Section A:

1. Which of these is the correct definition of activation energy?

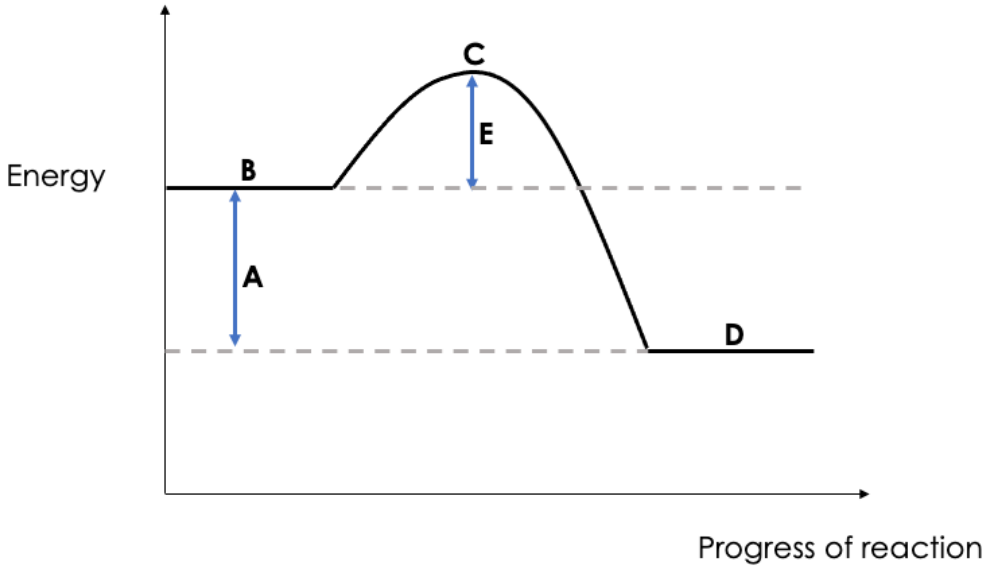
   Tick one box.

   The amount of energy that particles have ☐

   The amount of energy released or taken in during a chemical reaction ☐

   The minimum amount of energy particles need to have in order to react ☐

2. The reaction profile below shows the energy changes in the reaction between zinc and sulfuric acid.



   a. What kind of reaction is this showing?

   Tick one box.

   Exothermic ☐

   Endothermic ☐

   Neutralisation ☐

   b. Explain your answer.

   _____

   _____

c. What is represented by letter A?

Tick one box.

The activation energy ☐

The amount of energy in the reactants ☐

The overall energy change ☐

d. What is represented by letter E?

Tick one box.

The activation energy ☐

The temperature ☐

The overall energy change ☐

Section B

3. A student investigated the relationship between citric acid and sodium hydrogencarbonate. They measured the starting temperature and the temperature reached by the reaction mixture. They repeated the experiment 4 times and presented their results in the table below.

Trial	**1**	**2**	**3**	**4**	**Mean**
Temperature decrease (°C)	8.5	8.7	7.2	8.6	

a. Suggest the piece of apparatus the student used to take these measurements. Explain your answer.

_____

_____

_____

b. Complete the table by calculating the mean temperature decrease.

c. On the axes below, sketch a reaction profile for this reaction.



d. Add labels to the reaction profile to show:
   i. the activation energy
   ii. the overall change in energy

e. The student carried out the reaction again using a catalyst. Annotate the reaction profile using a dotted line to show the effect of adding a catalyst.

4. Hydrogen peroxide decomposes to form water and oxygen. The reaction is highly exothermic and can be represented by the following equation:

$$H_2O_2 \rightarrow H_2O + O_2$$

   a. Balance this equation.

   b. Suggest what it means for a reaction to be 'highly exothermic'.

   c. Calculate the percentage by mass of hydrogen in hydrogen peroxide.

d. 24 g of hydrogen peroxide decomposes to form 12.7 g of water. Calculate the mass of oxygen produced when 240 g of hydrogen peroxide decomposes.

Section C

5. Enzymes are biological catalysts, which speed up reactions in the body without being used up. There are a number of different enzymes involved in the digestive system.
    a. Are enzymes involved in mechanical or chemical digestion?
    b. Name the type of enzyme that catalyses the breakdown of protein.
    c. State the product of this reaction.
    d. The digestion of protein is an exothermic reaction. Sketch a reaction profile to show this reaction. Add a line to show how this reaction profile would be different if the enzyme was not present.
    e. The enzyme that speeds up the breakdown of proteins has an optimum pH of 3. Explain what this means and where this in the body this optimum pH is likely to be found.