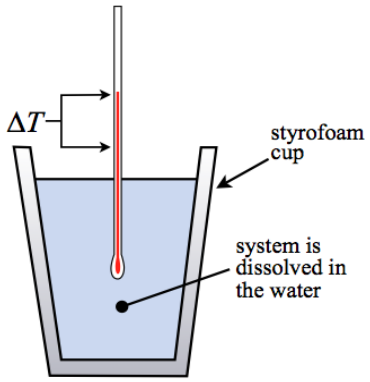
**Question 22** (5 marks)

Ammonium nitrate ($NH_4NO_3$) was dissolved in water and the change in temperature measured as shown:




a) A student recorded the following data when she added 20.0 g of ammonium nitrate to 200 g of water:

| *Initial Water Temperature ($^0C$)* | *Final Water Temperature ($^0C$)* | *Temperature Change ($^0C$)* |
|---|---|---|
| 25.0 | 11.4 | -8.6 |
| 25.0 | 11.6 | -8.4 |
| 25.0 | 13.3 | -8.7 |

Determine the enthalpy change (in kJ/mol) for this reaction. **3**

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b) This experiment makes use of polystyrene, a single-use plastic that can no longer be purchased. A replacement cup needs to be used for future experiments.

What property must be considered when selecting a different cup for this reaction. Justify your response **2**

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**Question 23** (3 marks)

Hydrogen peroxide decomposes to form water and oxygen gas as shown:

$$H_2O_2 \rightarrow H_2O + O_2$$

The reaction can be catalysed using iodide ions ($I^-$). In a series of steps:

$$H_2O_2 + I^- \rightarrow H_2O + OI^-$$

$$H_2O_2 + OI^- \rightarrow H_2O + O_2 + I^-$$

A student carried out BOTH reactions and recorded observations over 5 minutes.

| *Type of Reaction* | *Uncatalysed* | *Catalysed* |
|---|---|---|
| *Observations* | No change was observed | A large volume of oxygen gas formed |

With reference to the above, provide two features of iodide ions that are shared by most catalysts. **3**

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**Question 24** (2 marks)
Due to its high potassium content, eating a banana will provide you with a dose of 0.1 μSv of radiation from the naturally occurring potassium-40 isotope from beta decay.

(i) Suggest a reason why potassium-40 is an unstable isotope. **1**

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(ii) Write a nuclear equation to represent the decay of potassium-40 **1**

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**Question 25** (3 marks)

With reference to the Bohr model outline why different metals produce different colours in a flame test. **3**

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**Question 26** (3 marks)

Describe the term electronegativity and explain its trend on the periodic table. **3**

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**Question 27** (2 marks)

Draw the Lewis electron dot diagram for ammonia ($NH_3$) **1**

**Question 28** (4 marks)

Carbon dioxide ($CO_2$) is a gas at room temperature whereas water ($H_2O$) is liquid. Using your understanding of structure, intermolecular force and intramolecular force account for the difference in state at room temperature for these substances.
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**Question 29** (6 marks)

During this course you have prepared a standard solution.

a) A standard solution of copper (II) sulfate is being prepared. Calculate the mass of copper (II) sulfate needed to prepare a 0.2 mol $L^{-1}$ standard solution of copper (II) sulfate in a 500 mL volumetric flask. **2**

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b) Outline the steps to make 500 mL of 0.2 mol $L^{-1}$ of copper (II) sulfate standard solution in a laboratory. **2**

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c) What volume of copper (II) sulfate prepared in part b would be required if the solution needs to be diluted to make 500 mL of 0.6 mol $L^{-1}$ solution? **2**

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**Question 30** (2 marks)

Using the ideal gas law, calculate the number of moles of carbon dioxide needed to fill a 250 mL container to a pressure of 220 kPa at 25°C. **2**

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**Question 31** (4 marks)

The dichromate ion ($Cr_2O_7^{2-}$) is a powerful oxidant that can oxidise platinum to form its ion ($Pt^{2+}$). The reduction potential of platinum has been measured to be 1.2 V.

(a) Write a net ionic equation that relates to the reaction between dichromate ions and platinum. **2**

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(b) Determine the maximum theoretical voltage produced from a coupling of a standard $Pt/Pt^{2+}$ half-cell with a standard $Cr_2O_7^{2-}/Cr^{3+}$ half-cell. **2**

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**Question 32** (3 marks)

The following reaction shows the formation of carbon dioxide and sulfur dioxide:

$$CS_2\,(l) + 3O_2\,(g) \rightarrow CO_2\,(g) + 2SO_2\,(g)$$

The enthalpy change for the following reactions are accurately known:

i. $C\,(s) + O_2\,(g) \rightarrow CO_2\,(g) \qquad \Delta H = -393.5\ kJ/mol$

ii. $S\,(s) + O_2\,(g) \rightarrow SO_2\,(g) \qquad \Delta H = -296.8\ kJ/mol$

iii. $C\,(s) + 2S\,(s) \rightarrow CS_2\,(l) \qquad \Delta H = +87.9\ kJ/mol$

Determine the enthalpy change for the formation of $CO_2$ and $SO_2$ from $CS_2$ and $O_2$. **3**

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**Question 33** (2 marks)

The bond energies for several bonds are shown below.

| *Bond* | *Energy (kJ/mol)* |
|---|---|
| N-H | 464 |
| O-H | 389 |
| O=O | 498 |

Ammonia reacts with oxygen gas to produce nitrogen dioxide and water:

$$4NH_3(g) + 7O_2(g) \rightarrow 4NO_2(g) + 6H_2O\,(g) \qquad \Delta H = -1135\ kJ/mol$$

Determine the average bond energy for a bond in $NO_2$. **2**

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**End of Task**

# 11 Chemistry 2024 Marking Criteria

## Multiple Choice

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C | A | C | B | B | A | D | B | C | B | A | D | D | C | C |

## Question 16

a)

| Criteria | Mark |
|---|---|
| States an appropriate method of separation e.g. separating funnels | 1 |

Sample answer: Separating funnel

b)

| Criteria | Marks |
|---|---|
| Explains why the separation of two miscible substances is different to two immiscible liquids. | 2 |
| Identifying intermolecular bonding between water and ethanoic acid results in a miscible mixture. OR Some relevant information relating to separation of liquids. | 1 |

Sample answer: In part (a) the oil and water mixture is immiscible and can be separated with a separating funnel unlike the water/ethanoic acid mixture that is miscible due to the hydrogen bonding between the ‘like’ molecules. Therefore a technique such as distillation would be more appropriate.

## Question 17

| Criteria | Marks |
|---|---|
| Correctly calculates the relative atomic mass using the relative abundance of each isotope. | 2 |

| | |
|---|---|
| Attempts to calculate the relative atomic mass using the relative abundance of each isotope showing some correct working and/or rounds the answer | 1 |

Sample answer:

Relative atomic mass of S = 0.9499 x 32 + 0.0075 x 33 + 0.0425 x 34 + 0.0001 x 36 = 32.093 amu

## Question 18

| Criteria | Mark |
|---|---|
| • Correct working out provided.<br>• Correct answer was obtained. | 2 |
| • | |
| • Minimal mistakes in working out with an answer that makes sense with the error. | 1 |

Marker's Note: Students with correct working out, regardless of rounding get full marks

Sample Answer:

$n_{NH3}$= m/MM = 20/17.034

= 1.174 mol

n $NH_4Cl$= n $NH_3$=1.174 mol (1:1 molar ratio)

Mass of $NH_4Cl$=number of moles×molar mass=1.174 mol×53.492 g/mol≈62.799 g = 62.80 g

## Question 19

a)

| Criteria | Mark |
|---|---|
| • The correct balanced chemical equation for this reaction. | 1 |

Sample Answer:

$2Mg + O_2 \rightarrow 2MgO$

b)

| Criteria | Mark |
|---|---|
| • Working out was provided to work out the answer.<br>• The correct answer was obtained (0.75 mol) | 2 |
| • Working out was provided, but a mistake was made leading to the wrong answer<br>OR<br>• The correct answer was listed with no working out. | 1 |

Sample Answer:

Mole ratio for this reaction is 2:1:2 ($Mg:O_2:MgO$).

Moles of $O_2$ needed= 0.75/2 = 0.375 moles of $O_2$

We have 0.50 moles of $O_2$, which is more than 0.375 moles, so $O_2$ is in excess and Mg is the limiting reagent.

Now, calculate the moles of MgO produced based on the limiting reagent (Mg): The mole ratio of Mg to MgO is 2:2 or 1:1.

Moles of MgO produced=Moles of Mg=0.75 moles

c)

| Criteria | Mark |
|---|---|
| • Oxygen is identified as the substance in excess*<br>• Correct working out was provided.<br>• Correct answer was obtained. | 2 |
| • Oxygen is identified as the substance in excess.<br>• Working out was provided with minimal mistakes leading to another answer OR correct answer provided with no working out. | 1 ½ |
| • Oxygen is identified as the substance in excess. | 1 |

Sample Answer:

Excess moles of $O_2$= 0.50 − 0.375= 0.125 moles

Mass of excess $O_2$ = $nO_2$ x MM
0.125 ×32.00 = 4.00 g

## Question 20

Marking guide

(a)

| Criteria | Mark |
|---|---|
| Correctly ranks the metals from most reactive to least reactive | 1 |

Sample answer

Z>W>Y>X

(b)

| Criteria | Mark |
|---|---|
| • Describe the main features of a suitable test to compare the reactivities of metals Q and W.<br>• States relevant observations based on this test | 3 |
| • Describe a suitable test to compare the reactivities of metals V and W.<br>• States relevant observations based on this test | 2 |
| • Provides some relevant information | 1 |

Sample answer

The reactivities of metals Q and W could be compared using displacement reactions:

1. Place a sample of metal Q into a suitable solution containing metal W ions.
2. Place a sample of metal W into a suitable solution containing metal Q ions.

Observations:

If metal W forms on the surface of metal Q as a solid deposit, then metal Q is more reactive than metal W. No change will be observed in the other test.

If metal Q forms on the surface of metal W as a solid deposit, then metal W is more reactive than metal Q. No change will be observed in the other test.

## Q21 (a)

| Criteria | Mark |
|---|---|

| | |
|---|---|
| Writes a correctly balanced equation | 1 |

Sample answer:

$Mg\,(s) + 2HNO_3\,(aq) \rightarrow Mg(NO_3)_2\,(aq) + H_2\,(g)$

(b)

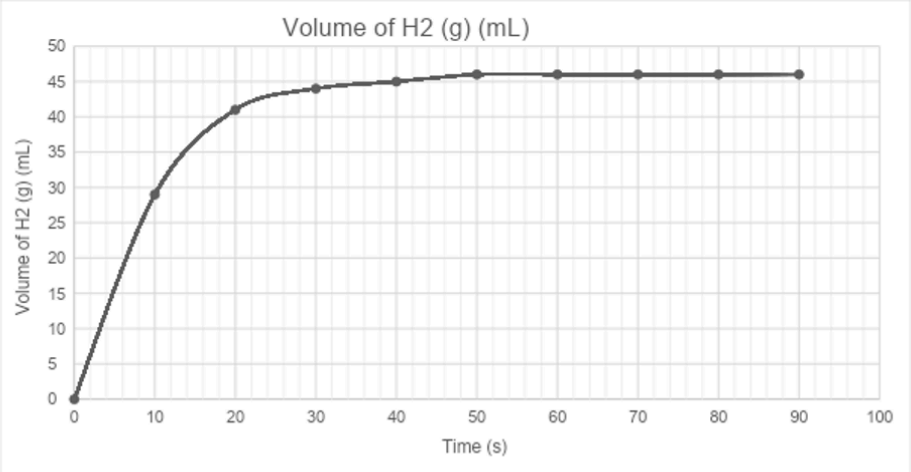
| Criteria | Mark |
|---|---|
| • Correct axes and unit<br>• Scaling and axis orientation<br>• Curve of best fit and Correct graph | 3 |
| • Two of above | 2 |
| • Provides some relevant information | 1 |

Marker's Notes: -1 if no curve

-½ if dots too big covering the area, not the point

**If any student has lost ½ mark for not using enough grid space - please give them that ½ mark.**

Sample answer




(c)

| Criteria | Mark |
|---|---|
| • Refers to Collision theory to correctly describe more collision because of an increase in reactant surface area<br>• Steeper gradient at the beginning or plateau out sooner but at same level | 2 |
| • One of above | 1 |
| • Some relevant information | 0.5 |

Sample answer

The smaller pieces of magnesium will increase the surface area of the metal. Based on collision theory, larger surface area will allow more collision between magnesium and hydrogen ions of acid. Therefore the rate of the reaction will increase. This leads to a steeper gradient of the graph during the initial interval before plateauing sooner than the original graph. The plateau would remain at the same level.

Question 22 a)

| Criteria | Mark |
|---|---|
| • Correct answer with working | 3 |
| • As above with a minor error<br>OR<br>• Calculates q & n | 2 |
| • Correct calculation with error carried forward but wrong units | 1.5 |
| • Shows one correct step in the calculation | 1 |
| • Writes a correct formula<br>OR<br>• Correct q but with unit for enthalpy change<br>or<br>• Calculates the average temperature change | 0.5 |

Sample Answer:

| | |
|---|---|
| n= m/MM<br><br>n= 20/14.01 ×2+1.008 ×4+16.00×3<br>= 20/80.052<br>n= 0.24983 mol | q=mcΔT<br>q=(0.200)(4.18×$10^3$)(-8.567)<br>q=-7162.012 J<br>q=-7.162012 kJ |

ΔH= -q/n

ΔH= 7.162012/0.24983

ΔH= 28.7 kJ/mol

**Marker's Notes:** If a student has got 7161.73J for q and lost a mark, they can be awarded that mark back.

If a student used 12.9 as average for temp. Change, they can have a mark too.

b)

| Criteria | Mark |
|---|---|
| • Justifies a property | 2 |
| • Identifies a source of error<br>OR<br>• Identifies a property<br>OR<br>• Identifies a suitable material | 1 |

Marker's Notes: Students lost a mark if they talked about losing heat and not absorbing heat as the question refers to **this** reaction and it is an endothermic reaction.

Sample Answer:

**2 marks**
The cup needs to be an insulator so that heat is not absorbed from the environment.
OR
The cup needs to prevent to absorption of heat from the environment

**1 mark**

The cup needs to be an insulator
OR
The cup needs to stop heat loss to the environment (NOTE: This is endothermic)

## Question 23

| Criteria | Mark |
|---|---|
| • Notes two reasons with reference to the stimulus | 3 |
| • Provides a reason with reference<br>• Provides two reasons with little reference to stimulus | 2 |
| • Provides relevant information | 1 |

Answers could include:

- The reaction is faster, as seen by the formation of the product (bubbles).
- The reaction proceeds via an alternate pathway, shown by the different steps.
- The iodide ions are not consumed in the reaction.

## Question 24

a

| Criteria | Mark |
|---|---|
| • Show understanding of the higher number of neutron in K-40 compared to K-39 | 1 |

Sample answer:
K-40 has 19 protons and 21 neutrons in the nucleus. It has one more neutron than the stable K-39.

b

| Criteria | Mark |
|---|---|
| • Correct nuclear equation with correct atomic number and mass number | 1 |
| • Correct nuclear equation with correct atomic symbols and missing electron symbol | 1/2 |

Sample answer:

$$^{40}_{19}K \rightarrow {}^{40}_{20}Ca + {}^{0}_{-1}e$$

## Question 25

| Criteria | Marks |
|---|---|
| Outlines the production of different wavelengths of light within an atom with reference to energy levels using the Bohr model as an example. With reference to the flame test. | 3 |
| Correctly references the Bohr model AND links the production of light with different energy levels within an atom. | 2 |

| | |
|---|---|
| Correctly references the Bohr model OR links the production of light with different energy levels within an atom. | 1 |

Sample answer:

The Bohr model of an atom demonstrates that electrons occupy different energy levels within atoms.

In a flame test electrons move from a lower energy level to a higher energy level. As the electrons relax back down to a lower energy state the atom emits the excess energy in the form of light.

The difference in energy levels is different for each atom resulting in different colours for metals in the flame test.

## Question 26

| **Criteria** | **Marks** |
|---|---|
| Clearly defines the term electronegativity AND explains the trend across a period AND along a group. | 3 |
| Clearly defines the term electronegativity AND explains the trend across a period OR along a group. | 2 |
| Attempts to define the term electronegativity OR identifies an appropriate trend for electronegativity on the periodic table. | 1 |

Sample answer:

Electronegativity refers to the ease an atom attracts BONDING electrons towards itself.

Going across a period, the atoms get smaller so the ability of the nucleus to add an extra electron to it increases, which means the electronegativity increases.

Going down a group, the atoms are getting bigger and there is more screening by completely filled electron shells. This means that the nucleus has less attracting power for extra electrons and so electronegativity decreases.

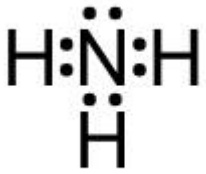
Note: Many students mistake that electronegativity is the ability of an atom to attract its own electrons or ability to ‘gain’ electrons. Both are incorrect.

Just writing ‘ability to attract electrons’ will not be rewarded marks. Has to be ‘Bonding electrons’

Diagonal trend will not gain mark.

## Question 27

| **Criteria** | **Marks** |
|---|---|
| Correctly draws the electron dot diagram for ammonia. | 1 |



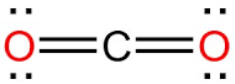
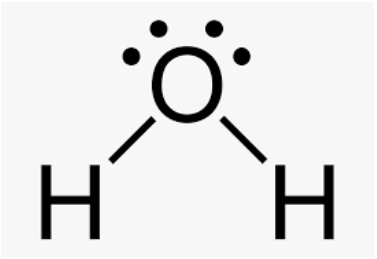
Sample answer:

Note: no half mark given, a bond between atoms will not be penalised here but strongly discouraged.

## Question 28

| **Criteria** | **Marks** |
|---|---|
| Accounts for the difference in state at room temperature with reference to structure AND intermolecular force AND intramolecular force. | 4 |
| Accounts for the difference in state at room temperature with reference to at least two of the following:<br>● structure<br>● intermolecular force<br>● intramolecular force. | 2-3 |
| Provides some relevant information | 1 |

Sample answer:

| | Carbon dioxide | Water |
|---|---|---|
| Structure | Linear molecule  | Bent molecule  |
| Intramolecular force | Covalent bonding with no net dipole | Covalent bonding with net dipole |
| Intermolecular force | Dispersion forces | Hydrogen bonding |

$CO_2$ and $H_2O$ both have covalent intramolecular bonds.

$CO_2$ are linear non-polar molecules that only have weak dispersion force between them. Therefore the molecules can easily overcome the weak dispersion force and are in gas state at room temperature.

$H_2O$ are bent polar molecules that have weak dispersion force, dipole-dipole attraction and hydrogen bond between them. Therefore the molecules require a large amount of energy to overcome the strong hydrogen bonding in addition to dispersion force and dipole-dipole attraction between them and are in liquid state at room temperature.

Note:

- Boiling is a change of state. It is a physical change, NO bonds are broken during boiling.
- C=O double bond strength is stronger than H-O single bond (749 vs 428 kJ/mol)

## Question 29

### a

| Criteria | Mark |
|---|---|
| • Correct answer with working (16 g) | 2 |

| | |
|---|---|
| • Working out with minimal errors leading to an incorrect answer (errors carried)<br>OR<br>• Calculates the moles of copper sulfate.<br>OR<br>• Correct answer is obtained with no working out. | 1 |
| • Identifies a relevant equation | 0.5 |

Marker's Note:
- we did not mark significant figures in this question. If a student had a logical answer (showing all working) they received 2 marks.

**Sample answer:**

Volume of solution = 500 mL = 0.500 L

Concentration (Molarity) = 0.2 mol $L^{-1}$

Number of moles (n)= Concentration (c) × Volume (V)

$n=0.2 \times 0.500$

n = 0.1 moles

Mass=n x MM = 0.1 × 159.62 = 16 grams

## b

| Criteria | Mark |
|---|---|
| • Outlines the important steps | 2 |
| • Identifies at least one correct step (other than weighing 16 g of solid)<br>For example:<br>o Dissolve solid copper sulfate in distilled water and pour into volumetric flask<br>o Rinse beaker with distilled water and transfer rinsings to flask<br>o Fill volumetric flask to 500 mL mark (not 'add 500 mL of water') | 1 |
| • Demonstrates some level of understanding that copper sulfate needs to be dissolved in water.<br><br>Students who said to add 500 mL of water to a volumetric flask, then add solid copper sulfate were also in this category. | 0.5 |

Note:
The best answer is shown below. Given this was only worth 2 marks, the <u>underlined statements</u> are best practice, but were not required. The **bold statements** were required. *Distilled water* should have been used. Marks were not deducted for neglecting this.

**Sample answer:**

Dissolve 16 g of copper sulfate in *distilled water* in a clean and dry beaker. Pour into a clean 500 mL volumetric flask using a funnel. **Rinse** the beaker and funnel with *distilled water* and **transfer** to the volumetric flask. Swirl to mix the contents. **Fill volumetric flask to the** 500 mL **marking**. Stopper, invert and mix.

## C Question removed due to typographical error

| Criteria | Mark |
|---|---|
| • Calculations for the volume that would be needed for the dilution.<br>• Volume needed extracted using a pipette. | 2 |
| • Identifies dilution equation<br>OR<br>• Shows substitution of values into a suitable equation | 1 |

Sample Answer:

$C_1V_1 = C_2V_2$

$(0.2)V_1 = (0.06)(0.50)$

$V_1 = 0.06 \times 0.50/0.2 = 0.15$ L

## Question 30

| Criteria | Mark |
|---|---|
| • correct answer with working | 2 |
| • Correct answer without sufficient significant figures | 1.5 |
| • As above with a minor error (e.g. neglects one or both unit conversions)<br>OR<br>• Calculates temperature in Kelvin | 1 |
| • States ideal gas law | 0.5 |

Sample Answer:

PV=nRT

(220)(0.250) = n(8.314)(25+273.15)

n = 0.0222 mol

## Question 31

## a

| Criteria | Mark |
|---|---|
| Write a correct net ionic equation for the redox reaction | 2 |
| All species correct. Incorrect balancing | 1.5 |
| Writes an equation which correctly shows the change in ONE species | 1 |

Sample answer:

$Cr_2O_7^{2-} + 3Pt\ (s) + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O + 3Pt^{2+}$

## b

| Criteria | Mark |
|---|---|
| • Calculates the correct EMF of the cell | 2 |
| • Provides some relevant information<br>(e.g. identifies the reduction or oxidation potential of the dichromate ion) | 1 |
| • States the general equation for the cell EMF | 0.5 |

Sample answer

$$EMF^{\circ}_{cell} = EMF^{\circ}_{ox} + EMF^{\circ}_{red}$$

$EMF^{\circ}_{cell}$ = -1.2 +1.36 = 0.16 V

# Question 32

| Criteria | Mark |
|---|---|
| • Calculates the enthalpy change for the reaction | 3 |
| • As above with a minor error<br>OR<br>• Correctly manipulates 2 equations | 2 |
| • Shows a relevant step in the calculation<br>e.g.<br>Manipulates one equation correctly (or leaves the first as is) | 1 |

Sample Answer:

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta H = -393.5$ kJ/mol

$2S(s) + 2O_2(g) \text{ ---> } 2SO_2(g)$ $\Delta H = -296.8$ kJ/mol x 2

$CS_2(\ell) \text{ ---> } C(s) + 2S(s)$ $\Delta H = 87.9$ kJ/mol x -1

$\Delta H = -393.5 + (-296.8 \times 2) + (-87.9) = -1075$ kJ/mol

## Question 33

**(This was a difficult question. So many people got this wrong I thought there was a mistake in the data. Sorry if I put a red line through your answer. Please ignore - it was marked)**

| Criteria | Mark |
|---|---|
| • Correct answer with working | 2 |
| • As above with a minor error<br><br>Examples of common answers that received 1.5:<br>406.36 (reversed +/- in a calculation)<br>1380.25 (dividing by -4 instead of -8 as there are 2 bonds in NO2) | 1.5 |
| • Shows a correct step in the working | 1 |
| • Multiples a bond energy by the number of bonds in the molecule OR the number of molecules present | 0.5 |

Sample Answer:

| Reactant Bonds | Product Bonds |
|---|---|
| N−H ⇒ 4 x 3 = 12 | N−O ⇒ 4 x 2 = 8 |
| O=O ⇒ 7 x 1 = 7 | O−H ⇒ 6 x 2 = 12 |

$\Delta H = \Sigma E_{\text{reactant bonds broken}} - \Sigma E_{\text{product bonds formed}}$

−1135 kJ = [(12) (464) + (7) (498)] − [(8) (NO bond energy) + (12) (389)]
= 690 kJ/mol