SECTION A General chemistry knowledge

1. Name two elements that are liquid at room temperature ...................................................... (2 marks)
   bromine and mercury ..............................................................................................................

2. Four new elements were added to the Periodic Table at the start of 2016.
   Name any one of the elements. ................................................................................................ (1 mark)
   ununtrium / ununpentium / ununseptium / ununoctium (any one, must be spelt correctly) ........................................

3. Name the element that can exist in one of three allotropes; diamond, graphite or fullerene. (1 mark)
   carbon ........................................................................................................................................

4. Name the radioactive element, an isotope of which was believed to be used to poison the Russian
   security agent, Alexander Litvinenko in 2006. .................................................................................... (1 mark)
   polonium (-210) ignore 210 ...............................................................................................................

5. The phrase ‘as mad as a hatter’ is believed to be a result of hat makers being exposed to the vapours of
   which element during the hat making process. .................................................................................... (1 mark)
   mercury ............................................................................................................................................

6. Name the process you would use to separate a liquid from an insoluble solid. (1 mark)
   filtration / filtering (or any variation) ..............................................................................................

7. Name the process you would use to separate a liquid from a soluble solid. (1 mark)
   distillation (ignore fractional or simple) ..........................................................................................

8. Name the compound found in dry ice. ......................................................................................... (1 mark)
   carbon dioxide (must be name, not chemical formula) ......................................................................

9. State the chemical name for vinegar. ............................................................................................ (1 mark)
   ethanoic acid .................................................................................................................................

Total: 10 marks
10. An endothermic process is a process that takes in energy from the surroundings.

An exothermic process is a process that gives out energy to the surroundings.

For example, respiration is an example of an exothermic process as energy is given out during the process.

State if the following processes are endothermic or exothermic:

a. evaporation - endothermic

b. melting an ice cube - endothermic

c. burning wood - exothermic

d. photosynthesis - endothermic

e. thermal decomposition of copper carbonate - endothermic

f. NaOH + HCl → NaCl + H₂O

11. A student is investigating the reaction of magnesium metal with hydrochloric acid. She reacts 25 cm³ of hydrochloric acid with a concentration of 1 mol/dm³ with a 3 cm strip of magnesium ribbon.

a. i. Complete the word equation for the reaction. (1 mark)

magnesium + hydrochloric acid → magnesium chloride + hydrogen............................

(both products correctly named for 1 mark)......................

ii. Write a balanced symbol equation for the reaction. (2 marks)

Mg + 2HCl → MgCl₂ + H₂ (1 mark correct symbols, 1 mark balancing)..........................

b. The hydrochloric acid is in excess. Explain what this means. (1 mark)

The hydrochloric acid doesn’t control/limit the amount of products produced / some hydrochloric acid will be left over unreacted at the end of the reaction (or words to this effect) ......................
The student measures the temperature change during the experiment. Her results are shown in the table below:

<table>
<thead>
<tr>
<th>Temperature of hydrochloric acid at start / °C</th>
<th>18.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature of hydrochloric acid at end / °C</td>
<td>21.5</td>
</tr>
<tr>
<td>Temperature change / °C</td>
<td>3.0 (must be .0)</td>
</tr>
</tbody>
</table>

c.  i. Complete the table by calculating the temperature change for the experiment.  
   (1 mark)
   
   ii. State if the reaction is **endothermic** or **exothermic**.  
   (1 mark)

   *exothermic ...............................................................................................................................

d.  The student wishes to investigate what effect increasing the volume of hydrochloric acid will have on the temperature change recorded.

   i. Describe the experiment the student could carry out to investigate how increasing the volume of hydrochloric acid affects the temperature change.

   Include details about how to make the experiment a fair test.  
   (4 marks)

   *Repeat the experiment using:.................................................................

   - same amount / 3 cm strip of magnesium ribbon (1 mark) .......................
   - same concentration of hydrochloric acid (1 mark) ........................................
   - double / increased volume of hydrochloric acid (1 mark) ...........................

   *Record the new temperature change or description of recording temperature at start and at end (1 mark) ...........................................................

   ...............................................................................................................................
   ...........................................................................................................................................
   ...........................................................................................................................................
   ...........................................................................................................................................

   ii. A **hypothesis** is an idea about what will happen in an experiment.

   Write a hypothesis to predict what effect increasing the volume of the hydrochloric acid will have on the temperature change observed.

   Explain the reasons behind your hypothesis.  
   (3 marks)

   *The more hydrochloric acid used the lower the temperature change (1 mark)............

   *Same amount of magnesium reacting so same energy given out (1 mark)............

   *But a larger volume of solution to heat up with this energy resulting in a lower temperature change (1 mark)..........................................................
Humans obtain the energy they need to survive from the food they eat.

The energy content of foods is given along with other nutritional information on the side of a food packet.

Josh looks at this label on a packet of biscuits. It shows the nutritional information for 100 g of biscuits.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy / kJ</td>
<td>2179</td>
</tr>
<tr>
<td>Energy / kcal</td>
<td>521</td>
</tr>
<tr>
<td>Fat / g</td>
<td>27.3</td>
</tr>
<tr>
<td>of which saturates / g</td>
<td>15.8</td>
</tr>
<tr>
<td>Carbohydrates / g</td>
<td>61.3</td>
</tr>
<tr>
<td>of which sugars / g</td>
<td>40.1</td>
</tr>
<tr>
<td>Fibre / g</td>
<td>2.5</td>
</tr>
<tr>
<td>Protein / g</td>
<td>6.3</td>
</tr>
</tbody>
</table>

a. If one biscuit has a mass of 10 g, calculate the energy content in kJ in a single biscuit. (1 mark)

\[
2179 \text{ kJ} / 10 = 217.9 \text{ kJ or } 218 \text{ kJ}
\]

b. The Guideline Daily Amount (GDA) for energy is 2000 kcal. Calculate the percentage of the GDA for energy in 100 g of biscuits. (2 marks)

Energy in 100 g of biscuits = 521 kJ (1 mark)

As percentage of GDA = \( (521 / 2000) \times 100\% = 26.05 / 26.1 / 26 \% \) (1 mark)

c. Using the information in the table, calculate the amount of energy in kJ that is equivalent to 1 kcal. (1 mark)

521 kcal = 2179 kJ

\[
1 \text{ kcal} = \frac{2179}{521} \text{ kJ}
\]

1 kcal = 4.18 kJ (allow any accuracy)
13. Combustion is an **exothermic** process. Heat energy is given out from the combustion of a fuel.

   a. Complete the diagram of the fire triangle by writing the three elements a fire needs to ignite around the edges of the triangle. (3 marks)

   ![Fire Triangle Diagram](Image © Shutterstock)

   - **Heat**
   - **Fuel**
   - **Oxygen**

   (in any order)

   b. Complete combustion of any fuel requires a plentiful supply of oxygen and produces carbon dioxide and water only.

   Write a balanced symbol equation for the complete combustion of ethanol, C₂H₅OH. (2 marks)

   \[ C₂H₅OH + 3O₂ \rightarrow 2CO₂ + 3H₂O \]  

   (1 mark symbols, 1 mark balancing)  

   (allow multiples) ..........

   Many conventional petrol engines will run on ethanol, or mixtures of petrol and ethanol. Much of the petrol sold in the UK at present has 5-10% ethanol added.

   One method for producing ethanol is via the fermentation of glucose. A balanced symbol equation for fermentation is shown below;

   \[ C₆H₁₂O₆ \rightarrow 2C₂H₅OH + 2CO₂ \]

   The glucose needed for fermentation is made from plants during photosynthesis. A balanced symbol equation for fermentation is shown below;

   \[ 6CO₂ + 6H₂O \rightarrow C₆H₁₂O₆ + 6O₂ \]

   c. Ethanol made by fermentation is sometimes termed **carbon neutral**. This means that the carbon dioxide released when it is produced and burnt is balanced by the carbon dioxide absorbed by the plant from which it is originally obtained, during photosynthesis.

   Use the equations above and your answer part (b) to prove that ethanol is a carbon neutral fuel.

   CO₂ taken in during photosynthesis = 6 CO₂ (6CO₂ + 6H₂O \rightarrow C₆H₁₂O₆ + 6O₂)............................

   CO₂ given out during fermentation = 2 CO₂ (C₆H₁₂O₆ \rightarrow 2C₂H₅OH + 2CO₂)..................................

   CO₂ given out during combustion of fuel = 4 CO₂ (2C₂H₅OH + 6O₂ \rightarrow 4CO₂ + 6H₂O)

   Total in 6CO₂ (1 mark) = total out 4+2 CO₂ (1 mark) ................................................................. (2 marks)

   Essentially 2 marks here for demonstrating that total CO₂ taken in = total CO₂ given out

   **Total: 30 marks**