Name: ________________________
Class: ________________________
Date: _________________________

Time: 38 minutes

Marks: 38 marks

Comments:
Q1.

Formulae and equations are used to describe chemical reactions.

(a) Aluminium reacts with sulfuric acid (H\textsubscript{2}SO\textsubscript{4}) to produce aluminium sulfate, Al\textsubscript{2}(SO\textsubscript{4})\textsubscript{3} and hydrogen (H\textsubscript{2}).

Complete and balance the equation for this reaction.

\[
\text{____Al} \quad + \quad \text{____________} \quad \rightarrow \quad \text{____________} \quad + \quad \text{____________}
\]

(b) Calcium carbonate reacts with nitric acid to produce calcium nitrate.

Calculate the relative formula mass \((M_r)\) of calcium nitrate, Ca(NO\textsubscript{3})\textsubscript{2}

Relative atomic masses \((A_r)\): N = 14; O = 16; Ca = 40

\[
\text{Relative formula mass } (M_r) = \text{__________________________}
\]

(c) Zinc carbonate decomposes when heated.

A student heated 25 g zinc carbonate (ZnCO\textsubscript{3}).

The figure below shows how he set up the apparatus.

The balanced chemical equation for the decomposition reaction is:

\[
\text{ZnCO}_3 (s) \quad \rightarrow \quad \text{ZnO (s)} \quad + \quad \text{CO}_2 (g)
\]

The student measured the mass of solid product after heating until there was no further change in mass.

The student did the experiment four times. The table below shows the results.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass of solid product in g</td>
<td>17.4</td>
<td>19.7</td>
<td>17.6</td>
<td>16.9</td>
</tr>
</tbody>
</table>

Calculate the mean mass of the solid product.

Do **not** use any anomalous results in your calculation.
Mean mass = _________________ g

Q2.
This question is about carbon and gases in the air.

(a) Carbon atoms have protons, neutrons and electrons.
Complete the table by writing the relative mass of a neutron and an electron.

<table>
<thead>
<tr>
<th>Name of particle</th>
<th>Relative mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>proton</td>
<td>1</td>
</tr>
<tr>
<td>neutron</td>
<td></td>
</tr>
<tr>
<td>electron</td>
<td></td>
</tr>
</tbody>
</table>

(b) What is the total number of protons and neutrons in an atom called?
Tick (✓) one box.

The atomic number

The mass number

One mole of the atom

(1)

(c) An atom of carbon has six electrons.
Which structure, A, B or C, represents the electronic structure of the carbon atom?
(d) Carbon reacts with oxygen to produce carbon dioxide ($CO_2$).

(i) How many different elements are in one molecule of carbon dioxide?

(ii) What is the total number of atoms in one molecule of carbon dioxide?

(e) Sometimes carbon reacts with oxygen to produce carbon monoxide ($CO$).

(i) Calculate the relative formula mass ($M_r$) of carbon monoxide.

Relative atomic masses ($A_r$): $C = 12; O = 16$

(ii) Calculate the percentage by mass of carbon in carbon monoxide.

(f) Carbon dioxide is one of the gases in the air.

(i) The graph shows the percentage of argon and the percentage of carbon dioxide in the air.
What is the percentage of argon in the air?

Percentage of argon = ____________________ %

(ii) An instrumental method is used to measure the amount of carbon dioxide in the air.

Give one reason for using an instrumental method.

______________________________________________________________

______________________________________________________________

(Total 10 marks)

Q3.

Calcium oxide (quicklime) is made by heating calcium carbonate (limestone).

\[
\text{calcium carbonate} \rightarrow \text{calcium oxide} + \text{carbon dioxide}
\]

\[
100 \text{ g} \rightarrow ? + 44 \text{ g}
\]

(a) 44 grams of carbon dioxide is produced when 100 grams of calcium carbonate is heated.

Calculate the mass of calcium oxide produced when 100 grams of calcium carbonate is heated.

______________________________________________________________

mass _____________ g

(1)

(b) What mass of carbon dioxide could be made from 100 tonnes of calcium carbonate?

mass ______________ tonne
Q4.

Firework rockets contain fuel and potassium nitrate.

Contains fuel and potassium nitrate

The potassium nitrate provides oxygen for the fuel to react.

(a) The table shows how a student worked out the relative formula mass \((M)\) of potassium nitrate.

Some of the numbers are missing.

Relative atomic masses \((A)_r\): N = 14; O = 16; K = 39.

<table>
<thead>
<tr>
<th>Name of atom (symbol)</th>
<th>Number of atoms</th>
<th>(A_r)</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>potassium (K)</td>
<td>1</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td>nitrogen (N)</td>
<td>1</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>oxygen (O)</td>
<td></td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

\[
\text{The } M_r \text{ of potassium nitrate} = 101
\]

(i) The mass of oxygen is not shown in the table.

Draw a ring around the correct mass of oxygen.

\[\underline{16} \quad \underline{32} \quad \underline{48}\]

(ii) Draw a ring around the number of oxygen atoms in the formula of potassium nitrate.

\[\underline{1} \quad \underline{2} \quad \underline{3}\]

(b) When the fuel reacts with the oxygen an \textit{exothermic} reaction takes place.
What does *exothermic* mean?

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
____________________________________________________

(2)

(c) The fuel contains carbon. Carbon reacts with oxygen to make carbon dioxide.

Which two statements in the table explain why carbon dioxide is a gas at room temperature?

Tick (√) the two statements.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Tick (√)</th>
</tr>
</thead>
<tbody>
<tr>
<td>It has a giant structure</td>
<td></td>
</tr>
<tr>
<td>It has a low boiling point.</td>
<td></td>
</tr>
<tr>
<td>It is made of small molecules.</td>
<td></td>
</tr>
<tr>
<td>It is made of ions.</td>
<td></td>
</tr>
</tbody>
</table>

(2)

(Total 6 marks)

Q5.

A student investigated heating metal carbonates.

The student used the apparatus in the figure below.

The student's results are shown in the table below.

<table>
<thead>
<tr>
<th>Metal carbonate</th>
<th>Colour before heating</th>
<th>Colour after heating</th>
<th>Mass before heating in g</th>
<th>Mass after heating in g</th>
<th>Solution A</th>
</tr>
</thead>
</table>
Copper carbonate | Green | Black | 12.4 | 8.0 | Turns cloudy  
Potassium carbonate | White | White | 13.8 | 13.8 | Stays colourless  
Zinc carbonate | White | White | 12.5 | 8.1 | Turns cloudy

(a) Use the correct answer from the box to complete the sentence.

black green white

The colour of copper oxide is _____________.  
(1)

(b) Solution A is used to test for carbon dioxide.

Carbon dioxide turns Solution A cloudy.

What is the name of Solution A?

___________________________________________________________________  
(1)

(Total 2 marks)

Q6.

This question is about lithium and sodium.

(a) Use the Chemistry Data Sheet to help you to answer this question.

In which group of the periodic table are lithium and sodium?  
Group __________  
(1)

(b) A lithium atom can be represented as $^7_3\text{Li}$

The diagram represents the lithium atom.

(i) Some particles in the nucleus have a positive charge.

What is the name of these particles?

___________________________________________________________________  
(1)
(ii) Some particles in the nucleus have no charge. What is the name of these particles?

______________________________________

(1)

(iii) Use the correct answer from the box to complete the sentence.

3 4 7

The mass number of this atom of lithium is ____________

(1)

(c) Sodium reacts with chlorine to produce sodium chloride.

sodium + chlorine → sodium chloride

The diagram shows how the reaction happens.

Only the outer electrons are shown.

Draw a ring around the correct answer to complete each sentence.

(i) A sodium atom changes into a sodium ion by gaining, losing, or sharing an electron.

(ii) A sodium ion has a negative, no, or a positive charge.

(iii) The ions in sodium chloride are held together by covalent, strong, or electrostatic forces.
(d) Sodium chloride is an ionic compound.

Tick (✓) two properties of ionic compounds.

<table>
<thead>
<tr>
<th>Property</th>
<th>Tick (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do not dissolve in water</td>
<td></td>
</tr>
<tr>
<td>High melting points</td>
<td></td>
</tr>
<tr>
<td>Low boiling points</td>
<td></td>
</tr>
<tr>
<td>Strong bonds</td>
<td></td>
</tr>
</tbody>
</table>

(e) (i) The formula of sodium chloride is NaCl

Calculate the relative formula mass of sodium chloride.

Relative atomic masses: Na = 23; Cl = 35.5

\[ \text{Relative formula mass} = \frac{23 \times 1 + 35.5 \times 1}{1} \]

\[ \text{Relative formula mass} = 58.5 \]

(ii) Draw a ring around the correct answer to complete each sentence.

The relative formula mass of a substance, in grams, is one isotope of the substance.

(f) Nanoparticles of sodium chloride (salt) are used to flavour crisps.

What are nanoparticles?

___________________________________________________________________

___________________________________________________________________

(Total 12 marks)
Mark schemes

**Q1.**

(a) \[2\text{Al} + 3\text{H}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{H}_2\]

*Formulae correct*  

*Balancing correct*  

(b) \[40 + 2(14 + (3 \times 16))\]

= 164

*Allow 164 with no working shown for 2 marks*  

(c) \[(17.4 + 17.6 + 16.9) / 3\]

= 17.3

*Allow 17.3 with no working shown for 2 marks*  

[6]

**Q2.**

(a) 1

*Must be in this order*  

*Very small*  

*Accept negligible, 1 / 2000*  

*Allow zero*  

(b) The mass number  

(c) C  

(d) (i) 2  

(ii) 3  

(e) (i) 28  

(ii) 42.9

*Accept ecf from (e)(i)*  

*Accept 42 - 43*  

(f) (i) 0.9  

1
(ii) any one from:

• accurate
• sensitive
• rapid
• small sample.

Q3.

(a) 56g

for 1 mark

(b) 44 tonnes

for 1 mark

Q4.

(a) (i) 48

1

(ii) 3

1

(b) heat / energy

given out / transfers to surroundings

the mark for given out / transfers to cannot be awarded

without heat / energy

allow given off

1

(c) it has a low boiling point

1

it is made of small molecules

1

Q5.

(a) black

1

(b) limewater

accept calcium hydroxide (solution)

1

Q6.
(a)  1 / one

(b)  (i)  protons
     (ii) neutrons
     (iii) 7

(c)  (i) losing
     (ii) a positive
     (iii) electrostatic

(d)  high melting points
     strong bonds

(e)  (i) 58.5
     (ii) mole

(f)  very small (particles) or
     *ignore tiny / small / smaller / microscopic etc.*
     1-100nm in size or
     (particle with a) few hundred atoms

[12]