13 Chemical Energetics

For each question, choose the most suitable option and write the letter (**A**, **B**, **C** or **D**) in the brackets provided.

Level 1

1. Which of the following is an **endothermic** reaction?

    A   Combustion of methane

    B   Neutralisation

    C   Photosynthesis

    D   Respiration ( )

2. Study the following process:

$$CO_2(s) \longrightarrow CO_2(g)$$

    Which of the following best describes the above process?

    A   Energy is absorbed during the process.

    B   Energy is absorbed, then released during the process.

    C   Energy is not required during the process.

    D   Energy is released during the process. ( )

3. Which of the following statements best describes an **exothermic** reaction?

    A   Energy is absorbed during the reaction.

    B   Energy is released during the reaction.

    C   The overall energy of the reaction does not change.

    D   The overall energy of the reaction increases. ( )

4. Which of the following is **always true** when forces of attraction between particles are overcome in a reaction or process?

    A   Forces of attraction are only overcome when a substance is boiling.

    B   The reaction or process is endothermic.

    C   The reaction or process is exothermic.

    D   There is a chemical change after the reaction. ( )

5. Which of the following temperature changes in a solution matches that of an **exothermic** reaction?

   A   0 °C to −5 °C

   B   25 °C to 5 °C

   C   25 °C to 25 °C

   D   25 °C to 55 °C   (   )

6. Which of the following statements is **true** of a neutralisation reaction?

   A   The temperature of the solution only increases.

   B   The temperature of the solution only decreases.

   C   The temperature of the solution decreases, then increases back to room temperature.

   D   The temperature of the solution increases, then decreases back to room temperature.   (   )

(Level 2)

7. An energy level diagram shows the difference in the energy levels of the reactants and the products. When the reactants are lower in energy than the products, the reaction is an endothermic reaction. When the reactants are higher in energy than the products, the reaction is an exothermic reaction. The energy level diagram of a particular reaction is shown in Figure 13.1.
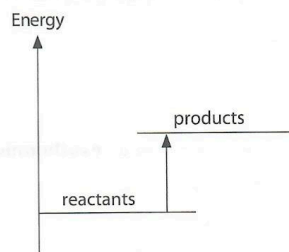
Energy

products

reactants
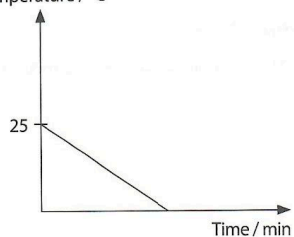
Figure 13.1

Which of the following is **true** of the reaction above?

   A   The energy level diagram could represent the burning of methane.

   B   The energy level diagram could represent the reaction between hydrochloric acid and sodium hydroxide.

   C   The reaction releases energy.

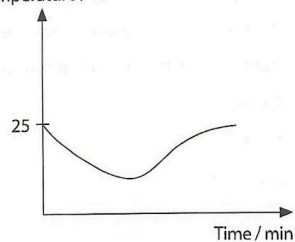   D   The temperature of the reaction mixture decreases.   (   )

8. Which of the following graphs shows what happens when a small amount of ammonium chloride is added into water?
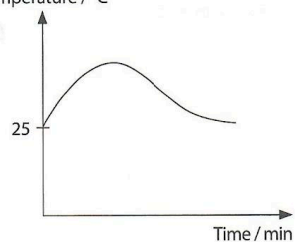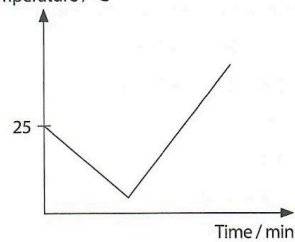
A Temperature / °C

Time / min

B Temperature / °C

Time / min

C Temperature / °C

Time / min

D Temperature / °C

Time / min

( )

9. The following information about four fuels, **W**, **X**, **Y** and **Z**, are provided in Table 13.1.

Table 13.1

Fuel	M_r	Energy Released When Burnt / kJ/mol
W	16	891
X	28	283
Y	46	1367
Z	114	5430

Which fuel produces the **most** energy when 10 g of it is burnt?

A   Fuel **W**

B   Fuel **X**

C   Fuel **Y**

D   Fuel **Z**

( )

10. The temperature of a solution in which an exothermic reaction occurs will eventually fall back to room temperature. This is because _____.

    1   energy is lost to the surroundings

    2   the reactants are used up and hence no more energy is released

    3   there is a difference in the temperature of the reaction mixture and its surroundings

    A   1 only

    B   1 and 2 only

    C   2 and 3 only

    D   All of the above   (   )

11. Which of the following equations represent(s) that of an **exothermic** reaction?

    1   $H^+ + OH^- \longrightarrow H_2O$

    2   $2H_2 + O_2 \longrightarrow 2H_2O$

    3   $ZnCO_3 \longrightarrow ZnO + CO_2$

    A   1 only

    B   1 and 2 only

    C   2 and 3 only

    D   All of the above   (   )

(Level 3)

12. The overall energy change of a reaction can be represented by the expression, ΔH. It can be calculated by the following equation.

    $$\Delta H = \text{Energy of products} - \text{Energy of reactants}$$

    In an exothermic reaction, ΔH has a negative value whereas in an endothermic reaction, ΔH has a positive value.

    Which of the following are **true**?

	Experiment	Energy of Products	Energy of Reactants	ΔH
A	Adding hydrochloric acid to sodium hydroxide	Low	High	> 0
B	Burning methane as a fuel	High	Low	< 0
C	Decomposing calcium carbonate using heat	Low	High	< 0
D	Dissolving ammonium chloride in water	High	Low	> 0

                                                                           (   )

13. A student wanted to determine the volume of an unknown concentration of aqueous sodium hydroxide required to completely neutralise 20 cm³ of 1.0 mol/dm³ nitric acid. He added various amounts of the alkali in separate solutions of nitric acid and measured the highest temperature reached for the reaction. The data obtained from the experiment is shown in Figure 13.2.
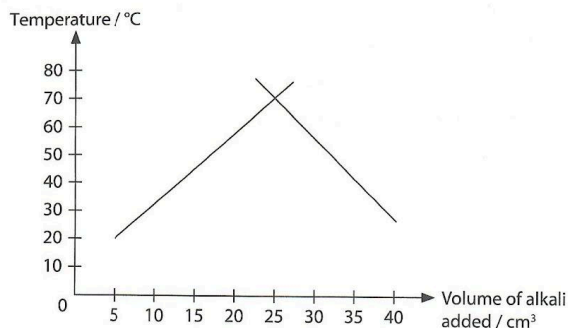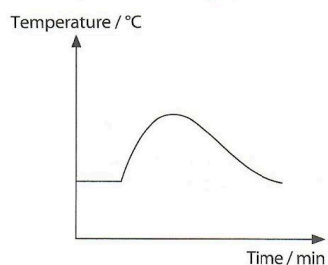

Figure 13.2

Which of the following statements are **correct**?

1   The volume of the alkali required for complete neutralisation is 25 cm³.

2   Neutralisation is an exothermic reaction.

3   The concentration of the aqueous sodium hydroxide used in the experiment is 0.800 mol/dm³.

4   The highest temperature reached is when more than 25 cm³ of aqueous sodium hydroxide is added.

A   1 and 2 only

B   1, 2 and 3 only

C   2, 3 and 4 only

D   3 and 4 only   (   )

14. The enthalpy change of formation of a compound is the energy change involved when 1 mol of a compound is formed from its elements.

Which of the following equations **correctly** depicts the formation of water?

A $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$

B $2H^+ + O^{2-} \longrightarrow H_2O$

C $2H + O \longrightarrow H_2O$

D $2H_2 + O_2 \longrightarrow 2H_2O$ (   )

15. A small piece of calcium metal was added to a solution of copper(II) nitrate in a beaker, at room temperature. Vigorous effervescence was observed, followed by the appearance of a red-brown solid. The beaker felt hot to the touch.

Which of the following statements is/are **true** of the above reaction?

1   The ionic equation for the reaction is $Ca(s) + Cu^{2+}(aq) \longrightarrow Cu(s) + Ca^{2+}(aq)$.

2   The overall reaction absorbs energy.

3   The temperature of the reaction mixture after a few hours is 25 °C.

4   The temperature-time graph of the reaction could look like:

Temperature / °C

Time / min

A   1 and 2 only

B   1, 3 and 4 only

C   2, 3 and 4 only

D   3 only   (   )