General

[SBPtrial10-10] In which of the chemical reactions releases heat to the surroundings?

A Dissolving potassium nitrate in water
B Dissolving ammonium sulphate in water
C Adding calcium carbonate to nitric acid
D Adding potassium hydrogen carbonate to hydrochloric acid

[SPM06-20] What is the meaning of *heat of reaction*?

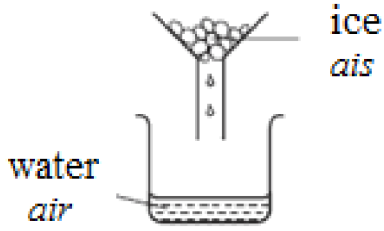
A The energy needed to break the chemical bond
B The energy needed to start a reaction
C The energy involved when change of state of matter happens
D The change in the energy contained in the products and in the reactants

[MRSM07-16] The reaction between solution P and solution Q is exothermic.
A student confirms this statement by mixing equal volumes of the two solutions and measuring the temperature change. Which two pieces of apparatus should the student use?

A Balance and stop watch
B Balance and thermometer
C Pipette and stop watch
D Pipette and thermometer

[MRSM11-19] Which diagram shows an endothermic reaction?

A



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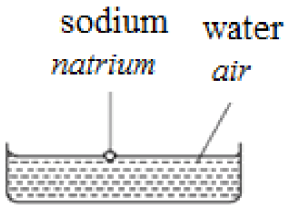

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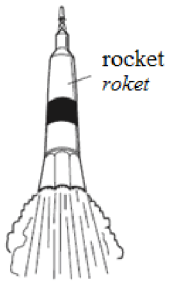

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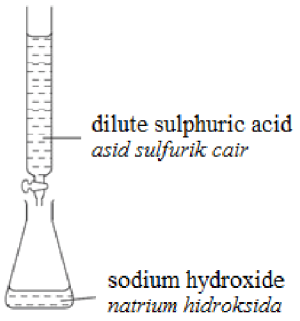


[MRSM07-33] Diagram 20 shows a match. By striking the match, a chemical reaction is initiated.

Diagram 20

Which statements about the chemical reaction are correct?

A Reaction is endothermic because energy is used to strike the match
B Reaction is endothermic because energy is given out as the match burns
C Reaction is exothermic because energy is used to strike the match
D Reaction is exothermic because energy is given out as the match burns

[MRSM05-19] The following thermochemical equation represents the formation of hydrogen chloride gas.

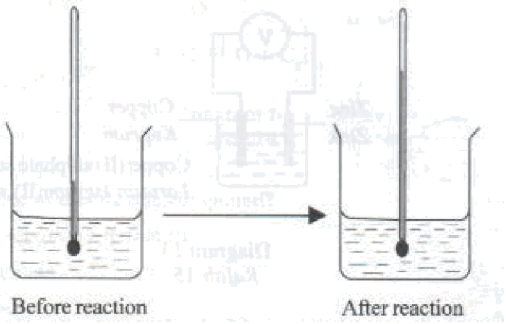
$$H_2\ (g) + Cl_2\ (g) \text{ -- > } 2\ HCl\ (g) \qquad \Delta H = -x\ kJ\ mole\text{-}1$$

Which of the following statements are true for the reaction?

I It is an endothermic reaction.
II Heat energy is absorbed during bond breaking of hydrogen and chlorine molecules
III Heat energy is released during the formation of hydrogen chloride molecules
IV x kJ of heat is liberated when 1 mole of hydrogen chloride produced.

A I and III only
B II and IV only
C I , II and III only
D II , III and IV only

[SPM07-48] Diagram 16 shows the mercury level of a thermometer in reaction.



Which of the following is true about the reaction?

A Endothermic reaction
B Exothermic reaction
C Bond breaking in the reaction absorbs energy
D The amount of energy in the product is higher that of the reactants

[SPM03-12] Which of the following absorbs heat from the surroundings?

A Adding acid to alkali
B Adding concentrated acid to water
C Dissolving solid ammonium chloride in water
D Dissolving anhydrous copper (II) sulphate in water

[SPM05-49] A pupil discovered that a water container becomes cold when a chemical is dissolved in the water. Which of the following is the chemical?

A Sulphuric acid
B Ammonium chloride
C Sodium hydroxide
D Calcium oxide

[SBPtrial07-12] Which of the following processes occurs when ice changes to water?

A Endothermic
B Exothermic
C Neutralization
D Freezing

[SPM08-17] Which process absorbs energy?

A Evaporation
B Combustion
C Neutralisation
D Displacement

[SPM11-19] Which statement is correct about exothermic reaction?

A The heat absorbed during bond breaking is more than the heat released during bond formation
B The heat absorbed during bond breaking is less than the heat released during bond formation
C The heat absorbed during bond breaking is equal to the heat released during bond formation
D No heat is absorbed or released during bond breaking and bond formation

[MRSM09-17] Which of the following is true about endothermic reaction?

A The heat of reaction has negative value
B Heat is absorbed from the surrounding
C The reaction shows an increase in temperature
D The energy of the reactants is higher than the products

[MRSM03-11] Which of the following reactions is an endothermic reaction?

A $KN0_3$ (s) -- > KNO_3 (aq)
B NaOH(s) -- > NaOH (aq)
C N_2 (g) + $3H_2$ (g) -- > $2NH_3$ (g)
D Cu (s) + $2AgN0_3$ (aq) -- > 2Ag (s) + $Cu(N0_3)_2$ (aq)

[SPM08-28] Diagram 4 is an energy level diagram.

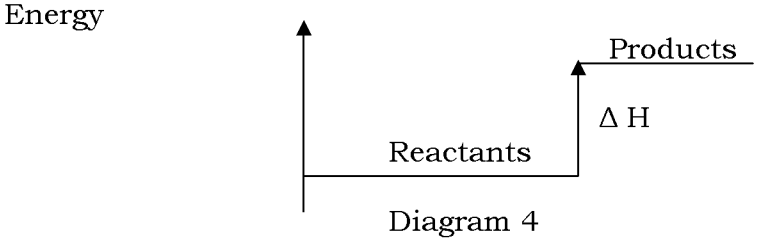


Diagram 4

Which of the following can be deduced from Diagram 4?

A Heat is absorbed
B The products are more stable than the reactants
C The surrounding temperature increases during the reaction
D The total energy of the reactants is more than the total energy of the products

[SBPtrial11-12] Diagram 3 shows the energy profile for the reaction between X and Y to produce Z.

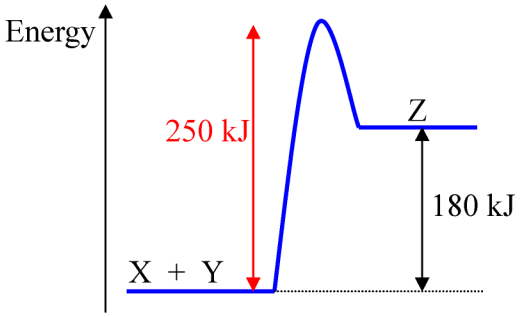
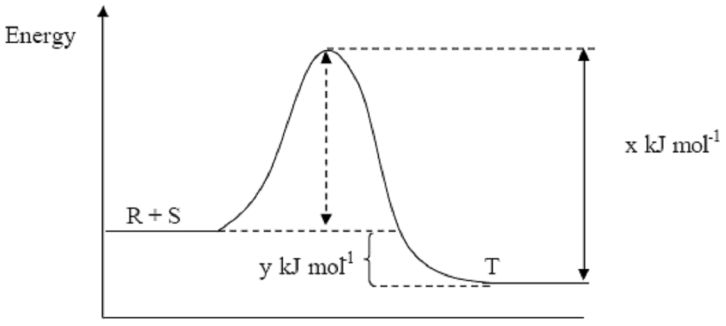


Diagram 3

What is the activation energy of the reaction and the type of reaction?

	Activation energy / kJ	**Types of reaction**
A	250	Exothermic
B	250	Endothermic
C	189	Exothermic
D	180	Endothermic

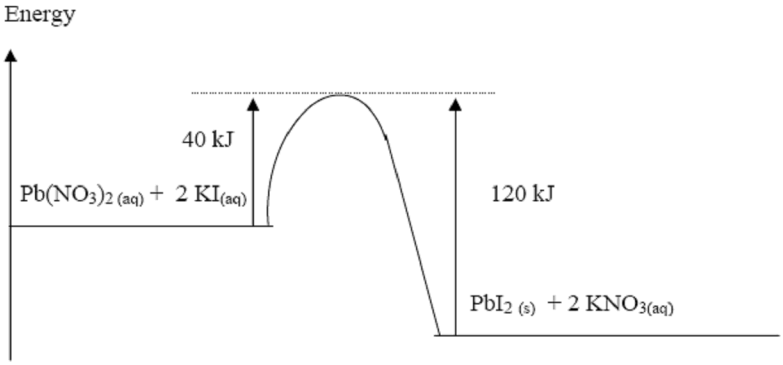
[MRSM06-37] The diagram shows the energy profile for the formation of T from R and S.



What is the activation energy for the reaction?

A y kJ mol^{-1}
B (x + y) kJ mol^{-1}
C x kJ mol^{-1}
D (x-y) kJ mol^{-1}

[MRSM05-34] The diagram shows the energy level of a chemical reaction



Which of the following statements can be inferred from the diagram?

I Formation of 1 mol of lead(II) iodide releases 80 kJ of heat.
II Activation energy for the reaction is 120 kJ mol-1 of heat.
III 80 kJ of heat energy is released when 1 mole of lead(II) nitrate reacts with 2 moles of potassium iodide.
IV Ionic equation for the reaction is $K^+(ak) + NO_3^-(ak) \text{ -- > } KNO_3(ak)$

A I only
B I and III only
C III and IV only
D I , II , III and IV

[MRSM09-18] Diagram 7 represents an energy profile diagram representing an endothermic reaction.

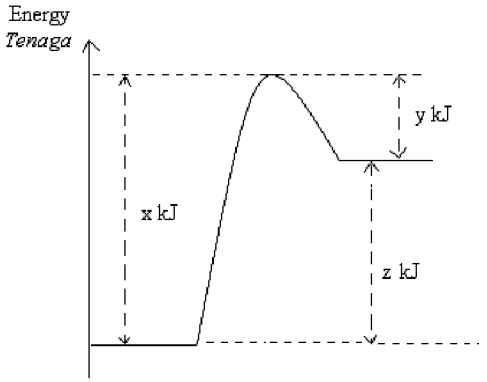
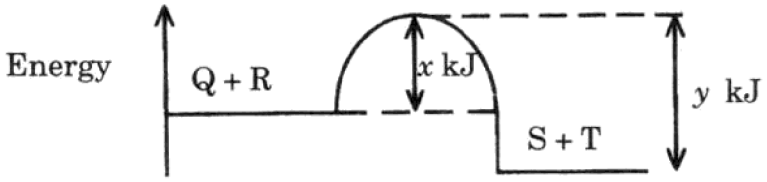


Diagram 7

What is the value of activation energy?

A x kJ
B y kJ
C z kJ
D (x - y) kJ

[SPM05-35] The diagram shows the energy profile of a reaction.



Which of the following is true about the diagram?

A The reaction is endothermic
B The activation energy is y kJ
C The heat of reaction is –(y-x) kJ
D y value increase with the presence of a catalyst

[MRSM04-46] Below is a thermochemical equation.

$$2Fe(p) + 3Cl_2(g) \text{ -- > } 2FeCl_3 \quad ; \quad \Delta H = - y \text{ kJ}$$

What is the amount of heat released if 1 mol iron reacts with 3 mol chlorine gas?

A y/3 kJ
B y/2 kJ
C y kJ
D 2y kJ

[SPM04-48] Yogurt is prepared by adding 20.0 cm^3 of lime juice into 200.0 cm^3 of fresh milk. It is found that the temperature of the yogurt increases by 2.0 °C.
What is the total amount of heat released?

Use the information that the specific heat capacity of yogurt = X $Jg^{-1}°C^{-1}$.
Assume that 1 cm^3 of solution is equal to 1 gram of solution.

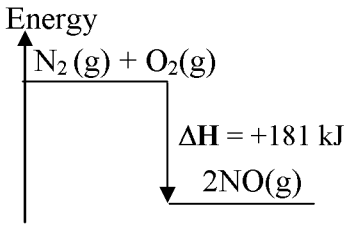
A 40X J
B 220X J
C 400X J
D 440X J

[SBPtrial07-25] The reaction between nitrogen and oxygen can be represented by the following equation:

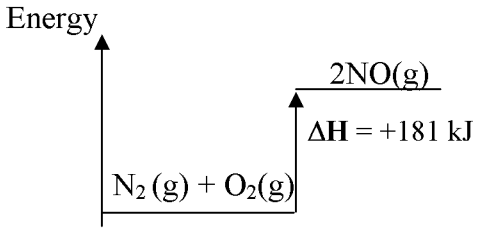
$$N_2(g) + O_2(g) \rightarrow 2NO(g) \qquad \Delta H = +181 \text{ kJ}$$

Which of the following energy level diagrams represent the above reaction?

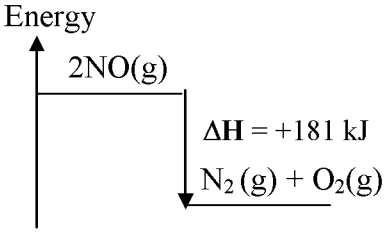
A



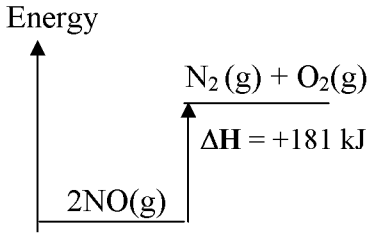
B



C



D



[SBPtrial08-24] Diagram 8 shows the energy profile diagram for the following reaction:

K + L → M + N

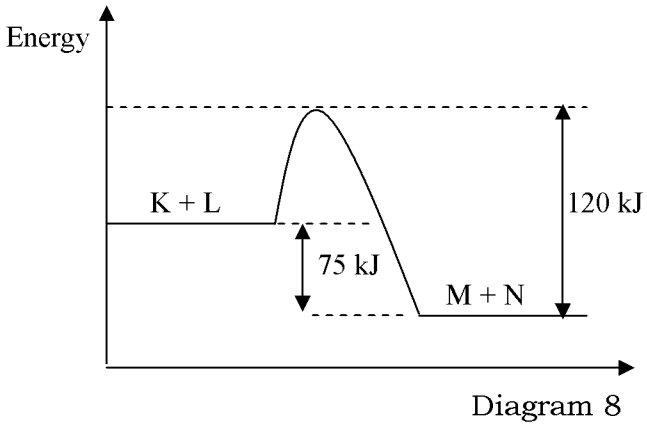


Diagram 8

What is the value of the activation energy?

A 25 kJ
B 45 kJ
C 75 kJ
D 120 kJ

[SBPtrial08-12] Which of the following processes absorbs heat energy?

A Combustion of a hydrocarbon
B Neutralisation between acid and alkali
C Dissolving sodium hydroxide in water
D Breaking the H-H bond in the hydrogen molecule

[SBPtrial08-26] Diagram 9 shows the energy level diagram for the reaction between silver ions and chloride ions.

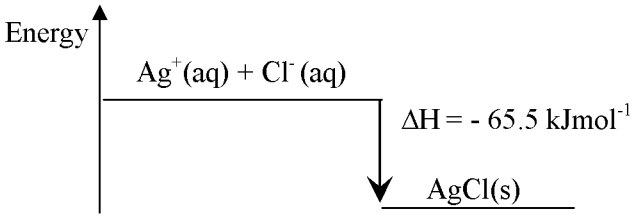


Diagram 9

Which of the following statements is true about this reaction?

A Endothermic reaction occurs
B The energy content of the product is higher than the reactants
C 65 kJ of heat is absorbed when 1 mol of silver chloride is formed
D The final temperature at the end of the reaction is higher than the initial temperature

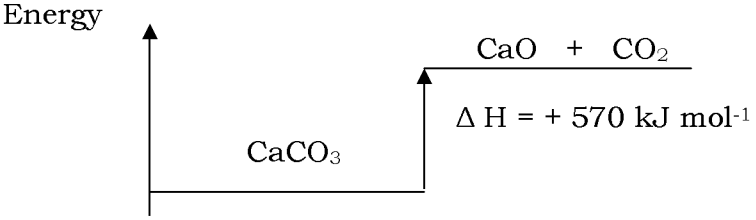
[SBPtrial09-12] Which of the following is true when ammonium nitrate dissolves in water in a test tube, the test tube becomes cold?

A The ions move slower.
B Water absorbs heat energy.
C Heat energy is lost to the surroundings.
D Heat energy is absorbed from the surroundings.

[SPM09-15] Which of the following is an endothermic reaction?

A $HCl + NaOH \rightarrow NaCl + H_2O$
B $HCl + NaHCO_3 \rightarrow NaCl + CO_2 + H_2O$
C $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$
D $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

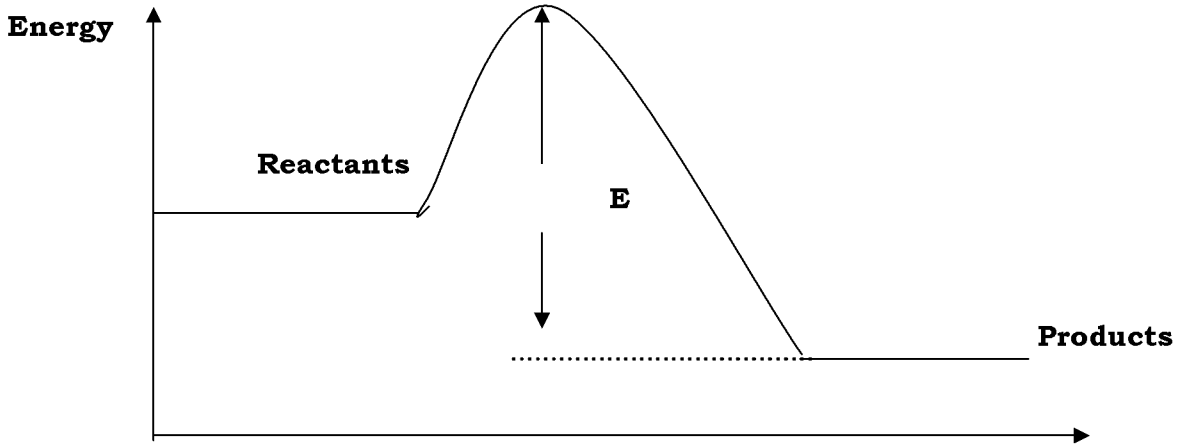
[SPM09-23] Diagram 4 shows an energy level diagram for the decomposition of calcium carbonate.



Which statement can be deduced from diagram 4?

A Heat is absorbed in the reaction
B The reaction is exothermic
C Total energy of the reactant and the product is 579 kJ
D The reactant has more energy than the products

[SBPmidYearF5-16]



From the diagram above, it can be concluded that

A heat is required to start the reaction.
B the activation energy for the reaction is E.
C the reaction is exothermic.
D the reactants are higher in concentration than the products.

[MRSM10-19] Diagram 4 shows the application of chemical reactions in daily life.

Materials		
Name	Cold pack	Hot pack
Chemicals used	M and water	N and water

What is M and N?

	Material M	**Material N**
A	Ammonium nitrate	Anhydrous magnesium sulphate
B	Ammonium hydroxide	Calcium chloride
C	Sodium carbonate	Sodium hydroxide
D	Sodium acetate	Sodium bicarbonate

[SPM11-15] Cold packs contain chemicals that react to absorb heat. Which substance is used in cold packs?

A Calcium chloride
B Sodium carbonate
C Magnesium sulphate
D Ammonium nitrate

Heat of Precipitation

[SPM07-19] Which of the following must be known to calculate the heat of precipitation in the reaction between silver nitrate and sodium chloride?

A The chemical formula of the precipitate that is formed
B The reaction that takes place is exothermic
C The number of moles of the reactants is 1 mol
D No heat has escaped to the surroundings

[SPM06-32] The following chemical equation shows the reaction of the formation of lead (II) sulphate precipitate.

$$Pb^{2+}_{(aq)} + SO_4^{2-}_{(aq)} \text{ -- > } PbSO_{4(s)} \; ; \Delta H = -42 \text{ kJ mol}^{-1}$$

Which of the following is true about the reaction?

	Heat change	**Type of reaction**
A	Heat is released	Endothermic
B	Heat is absorbed	Exothermic
C	Heat is released	Exothermic
D	Heat is absorbed	Endothermic

[SPM04-34] The following equation shows the reaction between Ag^+ and Cl^- ions.

$$\mathbf{Ag^+_{(aq)} + Cl^-_{(aq)} \longrightarrow AgCl_{(s)}, \Delta H = -65 \text{ kJ mol}^{-1}}$$

Which of the following is true about the above equation?

A endothermic reaction occurs
B heat is released to the surroundings
C the temperature of the product decreases
D 65 kJ of heat absorbed when 1 mole of silver chloride is formed

[MRSM09-35] The following thermochemical equation shows the formation of lead (II) sulphate.

$$\mathbf{Pb^{2+} + SO_4^{2-} \rightarrow PbSO_4 \quad \Delta H = -50 \text{ kJ mol}^{-1}}$$

Which of the following statements is true regarding the reaction?

I White precipitate is formed
II Reaction is exothermic
III Temperature decreases during the reaction
IV The heat released when 0.2 mole of lead(II) ions react is 10.0 kJ

A I and III
B II and IV
C I, II and IV
D II, III and IV

[SPM07-35] The following equation shows the reaction between silver nitrate, $AgNO_3$ and sodium chloride, NaCl.

$$\mathbf{AgNO_{3(aq)} + NaCl_{(aq)} \text{ -- > } AgCl_{(s)} + NaNO_{3(aq)}, \Delta H = -65.5 \text{ kJ mol}^{-1}}$$

Which of the following shows that the reaction is an exothermic reaction?

A Silver chloride precipitate is formed in the reaction
B The reaction needs 65.5 kJ of heat energy to form 1 mol of silver chloride
C The total energy absorbed to break the bonds is more than the total energy released during the precipitation of silver chloride.
D The energy contained in silver nitrate and sodium chloride is higher than the energy contained in silver chloride and sodium nitrate.

[MRSM04-50] An experiment was carried out to determine the heat of precipitation for the reaction between silver nitrate and sodium chloride. Table 5 shows the temperature reading of both solutions.

Initial temperature for 50 cm^3 silver nitrate 1 mol dm^{-3}	30 °C
Initial temperature for 50 cm^3 sodium chloride 1 mol dm^{-3}	30 °C
Maximum temperature for mixture of both solutions	35 °C

Table 5

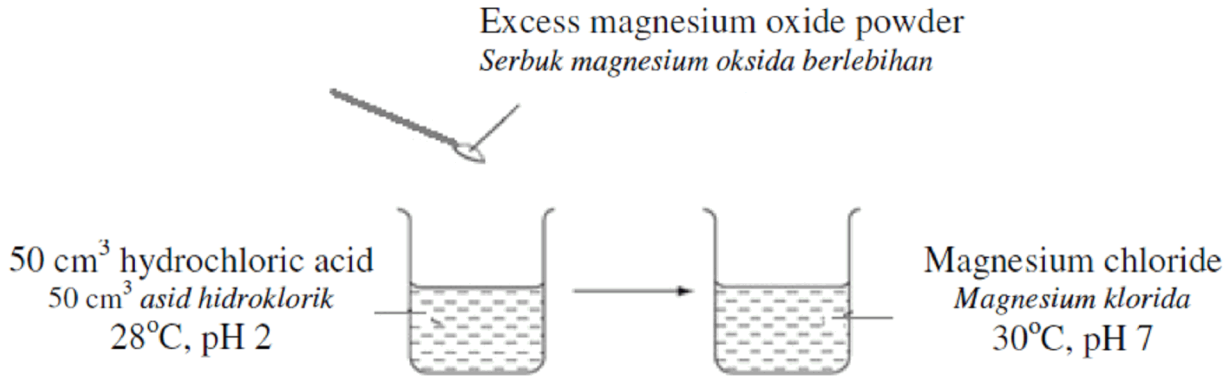
Based on Table 5, which of the following is true?
[Specific heat capacity: 4.0 J g-1 $°C^{-1}$; Relative atomic mass: Ag=108; Cl=35.5]

I 7.2 g white precipitate is formed.
II Heat released during the experiment is 2000 J
III The amount of silver nitrate used is 0.05 mol
IV Heat released during the formation of bonds is more than heat absorbed during the breaking of bonds.

A I and III only
B II and IV only
C II, III and IV only
D I, II, III and IV

Heat of Displacement

[MRSM11-34] Diagram 14 shows an experiment where excess magnesium oxide powder is added to 50 cm^3 dilute hydrochloric acid.
[Specific heat capacity of water 4.2 Jg^{-1} $°C^{-1}$]



	Exothermic	Neutralization	Heat given out (J)
A	√	X	400
B	√	√	420
C	X	√	400
D	X	X	420

[SPM11-41] When excess zinc powder is added to 25 cm^3 of 0.2 mol dm^{-3} copper(II) sulphate solution, the temperature increases from 30 °C to 40 °C.
What is the heat of displacement of copper?
[Specific heat capacity of the solution = 4.2 J g^{-1} $°C^{-1}$; Density of solution = 1 g cm^{-3}]

A - 21 kJ mol^{-1}
B - 42 kJ mol^{-1}
C - 210 kJ mol^{-1}
D - 420 kJ mol^{-1}

[SPM10-42] The following thermochemical equation shows a displacement reaction. Based on the equation, which statement is correct?

$$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu, \quad \Delta H = -210 \text{ kJ mol}^{-1}$$

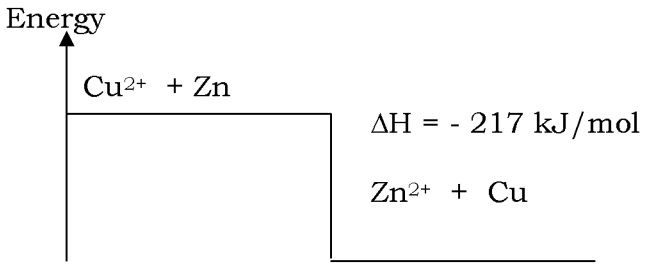
A The reaction is endothermic
B The activation energy is 210kJ mol^{-1}
C The temperature of the mixture increases
D The total energy of the reactants is lower than the products

[MRSM03-19] The heat of displacement of copper can be determined by adding excess magnesium powder to copper(II) sulphate solution. Besides the rise in temperature, the other data needed are

I mass of the magnesium powder
II volume of copper(II) sulphate solution
III relative atomic mass of magnesium
IV molarity of the copper (II) sulphate solution

A I and III only
B II and IV only
C I, II and III only
D II, III and IV only

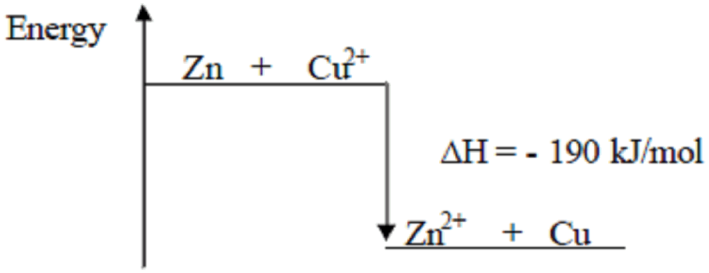
[MRSM05-50] The diagram shows the energy level for the displacement reaction of copper by zinc.



What is the total amount of heat released when 50.0 cm^3 of 0.5 mol dm^{-3} copper(II) sulphate solution reacts in access zinc.

A 5.4 kJ
B 10.8 kJ
C 21.6 kJ
D 54.0 kJ

[MRSM06–45] The following shows the energy level diagram of a reaction.



Which of the following statements are true about the reaction?

I Zinc is oxidized
II The reaction is exothermic
III The temperature decreases during the reaction
IV 95 kJ of heat is released when 0.5 mol of copper is displaced

A I and III only
B II and IV only
C III and IV only
D I, II and IV only

[MRSM07-49] The thermochemical equation represents the displacement of iron.

$$\mathbf{Mg(s) + Fe^{2+}(aq) \rightarrow Mg^{2+}(aq) + Fe(s) \quad ; \quad \Delta H = -189\ kJ\ mol^{-1}}$$

Which of the following statements are true?

I Magnesium is oxidized
II Reaction is exothermic
III The temperature decreases
IV The heat released by reacting 0.2 mol of iron(II) ions is 37.8 kJ

A I and II only
B II and IV only
C III and IV only
D I, II and IV only

[SPM03-50] The equation below shows a displacement reaction and its heat of reaction.

$$Mg + Fe^{2+} \longrightarrow Mg^{2+} + Fe \quad ; \quad \Delta H = -189\ kJ\ mol^{-1}$$

Which of the following statements are true about the reaction represented by the above equation?

I Magnesium is oxidized
II The reaction is exothermic
III The temperature decreases during the reaction
IV The heat released by reacting 0.2 mole of iron(II) ions is 37.8 kJ

A I and II only
B II and IV only
C III and IV only
D I, II and IV only

[SPM07-49] In an experiment 2.4 g of magnesium powder is added to 100 cm^3 of 2.0 mol dm^{-3} copper(II) sulphate solution. The temperature of the mixture increases by 1.0 °C. What is the heat of reaction in the experiment?
[Specific heat capacity of a solution = 4.2 J g^{-1} $^0C^{-1}$; Relative atomic mass of Mg=24]

A - 0.42 kJ mol^{-1}
B - 0.48 kJ mol^{-1}
C - 4.20 kJ mol^{-1}
D - 4.80 kJ mol^{-1}

[SPM08-43] The following is a thermochemical equation.

$$Fe + CuSO_4 \text{ -- > } FeSO_4 + Cu \; ; \Delta H = -150 \text{ kJ mol}^{-1}$$

What is the heat change when 3.2g of copper is formed in this reaction?
[Relative atomic mass: Cu=64]

A 1.37 kJ
B 7.50 kJ
C 46.90 kJ
D 480.00 kJ

[SBPtrial08-41] Diagram 14 shows the energy level diagram of the displacement reaction between magnesium and iron(II) chloride solution.

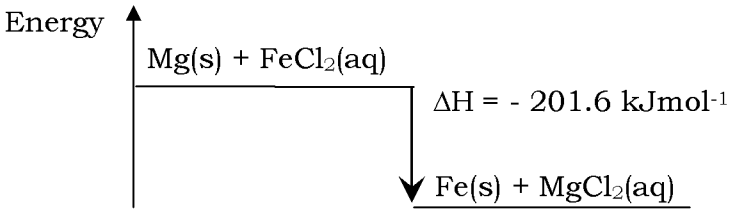


Diagram 14

What is the increase in temperature if 50 cm^3 of 0.25 mol dm^{-3} iron(II) chloride solution is reacted with excess magnesium?
[Specific heat capacity of the solution = 4.2 J g^{-1} °C^{-1}]

A 12 °C
B 16 °C
C 22 °C
D 24 °C

[SPM03-46] Diagram 11 shows an energy level diagram.

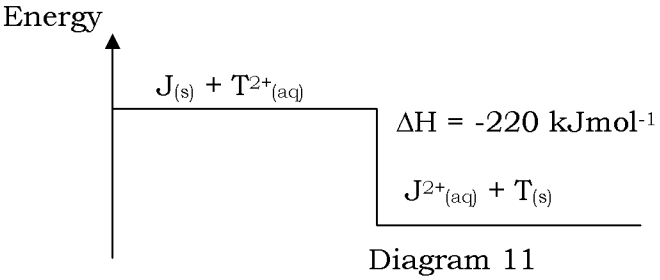
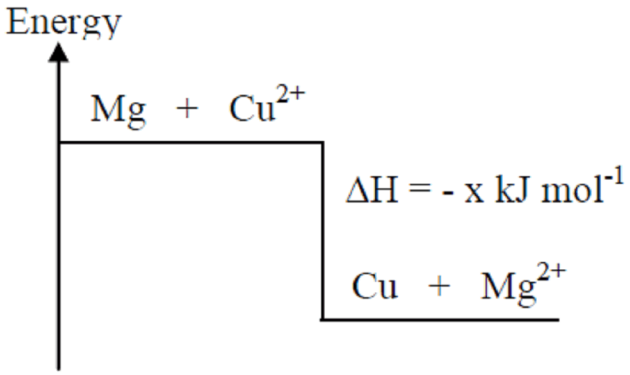


Diagram 11

Based on Diagram 11, what is the increase in temperature of the solution if excess J powder is added to 50 cm^3 of T salt solution 0.2 mol dm^{-3}
[Specific heat capacity of solution: 4.0 J g^{-1} °C^{-1}]

A 4.4 °C
B 5.5 °C
C 8.8 °C
D 11.0 °C

[SBPtrial11-25] Diagram 10 shows an energy level diagram for the displacement reaction



Which statement can be deduced from the Diagram 10?

A The heat of displacement is - x kJ mol^{-1}
B x kJ of energy is needed for the reaction
C The products contain more energy than the reactants
D The temperature at the end of the reaction is lower than that at the beginning of the reaction

Heat of Neutralisation

[MRSM11-50] Diagram 22 shows the energy level diagram for neutralisation reaction.

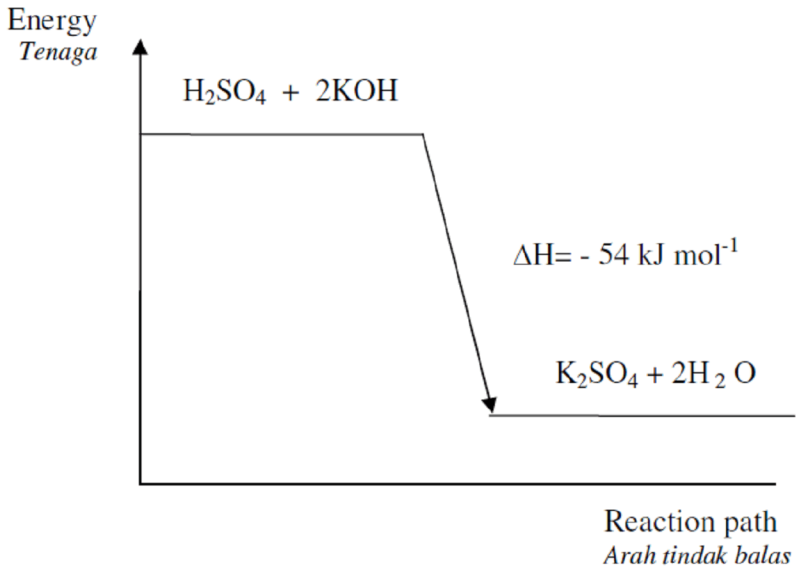


Diagram 22

What is the amount of heat released when 50 cm^3 2 mol dm^{-3} sulphuric acid reacts with 50 cm^3 2 mol dm^{-3} potassium hydroxide solution?

A 5.4 kJ
B 10.8 kJ
C 27.0 kJ
D 54.0 kJ

[MRSM10-50] Diagram 12 shows an energy level diagram for the reaction between acid and alkali.

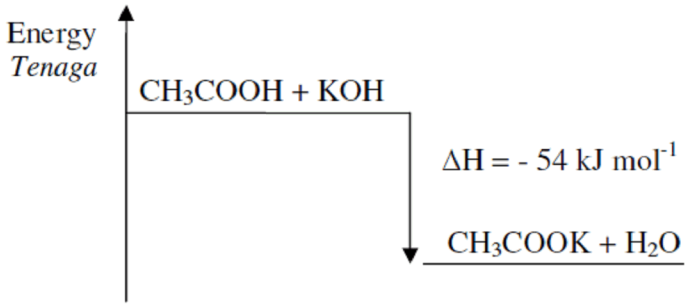


Diagram 12

Calculate the amount of heat released when 50 cm^3 of 2 mol dm^{-3} ethanoic acid reacts with 50 cm^3 of 2 mol dm^{-3} potassium hydroxide solution.

A 540 J
B 5400 J
C 27000 J
D 54000 J

[SBPtrial10-39] Which of the following acids, when added to 50 cm^3 of 0.01 mol dm^{-3} sodium hydroxide solution, produce the same rise in temperature of the mixture?

I 50 cm^3 of 0.01 mol dm^{-3} hydrochloric acid
II 25 cm^3 of 0.01 mol dm^{-3} sulphuric acid
III 50 cm^3 of 0.01 mol dm^{-3} nitric acid
IV 50 cm^3 of 0.01 mol dm^{-3} ethanoic acid

A I and III
B III and IV
C I, II and III
D I, II, III and IV

[MRSM10-34] When 50 cm^3 of 1.0 $moldm^{-3}$ nitric acid is mixed with 50 cm^3 of 1.0 $moldm^{-3}$ sodium hydroxide solution the temperature increases by 6.0 °C. What is the temperature change if the experiment is repeated using 50 cm^3 of 2.0 mol dm^{-3} nitric acid with 50 cm^3 of 1.0 mol dm^{-3} sodium hydroxide?

A 3.0 °C
B 6.0 °C
C 9.0 °C
D 12.0 °C

[SBPtrial10-24] The following equation shows the reaction between potassium hydroxide solution and nitric acid.

$$KOH_{(aq)} + HNO_{3(aq)} \rightarrow KNO_{3(aq)} + H_2O_{(l)} \; ; \Delta H = - 57 \text{ kJ mol}^{-1}$$

Which of the following statements is true?

A 57 kJ of heat energy is absorbed to form 1 mole of water
B The temperature of the solution mixtures rises
C The heat is absorbed from the surroundings
D The reaction is endothermic

[SPM2010-44] What is the meaning of heat of neutralization?

A The heat absorbed when acid reacts with an alkali?
B The heat released when acid reacts with alkali
C The heat change when one mole of water is formed from the reaction between acid and alkali
D The heat change when one mole of salt is formed from the reaction between acid and alkali

[SBPtrial09-36] In an experiment 50 cm^3 1.0 mol $dm^{-3}$of dilute nitric acid solution is mixed with 50 cm^3 of 1.0 mol dm^{-3} sodium hydroxide solution in a polystyrene cup. The temperature of the mixture increased by 14 °C. What is the heat released in the experiment? [Specific heat capacity of the solution is 4.2 $Jg^{-1o}C^{-1}$]

A 1470 J
B 2940 J
C 4410 J
D 5880 J

[SPM05-48] In an experiment 100 cm^3 of dilute hydrochloric acid solution is mixed with 100 cm^3 sodium hydroxide solution in a polystyrene cup. The concentrations of the two solutions are the same.

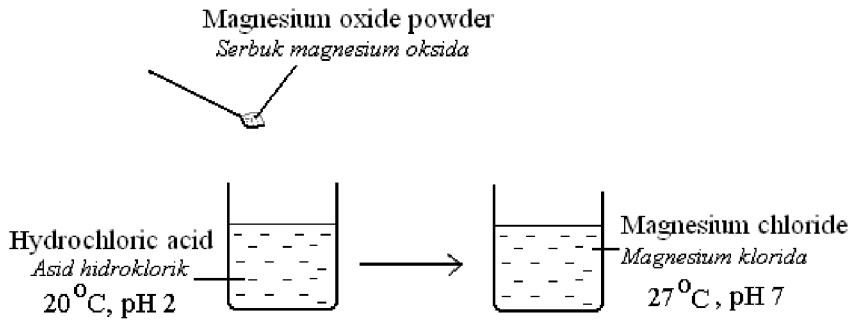
During the mixing the temperature of the mixture increased by 7 °C. What is the heat released in the experiment?
[Specific heat capacity of the solution is 4.2 $Jg^{-1}°C^{-1}$]

A 1 470 J
B 2 940 J
C 4 410 J
D 5 880 J

[SPM06-49] The reaction between 25.0 cm^3 of hydrochloric acid and 25.0 cm^3 of sodium hydroxide solution releases the heat of 2100 J. What is the temperature change of the mixture?
[Specific heat capacity of a solution= 4.2Jg^{-1} $°C^{-1}$. Assume that 1cm^3 of a solution is equal to 1g of the solution]

A 1 °C
B 2 °C
C 10 °C
D 20 °C

[MRSM07-19] Diagram 9 shows an experiment in which magnesium oxide powder is added to dilute hydrochloric acid.



Which reaction takes place in the experiment?

	Exothermic	Neutralisation
A	√	√
B	√	X
C	X	√
D	X	X

[MRSM04-29] Below are two thermo chemical equations for the neutralization process.

$NaOH + HCl \text{ -- > } NaCl + H2O$; $\Delta H = -57$ kJ mol-1

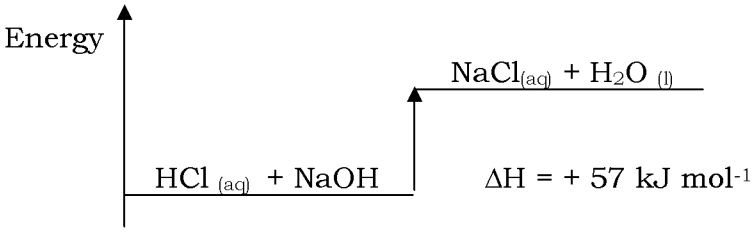
$NaOH + CH_3COOH \text{ -- > } CH_3COONa + H_2O$; $\Delta H = -55$ kJ mol-1

The value of the heat of neutralization for both processes are different because .....

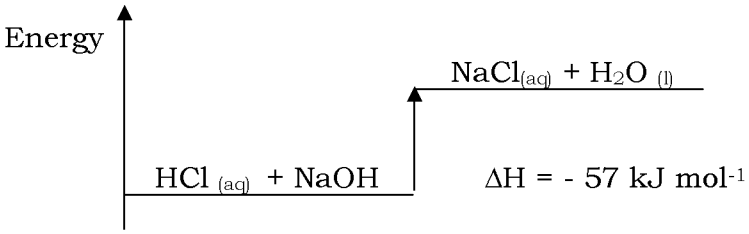
A the ethanoic acid is less soluble in water.
B the production of sodium ethanoate salt absorbs heat.
C the ethanoic acid produces only a small amount of hydrogen ions.
D greater amount of heat is absorbed to ionize the ethanoic acid molecule.

[SPM06-33] The reaction between hydrochloric acid and sodium hydroxide is an exothermic reaction. The heat of reaction is 57 kJ mol^{-1}. Which of the following energy level diagrams represents the reaction?

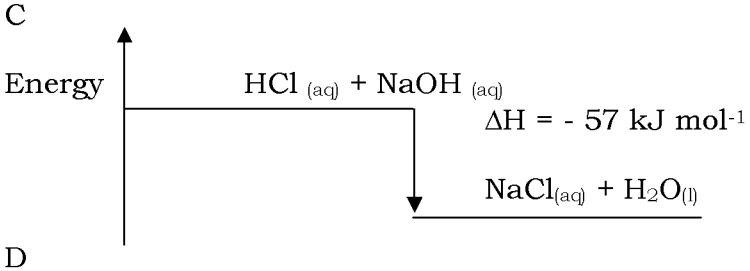
A



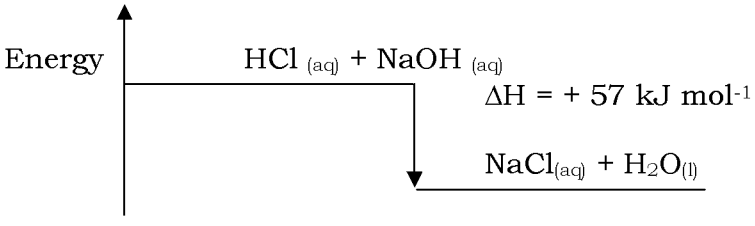
B



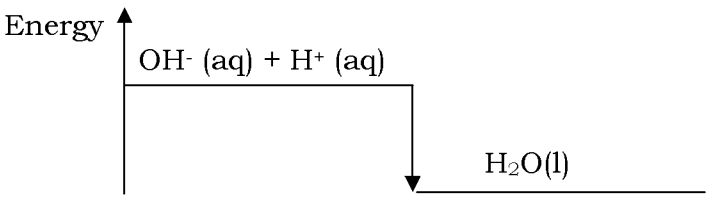
C



D



[SPM05-34] The following is an energy level diagram.



What conclusion can be made from the diagram?

A the product contains more energy than the reactants
B OH- ions contain more energy than H+ ions
C heat is needed to initiate the reaction
D heat is released in this reaction

[MRSM07-50] When 100 cm^3 of 1.0 mol dm^{-3} of sodium hydroxide is added to 100 cm^3 of 1.0 mol dm^{-3} of hydrochloric acid, temperature rises by 7 °C. Which of the following mixtures will produce an increment of 14 °C in temperature?

A 50 cm^3 of 1.0 mol dm^{-3} of sodium hydroxide 50 cm^3 of 1.0 mol dm^{-3} of hydrochloric acid
B 50 cm^3 of 2.0 mol dm^{-3} of sodium hydroxide and 50 cm^3 of 2.0 mol dm^{-3} of hydrochloric acid
C 100 cm^3 of 1.0 mol dm^{-3} of sodium hydroxide and 100 cm^3 of 4.0 mol dm^{-3} hydrochloric acid
D 200 cm^3 of 1.0 mol dm^{-3} sodium hydroxide and 200 cm^3 of 1.0 mol dm^{-3} hydrochloric acid

[MRSM06-40] The table shows two experiments carried out to investigate the reaction between calcium nitrate and sodium carbonate solution.

Experiment	**Calcium nitrate Solution**		**Sodium carbonate solution**		**Decrease in temperature,°C**
	Volume (cm^3)	**Concentration (mol dm^{-3})**	**Volume (cm^3)**	**Concentration, (mol dm^{-3})**	
I	100.0	1.0	100.0	1.0	6.0
II	50.0	2.0	50.0	2.0	X

What is the value of X?

A 1.5 °C
B 3.0 °C
C 6.0 °C
D 12.0 °C

[MRSM03-45] When 25 cm^3 of 2.0 mol dm^{-3} sodium hydroxide solution was added to 25 cm^3 of 2.0 mol dm^{-3} of nitric acid solution, the temperature increased by T °C. What is the increase in temperature if 25 cm^3 of 2.0 mol dm^{-3} sodium hydroxide solution was added to 25 cm^3 of 2.0 mol dm^{-3} sulphuric acid?

A T
B 2T
C 3T
D 4T

[MRSM05-48] When 100 cm^3 of 1.0 mol dm^{-3} hydrochloric acid reacts with 100 cm^3 of 1.0 mol dm^{-3} potassium hydrogen carbonate solution the temperature decreased by ***y*** ℃ . What is the decrease in temperature for the reaction when 50 cm^3 of 1.0 mol dm^{-3} hydrochloric acid reacts with 50 cm^3 of 1.0 mol dm^{-3} potassium hydrogen carbonate solution ?

A $0.1\ y$ ℃
B $0.5\ y$ ℃
C y ℃
D $2\ y$ ℃

[MRSM05-49] In a neutralization reaction, 50 cm^3 of 1.0 mol dm^{-3} nitric acid reacted with 50 cm^3 of 1.0 mol dm^{-3} sodium hydroxide solution. Which of the following acids can replace 50 cm^3 of 1.0 mol dm^{-3} nitric acid to release the same quantity of heat?

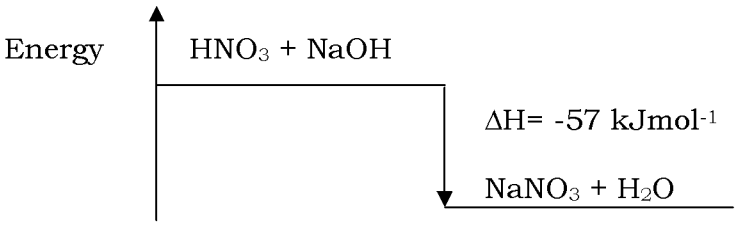
I 25 cm^3 of 2.0 mol dm^{-3} hydrochloric acid
II 25 cm^3 of 2.0 mol dm^{-3} sulphuric acid
III 20 cm^3 of 2.5 mol dm^{-3} nitric acid
IV 25 cm^3 of 1.0 mol dm^{-3} sulphuric acid

A I and II only
B III and IV only
C I, II and III only
D I, II, III and IV

[MRSM09-34] Which of the following acid releases the highest amount of heat when reacted with excess potassium hydroxide?

A 20 cm^3 of 1.0 mol dm^{-3} of sulphuric acid
B 20 cm^3 of 1.0 mol dm^{-3} of nitric acid
C 20 cm^3 of 1.0 mol dm^{-3} of ethanoic acid
D 20 cm^3 of 1.0 mol dm^{-3} of hydrochloric acid

[SPM05-47] The following is the energy level diagram of a reaction.



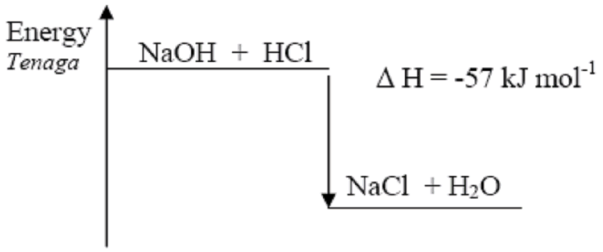
Which of the following acids is suitable to replace nitric acid, HNO_3 to obtain the same ΔH value?

A Ethanoic acid, CH_3COOH
B Carbonic acid, H_2CO_3
C Sulphuric acid, H_2SO_4
D Hydrochloric acid, HCl

[SPM04-16] Which of the following neutralization reactions releases the least heat ?

A nitric acid and sodium hydroxide
B sulphuric acid and sodium hydroxide
C Ethanoic acid and sodium hydroxide
D hydrochloric acid and potassium hydroxide

[MRSM07-19] Diagram 7 shows an energy level diagram for neutralisation process.



Based on Diagram 7, it can be concluded that

I the heat of neutralization is - 57 kJ mol^{-1}
II 57 kJ of energy is needed for the reaction
III the products of reaction contain less energy than the reactants
IV temperature drops when reaction takes place.

A I and III only
B II and III only
C I and IV only
D II, III and IV only

[SPM03-30] Diagram 8 shows an energy level diagram

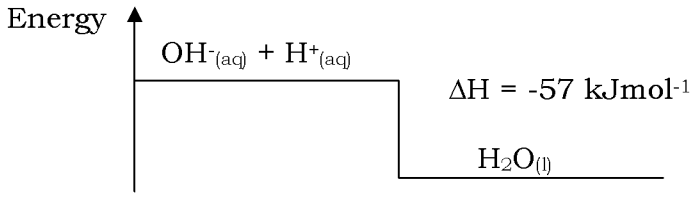


Diagram 8

Based on Diagram 8, it can be concluded that

A The heat of neutralization is – 57 kJ mol^{-1}
B 57 kJ of energy is needed for the reaction
C the products of reaction contain more energy than the reactants
D the temperature at the end of the reaction is lower than that at the beginning of the reaction

[SPM03-49] Diagram 12 shows a set up of apparatus to determine the heat of reaction.

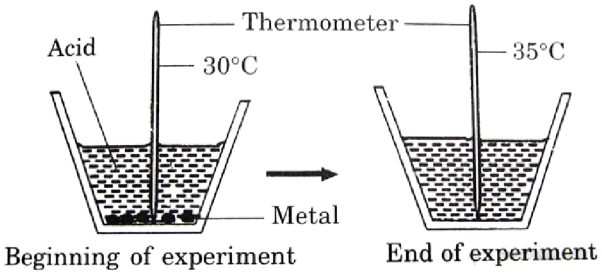


Diagram 12

Based on Diagram 12 which of the following statements is true?

I The process of bonding occurs
II Temperature increases during the reaction
III The ΔH value in the reaction is positive
IV The energy content of the products of reaction is higher than that of the reactants.

A I and II only
B III and IV only
C I, II and IV only
D I, II, III and IV

[SBPtrial07-38] The following equation shows the formation of water

$$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l), \quad \Delta H = -287 \text{ kJmol}^{-1}$$

Which of the following is true regarding the above equation?
A Activation energy for the reaction is high
B If 1 mole of oxygen reacts 574 kJ of heat energy is absorbed
C Combustion of 1 mole of hydrogen releases 287 kJ of heat energy
D 1 mole of water that is formed in the reaction received 287 kJ heat energy

[SBPtrial09-25] Table 3 shows the reactants and heat of neutralization of the reaction between sodium hydroxide solution with methanoic acid and hydrochloric acid.

Reactants	**Heat of neutralization/ kJ mol^{-1}**
Methanoic acid and sodium hydroxide solution	- 54.0
Hydrochloric acid and sodium hydroxide solution	-57.0

Table 3

Which of the following statements is true?

A Methanoic acid partially dissociates in water
B Methanoic acid releases energy to the surrounding
C Methanoic acid produces H^+ ions which can be replaced by Na^+ ions
D Methanoic acid absorbed some of the heat energy released to complete its dissociation in water

Heat of Combustion

[SBPtrial11-50] The following equation shows a combustion reaction on propanol?

$$w\ C_3H_7OH + xO_2 \rightarrow y\ CO_2 + z\ H_2O$$

What are the values of w, x, y and z?

	w	**x**	**y**	**z**
A	1	9	3	4
B	1	5	3	4
C	2	9	6	8
D	2	5	6	8

[SPM11-45] The following thermochemical equation shows a combustion reaction between hexane. C_6H_{14} and oxygen.

$$C_6H_{14} + 19/2\ O_2 \rightarrow 6CO_2 + 7H_2O; \quad \Delta H = -3500 \text{ kJmol}^{-1}$$

What is the mass of hexane need to be burnt to produce heat that can heat up 2 kg of water from 25 °C to 100°C?
[Relative atomic mass : C=12, H=l; specific heat capacity of water = 4.2 $Jg^{-1}\ ^{\circ}C^{-1}$]

A 5.16 g
B 5.56 g
C 15.48 g
D 16.67 g

[SBPtrial11-38] Carbon burns in oxygen in a reaction as shown in the equation below.

$$C_{(s)} + O_{2(g)} \rightarrow CO_{2\,(g)} \quad : \Delta H = -394 \text{ kJ mol}^{-1}$$

What is the mass of carbon that must be burnt completely to produce 78.8 kJ of heat?

A 0.2 g
B 1.2 g
C 2.4 g
D 6.0 g

[SPM10-43] 100 cm^3 of water is heated by the burning of a sample of ethanol. The heat released by the combustion is 10-5 kJ. What is the maximum increases in temperature of the water? [Specific heat capacity of water = 4.2 J g^{-1} $°C^{-1}$]

A 0.025 °C
B 0.25 °C
C 2.5 °C
D 25 °C

[MRSM2010-35] A student carries out an experiment to determine the heat of combustion of propanol. Which of the following information does he need in order to calculate the heat of combustion?

I Mass of water
II Volume of propanol
III Initial temperature of propanol
IV Highest temperature of water

A I and II
B I and IV
C II and III
D III and IV

[MRSM07-49] The burning of 0.6 g of X causes the temperature of 100 cm^3 water to increase by 12 °C. What is the heat of combustion of X?
[Relative molecular mass of X = 60; specific heat capacity of water = 4.2 J g^{-1} $°C^{-1}$]

A 50.4 kJ mol^{-1}
B 72.0 kJ mol^{-1}
C 302.4 kJ mol^{-1}
D 504.0 kJ mol^{-1}

[MRSM09-50] The heat of combustion for propanol, C_3H_7OH is – 2016 kJ mol^{-1}. When 0.3 g of propanol is completely burnt, the heat given out is used to heat 250 cm^3 of water.
What is the rise in temperature for the water?
[Specific heat capacity of water = 4.2 J g^{-1} $°C^{-1}$. Molar mass of propanol = 60 g mol^{-1}]

A 2.4 °C
B 4.8 °C
C 9.6 °C
D 19.2 °C

[SPM06-50] The following information shows the result of an experiment to determine the heat change for the combustion of propanol, C_3H_7OH.

Volume of water in the copper container = 300 cm^3
Initial temperature of water in the copper container = 27.5 °C
Highest temperature of water in the copper container = 68.5 °C

What is the heat released by the combustion of propanol, C_3H_7OH.
[Specific heat capacity of water = 4.2$Jg^{-1}\,{}^0C^{-1}$; Water density = 1g cm^{-3}]

A 34.65 kJ
B 51.66 kJ
C 86.31 kJ
D 120.96 kJ

[SPM04-35] The table shows the heat of combustion of three alcohols.

Alcohol	**Heat of combustion/ kJ mol^{-1}**
CH_3OH	710
C_2H_5OH	- 1 370
C_4H_9OH	- 2 670

Which of the following factors increases the heat of combustion of alcohols?

A size of molecules decreases
B number of carbon atoms per molecule increases
C number of oxygen atoms per molecule increases
D number of hydrogen atoms per molecule decreases

[SPM04-49] The following equation shows the combustion of heptene, C_7H_{16} in excess oxygen

$$\mathbf{C_7H_{16}(l) + 11O_2(g) \longrightarrow 7CO_2(g) + 8H_2O(l)\ ;\ \Delta H = -5\,512\ kJmol^{-1}}$$

The combustion of heptene in excess oxygen releases 1 378 kJ of energy. What is the mass of heptene used? [Relative atomic mass: H=1, C=12]
A 25.0g
B 36.0 g
C 77.0 g
D 88.0 g

[SPM07-32] Which of the following is true about the heat of combustion, ΔH, for ethanol, propanol and butanol?

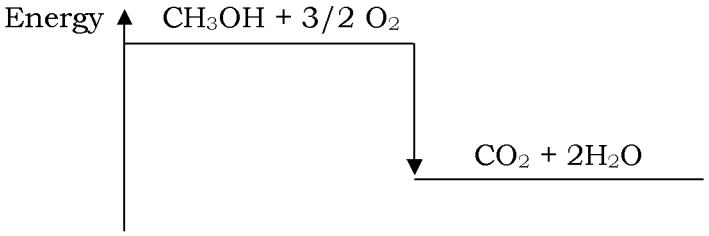
	Ethanol	**Propanol**	**Butanol**
A	-2015 kJ mol^{-1}	-1376 kJ mol^{-1}	-725 kJ mol^{-1}
B	-2015 kJ mol^{-1}	-2676 kJ mol^{-1}	-725 kJ mol^{-1}
C	-2676 kJ mol^{-1}	-725 kJ mol^{-1}	-1376 kJ mol^{-1}
D	-1376 kJ mol^{-1}	-2015 kJ mol^{-1}	-2676 kJ mol^{-1}

[SPM07-34] The following equation shows a combustion reaction of methanol.

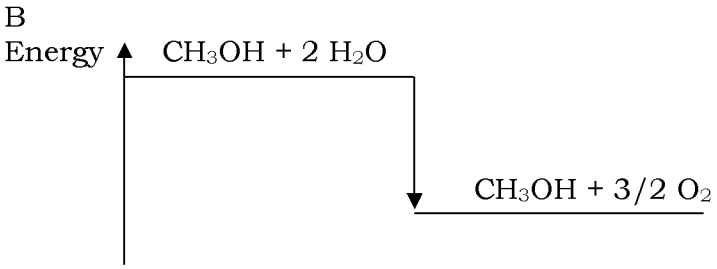
$$CH_3OH(l) + 3/2\ O_2(g) \text{ -- > } CO_2(g) + 2H_2O(l),\ \Delta H = -726\ kJ\ mol^{-1}$$

Which of the energy level diagrams represents the reaction?

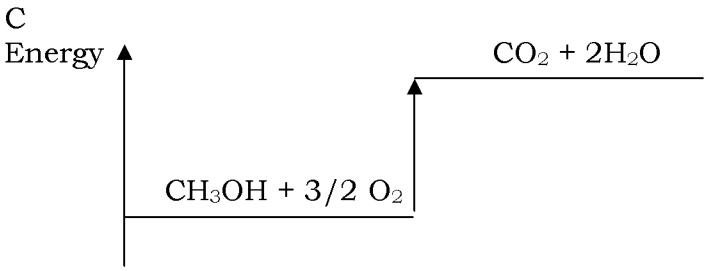
A



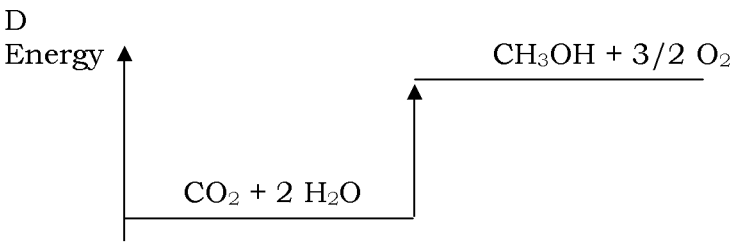
B



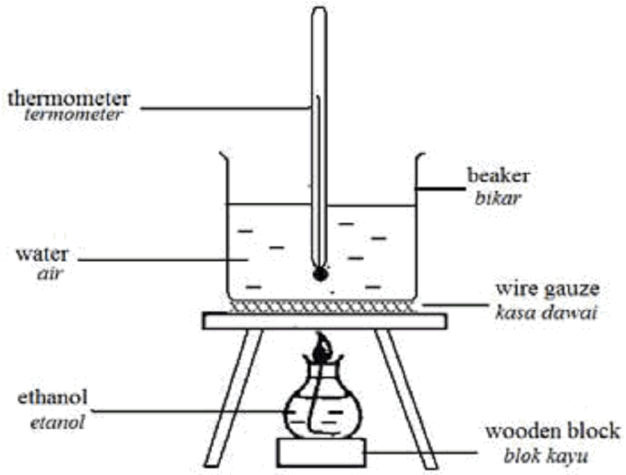
C



D



[MRSM07-34] Diagram 15 shows the set-up of apparatus to determine heat of combustion of ethanol.



The heat of combustion of ethanol was found less than the theoretical value. What can be done to improve the experimental value?

I Remove the wooden block
II Use copper container to replace beaker
III Do not use wire gauze when heating
IV Use greater volume of water

A II and III only
B I, II and III only
C II, III and IV only
D I, II, III and IV

[MRSM03-46] The thermochemical equation below represents the combustion of methane in excess oxygen

$$CH_4(g) + 2O_2(g) \text{-- } > CO_2(g) + 2H_2O(l) \quad ; \quad AH = -890\ kJmol^{-1}$$

Which of the following are true when 3.2 g methane was burnt in excess oxygen?
[Relative atomic mass: H=1; C=12; O=16; Molar volume of gas; 24 dm^3 at room conditions]

I 178 kJ heat was evolved
II 0.2 mol of oxygen used
III 7.2 g water produced
IV 240 cm^3 carbon dioxide evolved

A I and III only
B II and IV only
C I, II and III only
D I, II, III and IV

[MRSM06-50] Information on methane and butane is shown in the following table.

Fuel	Relative molecular mass	Chemical equation	Heat of Combustion
Methane	16	$CH_4 + 2O_2$ -- $>CO_2 + 2H_2O$	-890 kJ mol^{-1}
Butane	58	$C_4H_{10} + 13/2\ O_2$ -- $>4CO_2 + 5H_2O$	-2882 kJ mol^{-1}

Based on the information shown in the table, the conclusions are .....
I butane is more combustible than methane
II combustion of 1 g of methane produces more heat than 1 g of butane
III energy content of butane is higher than methane
IV combustion of 1 mole of butane produces more carbon dioxide than 1 mole of Methane

A I and III only
B I, II and IV only
C II, III and IV only
D I, II, III and IV

[MRSM04-35] Combustion of methane in excess oxygen can be represented by the equation below.

$$CH_4 + 2O_2 \text{ -- } > CO_2 + 2H_2O \quad ; \quad \Delta H = -X\ kJ\ mol^{-1}$$

Which of the following is true?

I X kJ is released for every mole of methane burnt.
II 1 dm^3 of methane gas releases 1 dm3 carbon dioxide gas.
III The formation of carbon dioxide and water molecules releases heat.
IV The energy content of reactants is less than that of the products.

A I and III only
B II and IV only
C I, II and III only
D I, II, III and IV

Fuel Value

[MRSM11-35] Table 3 shows the energy released by the complete combustion of some carbon compounds.

Compound	**Relative molecular mass**	**ΔH (kJ/mol)**
Methane	16	- 880
Ethanol	46	- 1380
Pentanol	88	- 3332
Heptane	100	- 4800

Table 3

Which compound produces the most energy when 1 g is completely burnt?

A Ethanol
B Heptane
C Methane
D Pentanol

Structure {Paper02}

[SBPtrial04-05] {Translate}

One experiment to determine heat of precipitate of lead(II) sulphate was done by mix 25 cm^3 of 0.5 mol dm^{-3} lead(II) nitrate solution and 25 cm^3 of 0.5 mol dm^{-1} potassium sulphate solution. The result of the experiment in the table below:

Initial of temperature of lead(II) nitrate	= 28.0 °C
Initial of temperature of potassium sulphate	= 29.0 °C
The higher temperature of mixture	= 33.0 °C

(a) What mean by the heat of precipitate of that reaction. [1M]

.....

(b) Write the ionic equation for the reaction. [1M]

.....

(c) Calculate the number of mol of lead(II) ions and sulphate ions that exist in every solution. [2M]

(i) Lead(II) ions

(II) Sulphate ions

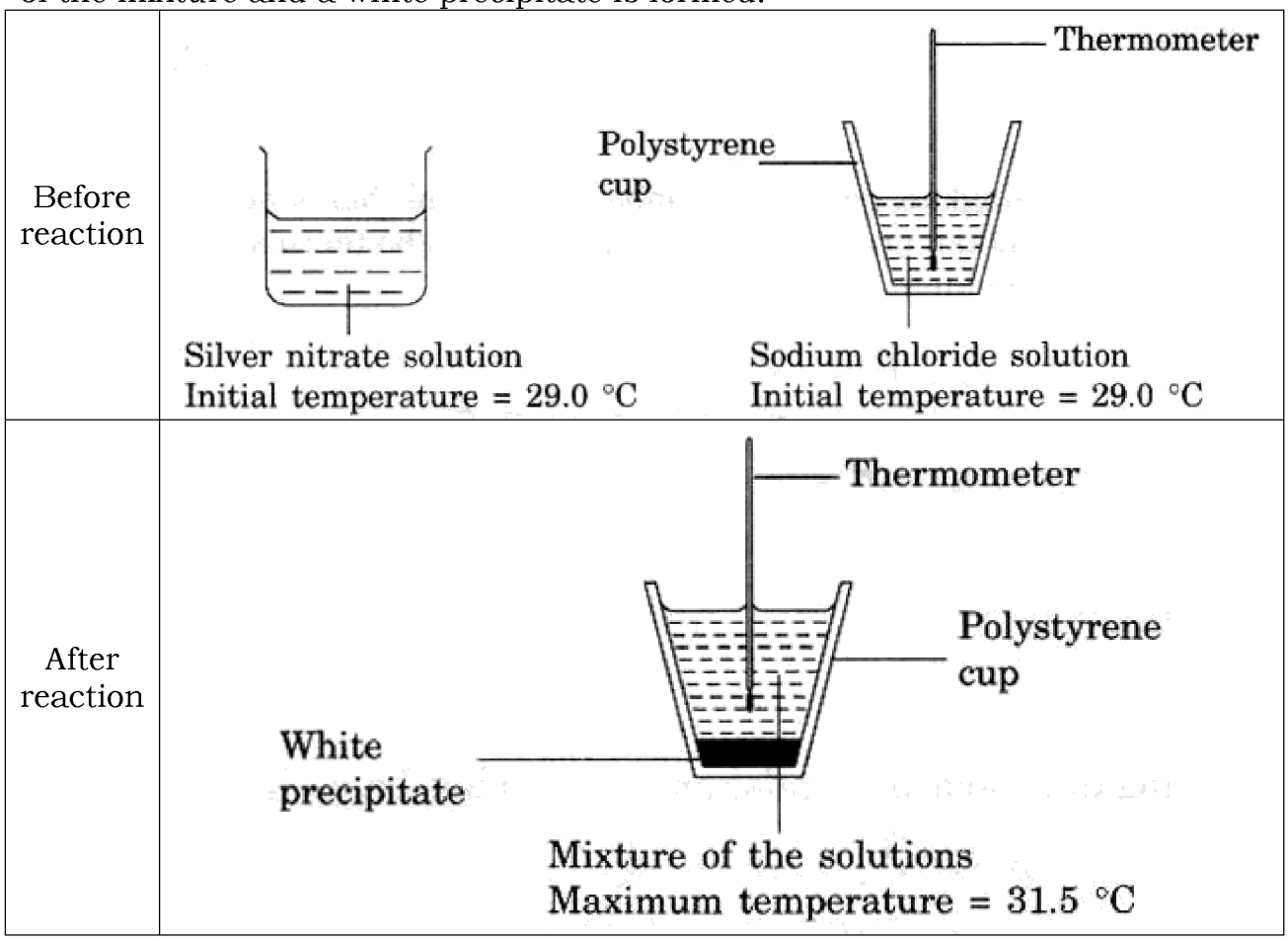
(d) Calculate the change of heat in the experiment. [2M]
[specific heat capacity of the solution=4.2 $Jg^{-1}°C^{-1}$]

(e) Calculate the heat of precipitate of this reaction. [2M]

(f) Draw the energy level diagram for the reaction. [2M]

[SPM04-04]

Diagram 4 shows the set-up of the apparatus of an experiment to determine the heat of precipitation. 25.0 cm^3 of 0.5 mol dm^{-3} silver nitrate solution is reacted with 25 cm^3 of 0.5 mol dm^{-3} sodium chloride solution. As a result there is a change in temperature of the mixture and a white precipitate is formed.



(a) Why is a polystyrene cup used in the experiment? [1M]

.....

(b) (i) Based on the change of temperature in the experiment, state the type of reaction that occurred. [1M]

.....

(ii) How is the total energy of the product different from the total energy of the reactants? [1M]

.....

(c) State one step that should be taken while adding the two solutions in order to get a more accurate result. [1M]

.....

(d) The ionic equation for the precipitation reaction of silver chloride is:

$$Ag^{+}_{(ag)} + Cl^{-}_{(ag)} \longrightarrow AgCl_{(s)}$$

(i) What is the number of moles of Ag^{+} ions that reacted with Cl^{-} ions ? [1M]

.....

(ii) Calculate the heat change of the precipitation reaction that has taken place. Use the information that the specific heat capacity of water is 4.2 J g^{-1} $°C^{-1}$ and density water is 1 g cm^{-3}. [2M]

(iii) Calculate the heat of precipitation for this reaction. [2M]

(e) The calculated value of the heat of precipitation for this reaction is less than the actual value. Give a reason. [1M]

.....

.....

.....

[SBPtrial05-05] {Translate}

In one experiment, the magnesium powder was added until excess into 50 cm^3 of 1 mol dm^{-3} copper(II) sulphate in a cup of polystyrene. The mixture was stir with thermometer and the highest temperature of mixture was recorded.

The result recorded as below:

Initial temperature of copper (II) sulphate = 28.0 °C
The highest temperature of mixture = 50.0 °C

[Density of the solution =1.0 g cm^{-1}, specific heat capacity of the solution=4.2 $Jg^{-1}\,{}^oC^{-1}$]

(a) State the type of the reaction above. [1M]

.....

(b) State two observations from the experiment. [2M]

.....

.....

.....

(c) Write the ionic equation for the reaction. [1M]

.....

(d) (i) Calculate the number of mole of copper produce from the reaction. [1M]

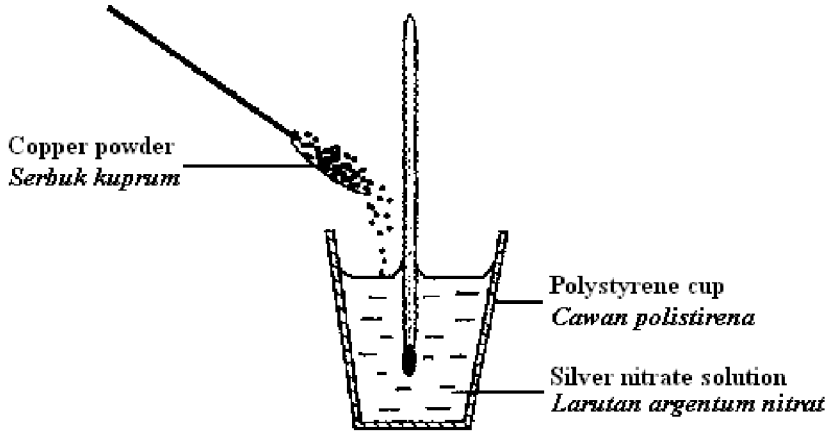
(ii) Calculate the change of heat in the experiment. [1M]

(iii) Calculate the heat of displacement of copper. [2M]

(e) Draw the energy level diagram for the reaction. [2M]

[SBPtrial11-06]

A student carried out an experiment to determine the value of heat of displacement. Diagram 6 shows the setup of the apparatus used in the experiment.



(a) Why is a polystyrene cup used in the experiment? [1M]

.....

(b) (i) State one observation in the experiment. [1M]

.....

(ii) State one reason for the observation in (b)(i). [1M]

.....

(iii) State the name of the substance that is oxidised during the reaction. Explain your answer in terms of the change in oxidation number. [2M]

.....

.....

.....

(c) In this experiment, excess copper is added to 100 cm^3 of 0.5 mol dm^{-3} silver nitrate solution. The heat of displacement in this experiment is -105 kJmol-1.
[Specific heat capacity of the solution is 4.2 Jg^{-1} $°C^{-1}$; the density of the solution is 1.0 gcm^{-3}]

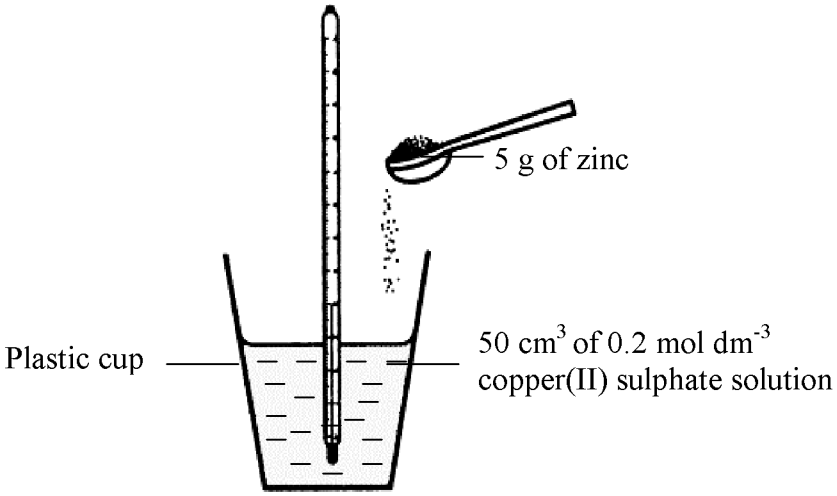
(i) Calculate the heat energy released in this experiment. [2M]

(ii) Calculate the temperature change in this experiment. [1M]

(d) Draw the energy level diagram for the reaction. [3M]

[SBPtrial08-06]

Diagram 6 shows the apparatus set-up for an experiment to determine the heat of displacement of copper.



The following data was obtained:

Initial temperature of copper(II) sulphate solution	= 28 °C
Highest temperature of the mixture of product	= 36 °C

(a) What is meant by the 'heat of displacement'? [1M]

.....

(b) Other than increased in the temperature, state another two observations in the experiment. [2M]

.....

.....

(c) Why is a plastic cup used in the experiment? [1M]

.....

(d) Write the ionic equation for the reaction. [1M]

.....

(e) Based on the information given in the experiment, calculate;

(i) the heat given out in the experiment [1M]
[Specific heat capacity of solution = 4.2 J g^{-1} $^oC^{-1}$, density of solution = 1 g cm^{-3}]

(ii) the heat of displacement of copper [2M]

(f) Draw the energy level diagram for the reaction. [2M]

[MRSM08-06]

Diagram 6 shows the apparatus set-up to determine the heat of displacement of copper from its salt solution by lead powder.

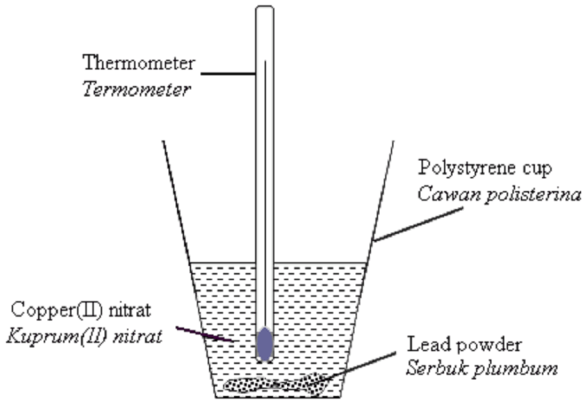


Diagram 6

50 cm^3 of 0.2 mol dm^{-3} copper (II) sulphate is poured into a polystyrene cup. The initial temperature of the solution is recorded.

Excess lead powder is added into the copper (II) sulphate solution, stirred and the maximum temperature is recorded.

Table 6 shows the result of the experiment.

Initial temperature/°C	28.0
Maximum temperature/°C	33.0

Table 6

(a) Give one suggestion on how the above apparatus can be improved to get a better result. [1M]

.....

(b) What is meant by the heat of displacement of copper by lead? [1M]

.....

.....

(c) Write the ionic equation for the reaction. [1M]

.....

(d) (i) Calculate the number of moles of copper(II) ions reacted. [1M]

(ii) Calculate the amount of heat released in the experiment. [1M]
[Density of solution=1.0 gcm^{-3} and specific heat capacity of water=4.2 $Jg^{-1}°C^{-1}$]

(iii) Calculate the heat of displacement of copper by lead. [1M]

(e) Draw the energy level diagram for the reaction. [2M]

(f) What happens to the temperature change if lead powder is replaced by magnesium powder? Explain. [3M]

.....

.....

.....

[SPM05-03]

A pupil carried out an experiment to determine the value of heat of displacement. Figure 3 shows the setup of the apparatus used in the experiment.

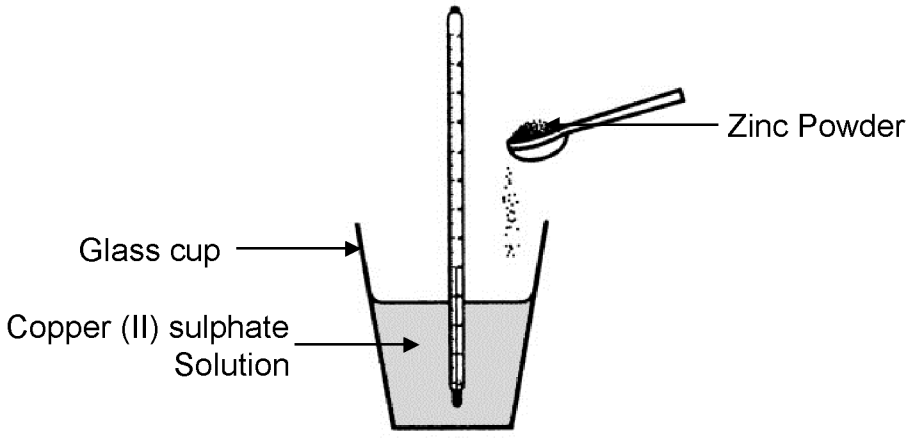


Figure 3

The following data was obtained:

Initial temperature of copper (II) sulphate solution, θ_1 = 28 °C
Highest temperature of the mixture of product, θ_2 = 48 °C

(a) Complete the ionic equation for the reaction that occurred. [1M]

$Zn + Cu^{2+} \longrightarrow$ _____

(b) In this experiment, excess zinc is added to 100cm^3 of 0.5 mol dm^{-3} copper (II) sulphate solution.
[Given that the specific heat capacity of the solution is 4.2 J g^{-1} $^oC^{-1}$ and the density of the solution is 1.0g cm^{-3}.]

(i) Calculate the change of heat capacity of the experiment. [2M]
Use the formula, $\Delta H = mc\theta$

(ii) Calculate the heat of displacement in the experiment. [2M]

The number of moles of copper (II) sulphate that reacted = ...

Heat of displacement = ...

(c) Draw the energy level diagram for reaction.[2M]

(d) It was found that the heat of displacement value in (b)(ii) is not the same as the actual value. Suggest **one** step that must be taken to get a more accurate value. [1M]

.....

(e) Based on the experiment, what is meant by the *heat of displacement* ? [1M]

.....

(f) The pupil repeats the experiment, replacing the metal zinc with metal X.
The following equation shows the reaction and the value of heat of displacement of metal iron and metal X.

Equation I : $Fe\ (s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu(s),\ \Delta H = -150\ kJ\ mol^{-1}$

Equation II : $X\ (s) + CuSO_4\ (aq) \rightarrow XSO_4\ (aq) + Cu(s),\ \Delta H = -100\ kJ\ mol^{-1}$

Predict the metal X.
Choose from this list: Aluminium, magnesium and tin. [1 M]

.....

[SPM03-06]

A student carried out an experiment to determine the heat of displacement for the reaction between copper and silver nitrate solution. In this experiment, excess copper powder was added to 100 cm3 of silver nitrate solution 0.5 mol dm^{-3}. The heat of displacement in this experiment was -105 kJ mol^{-1}.
[Specific heat capacity of the solution= 4.2 Jg^{-1} $°C^{-1}$, density of the solution=1 g cm^{-3}]

(a) What is meant by heat of displacement? [1M]

.....

(b) Besides the data given above, state one other piece of data that is needed to calculate the heat of displacement. [1M]

.....

(c) State one precaution that must be taken while carrying out the experiment. [1M]

.....

(d) (i) State one observation of the experiment. [1M]

.....

(ii) State the reason for the observation in (d) (i) [1M]

.....

(e) Based on the information from this experiment, calculate

(i) The number of moles of silver ions reacted. [1M]

(ii) The amount of heat released. [1M]

(iii) The change in temperature. [1M]

(f) Draw an energy level diagram for the reaction in this experiment. [2M]

(g) The experiment is repeated using 100 cm^3 of 1.0 mol dm^{-3} silver nitrate solution and excess copper powder. Calculate the temperature change in this experiment. Explain why this change of temperature is different from that in (e) (iii). [3M]

.....

.....

.....

[SBPtrial07-06]

A pupil carried out an experiment to determine the value of heat of neutralization. Diagram 6 shows the setup of the apparatus used in the experiment.

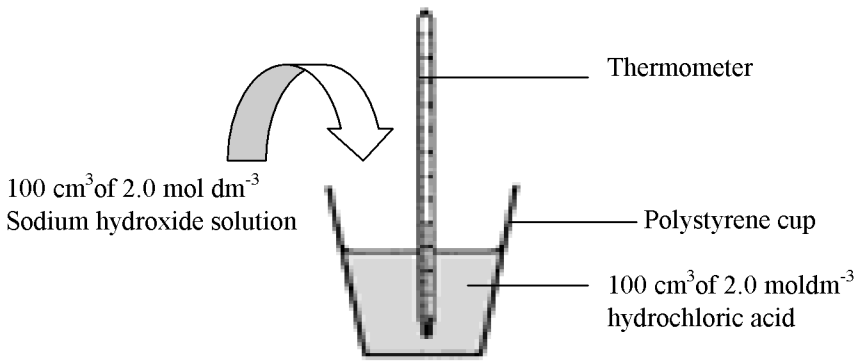


DIAGRAM 6

The following data was obtained:

Initial temperature of hydrochloric acid = 28 °C
Initial temperature of sodium hydroxide solution = 28 °C
Highest temperature of the mixture of product = 41 °C

(a) Why was a polystyrene cup used in this experiment? [1M]

.....

(b) Given that the specific heat capacity of the solution is 4.2 $Jg^{-1}{}^{o}C^{-1}$ and the density of the solution is 1.0 gcm^{-3}. [3M]

(i) Calculate the change of heat in the experiment.

(ii) Calculate the heat of neutralization in the experiment.

(c) Draw the energy level diagram for the reaction. [2M]

(d) Based on the experiment, what is meant by the heat of neutralisation? [1M]

.....

(e) The pupil repeats the experiment by replacing hydrochloric acid with ethanoic acid. All the other conditions remain unchanged.

(i) Predict the value of the heat of neutralisation? [1M]

.....

(ii) Explain why? [2M]

.....

.....

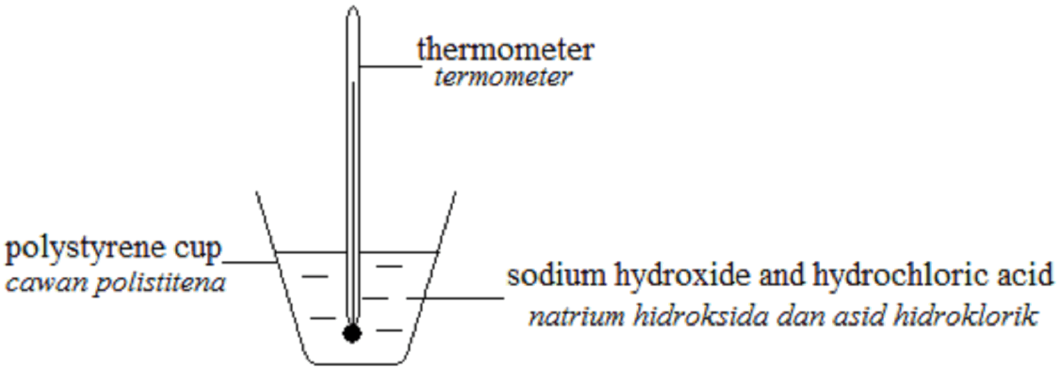
.....

.....

[MRSM07-06]

In an experiment to study the heat of neutralization, 25.0 cm^3 of a 1.0 mol dm^{-3} sodium hydroxide solution was added to 25.0 cm^{-3} of a 1.0 mol dm^{-3} aqueous hydrochloric acid. The mixture was then stirred and the maximum temperature was recorded.

Diagram 6 shows the setup of the apparatus used in the experiment.



The following data was obtained.

Initial temperature of sodium hydroxide solution	= 28.5°C
Initial temperature of hydrochloric acid solution	= 28.5°C
Maximum temperature of the mixture	= 34.5°C

(a) What is meant by heat of neutralization? [1M]

.....

(b) Write an ionic equation for the reaction between hydrochloric acid and sodium hydroxide. [1M]

.....

(c) Based on the data obtained from the experiment, calculate
(i) the number of moles of hydrochloric acid used. [1M]

(ii) the amount of heat released [1M]

(iii) the heat of neutralization [1M]

(d) Draw the energy level diagram for the reaction. [2M]

(e) (i) The heat of neutralization obtained from the experiment is less than the theoretical value. Give a reason. [1M]

.....

.....

(ii) Suggest one step that should be taken to modify the apparatus in order to get a more accurate result. [1M]

.....

.....

(f) The experiment is repeated by doubling the volume of both hydrochloric acid and sodium hydroxide. Assuming the initial temperature is maintained, what would be the maximum temperature of the mixture?

[MRSM06-03]

Diagram 3 shows the apparatus set up used in an experiment to determine the heat of neutralization. 25.0 cm^3 of nitric acid solution 2.0 mol dm^{-3} is reacted with 25.0 cm^3 potassium hydroxide solution 2.0 mol dm^{-3}. an increase in temperature is observed.

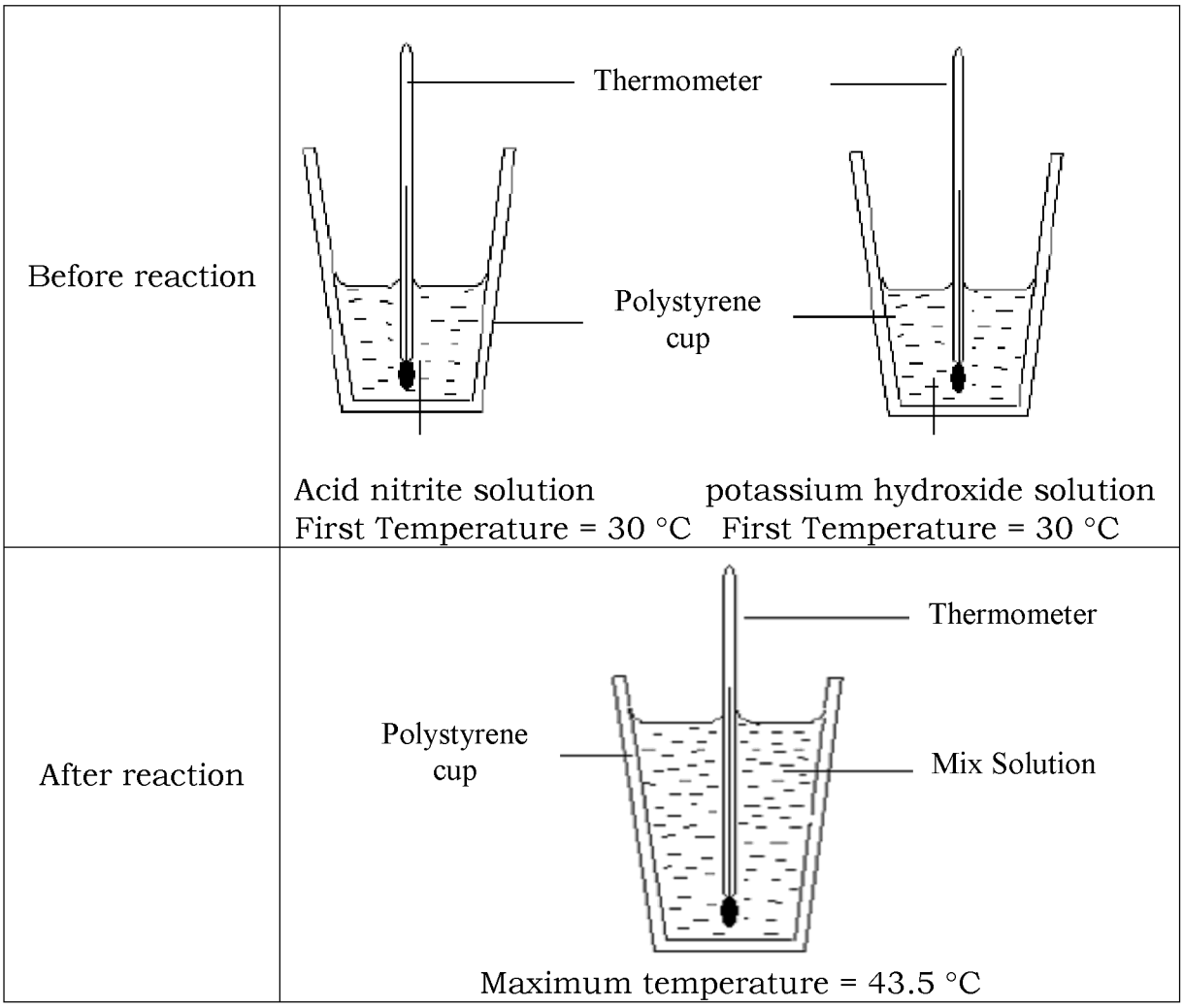


Diagram 3

(a) Suggest one precautionary step needed to be taken during the experiment. [[1M]]

.....

(b) State the type of reaction occurred in terms of heat change. [[1M]]

.....

(c) Write the chemical equation for the reaction. [[1M]]

.....

(d) Calculate

(i) The number of moles of nitric acid and potassium hydroxide. [1M]

(ii) The heat change in the experiment.
[Given the specific heat capacity of solution is 4.2 Jg^{-1} $°C^{-1}$ and the density of solution is 1 g cm^{-3}] [[1M]]

(iii) The heat of neutralisation for this reaction.

ΔH = _____ [2M]

(e) Draw the energy level diagram for this reaction. [2M]

(f) Predict the value of the heat of neutralisation if nitric acid is replaced with ethanoic acid to react with potassium hydroxide. [[1M]]

.....

[MRSM03-06]

An experiment was carried out using the set up as shown in figure 5.

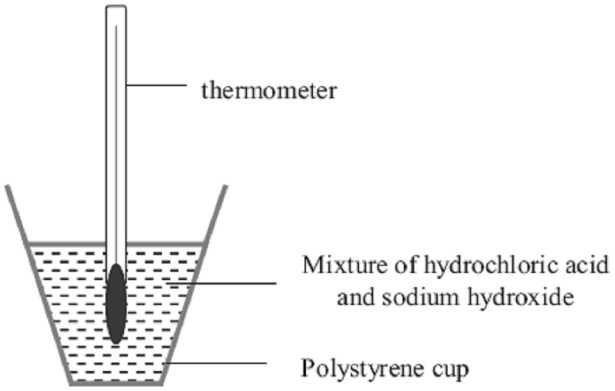


FIGURE 5

50.0 cm^3 of 1.0 mol dm^{-3} aqueous sodium hydroxide was poured into a polystyrene cup. The initial temperature was recorded.

50.0 cm^3 of 1.0 mol dm^{-3} hydrochloric acid was measured and its initial temperature recorded. The acid was then added to the aqueous sodium hydroxide in the cup. The mixture was stirred and the maximum temperature recorded.

Initial temperature of sodium hydroxide = 28 °C
Initial temperature of hydrochloric acid = 28 °C
Maximum temperature of mixture = 34 °C

(a) Write an ionic equation for the above reaction. [1M]

.....

(b) Calculate:

(i) The energy change in the reaction. [1M]
[Specific heat capacity 4.2 Jg^{-1} $°C^{-1}$]

(ii) The heat of neutralization for the above reaction. [2M]

(c) Draw the energy diagram for the above reaction. [2M]

(d) "The heat of neutralization obtained from the experiment is less than the standard value"

(i) Explain the above statement. 1M]

.....

.....

(ii) Suggest a way to improve the results obtained from this experiment. [1M]

.....

.....

(e) If water gets into a student's eye, it is suggested that he washed it with plenty of water and no to neutralize it with alkaline solutions. Explain. [2M]

.....

.....

.....

.....

[SPM08-06]

The thermochemical equation for neutralisation reaction between nitric acid and sodium hydroxide solution is given below.

$$HNO_3 + NaOH \text{ -- > } NaNO_3 + H_2O \ , \ \Delta H = -57.3 \text{ kJ}$$

(a) State the meaning of heat of neutralisation. [1M]

.....

(b) Based of the given thermochemical equation, state one observation when dilute nitric acid is added to sodium hydroxide solution. Explain your answer. [2M]

.....

.....

.....

(c) In an experiment, 100 cm^3 of 2 mol dm^{-3} nitric acid solution was added to 100 cm^3 of 2 mol dm^{-3} sodium hydroxide solution.
[Specific heat capacity of solution= 4.2 Jg^{-1} $°C^{-1}$, Density of solution=1 g cm^{-3}]

Calculate
(i) The heat energy released in this experiment, [2M]

(ii) The temperature change in this experiment. [2M]

(d) Draw the energy level diagram for the reaction between nitric acid and sodium hydroxide. [2M]

(e) Nitric acid and ethanoic acid both react with sodium hydroxide by a neutralisation reaction.

$HNO_3 + NaOH \text{ -- > } NaNO_3 + H_2O$, $\Delta H = -57.3$ kJ mol^{-1}
$CH_3COOH + NaOH \text{ -- > } CH_3COONa + H_2O$, $\Delta H = -55.2$ kJ mol^{-1}

Explain why the heat of neutralisation for each reaction is slightly different. [2M]

.....

.....

[SPM09-06]

Diagram 6 shows the apparatus set-up to determine the heat of neutralisation between nitric acid and sodium hydroxide solution.

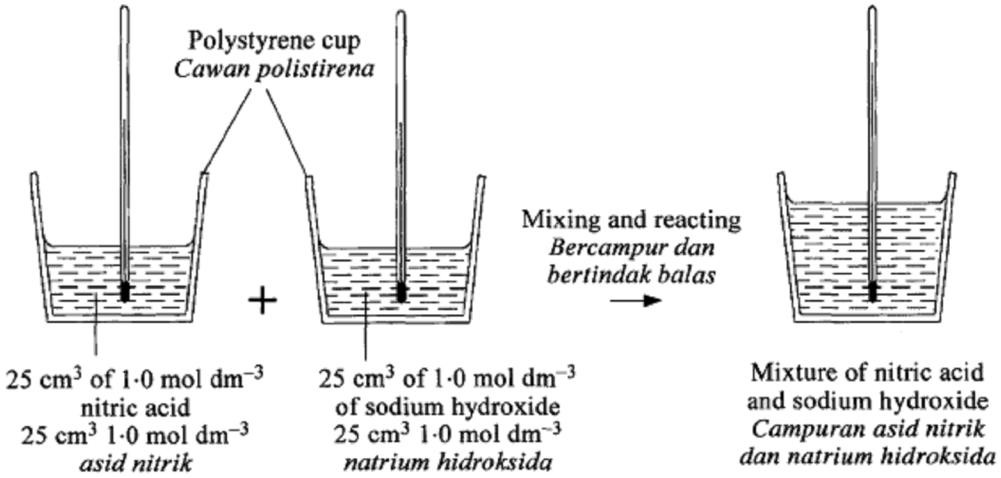


Diagram 6

Table 6 shows the result of this experiment.

Description	Temperature (°C)
Initial temperature of nitric acid	30.0
Initial temperature of sodium hydroxide	30.0
Highest temperature of the mixture	36.8

Table 6

(a) What is the meaning of heat of neutralisation? [1M]

.....

(b) calculate
(i) The heat released during the reaction. [1M]
[Specific heat capacity of solution, c = 4.2 J g^{-1} °C, Density of solution=1 gcm^{-3}]

(ii) The number of moles of nitric acid reacting. [1M]

(iii) The heat of neutralisation. [1M]

(e) Draw an energy level diagram for this reaction.[3M]

(d) The experiment is repeated using 25 cm^3 of 1.0 mol dm^{-3} ethanoic acid to replace the nitric acid. The heat of neutralisation using ethanoic acid is 55.0 kJ mol^{-1}. Explain the difference of the heat of neutralisation. [3M]

(e) Give one reason why a copper container cannot replace the polystyrene cup in this experiment.

.....

.....

.....

[SBPTrial2010-06]

An experiment is carried out to determine the heat of combustion of propanol. Table 6 shows the results obtained.

Mass of lamp + propanol before combustion /g	30.69
Mass of lamp + propanol after combustion / g	29.85
Volume of water / cm^3	
Initial temperature / °C	28.0
Highest temperature /°C	59.0

Table 6

(a) Draw a labelled diagram of apparatus set-up used in this experiment. [2M]

(b) Write the chemical equation for the complete combustion of propanol. [2M]

.....

(c) Based on the results of the experiment, calculate:

(i) Heat released when propanol is burnt.
[Given that the specific heat capacity for water is 4.2 J g-1 °C-1][1M]

(ii) number of moles of propanol burnt.
[Given that relative molecular mass of propanol is 60] [1M]

(iii) heat of combustion of propanol.in this experiment. [2M]

(iv) Draw the energy level diagram for this reaction. [2M]

(d) The heat of combustion obtained in this experiment is less than the actual theoretical value. Suggest one precaution that should be taken to obtain a more accurate value of the heat of combustion. [1 mark]

.....

[SPM05-05]

(a) What is the meaning of the *heat of combustion of an alcohol?* [1M]

.....

(b) Table 5 shows the heat of combustion of three types of alcohol.
The number of carbon atoms and the attractive force between molecules are among the factors that affect the value of heat of combustion.

Name of alcohol	**Molecular formula**	**Heat of combustion /kJ mol^{-1}**
Methanol	CH_3OH	725
Ethanol	C_2H_5OH	1376
Propanol	C_3H_7OH	2015

(i) Use data from Table 5 to draw the graph of the heat of combustion against number of carbon atoms on the graph paper below. [2M]

(ii) Based on the graph in (b)(i), as the number of carbon atoms increases so does the value of the heat of combustion. Explain why. [2M]

.....

.....

.....

(iii) Calculate the heat released when 2.3g of ethanol is completely burnt in air.
Given that the relative atomic mass of C=12, H=1, O=16.
Use the formula: Heat released = Number of moles X Heat of combustion. [2M]

(c) Methanol and ethanol do not have isomers. Propanol has two isomers.
Draw the structures of the two isomers of propanol. [2M]

(d) Table 5.2 shows the freezing and the boiling points of mercury, methanol, ethanol and butanol.

Substance	**Freezing point /°C**	**Boiling point /°C**
Mercury	- 39	357
Methanol	- 97	64
Ethanol	- 117	79
Butanol	- 90	117

Table 5.2

A thermometer may contain mercury or an alcohol.
A mercury thermometer is not suitable to measure the temperature at around -100 °C.
Name a suitable alcohol that can be used in a thermometer to measure the Temperature at around –100 ^{0}C. Give **one** reason for your choice. [2M]

Name of alcohol : .....

Reason : .....

.....

Essay {Paper02}

[MRSM11-10]

(*a*) Excess zinc powder is added to 50 cm^3 of 1.0 mol dm^{-3} copper(II) sulphate solution and stirred. Calculate the change of temperature in this experiment. [4M]
[Specific heat capacity of solution, c = 4.2 J g^{-1} $°C^{-1}$; Density of solution = 1g cm^{-3}]

(*b*) Hydrogen and chlorine gas can react to form an acidic gas.

(i) The bond energies of H – H bond is 436 kJ mol^{-1} , Cl – Cl bond is 243 kJ mol^{-1} and H – Cl bond is 432 kJ mol^{-1}. State whether the reaction to form the acidic gas is exothermic or endothermic. Explain your answer. [4M]

(ii) Draw the energy level diagram for the reaction. [2M]

(*c*) Plan an experiment to determine the heat of displacement for the reaction between zinc and copper(II) sulphate solution.

Your description must include the following: [10M]
• Procedure of the experiment
• The method to calculate the heat of displacement.

----------oooOO aĎaŽ OOooo----------

[SPM10-10]

Table 10 shows the heat of neutralisation of two different monoprotic acids, P and Q, with sodium hydroxide solution.

Experiment	Reactants	Heat of neutralisation (kJ mol^{-1})
I	100 cm^3 1.0 mol dm^{-3} sodium hydroxide solution + 100 $cm^3$1.0 mol dm^{-3} of monoprotic acid P	- 55.0
II	100 cm^3 1.0 mol dm^{-3} sodium hydroxide solution + 100 $cm^3$1.0 mol dm^{-3} of monoprotic acid Q	- 57.0

Table 10

(a)(i) Based on the information in Table 10, state one example which could be acid P and one which could be acid Q. [2M]

(ii) Explain why there is a difference in the values of the heat of neutralisation. [4M]

(b) Calculate the change in the temperature of the mixture in experiment I. [4M]
[Specific heat capacity of solution: 4.2 Jg^{-1} $°C^{-1}$]

(c) By using one of the acid in 9(a)(i), describe one experiment to determine the heat of neutralisation. [10M]

Your answer should consist of the following:

- Procedure of the experiment
- The method to calculate the heat of neutralization

----------oooOO aĎaŽ OOooo----------

[MRSM10-10]

(*a*) Diagram 10 shows an energy level diagram.

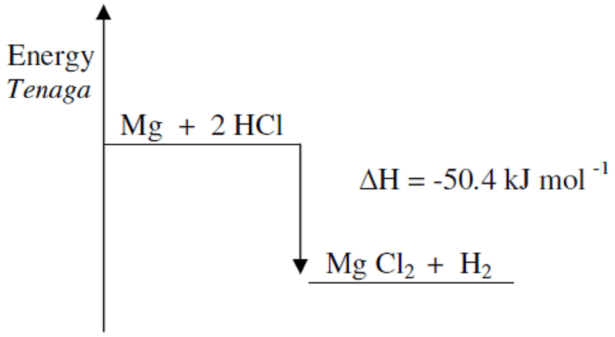


Diagram 10.1

Determine the temperature change when 50 cm^3 of 1.0 mol dm^{-3} of hydrochloric acid reacts with excess magnesium.
[Specific heat capacity of solution: 4.2 J g^{-1} $°C^{-1}$, density of solution: 1 g cm^{-3}] [4M]

(*b*) Table 10 shows the molecular formula and the heat of combustion for propanol and butanol.

Alcohol	**Molecular Formula**	**Heat of combustion/ kJ mol^{-1}**
Propanol	C_3H_7OH	-2100
Butanol	C_4H_9OH	-2877

Table 10

Based on the information in Table 10,

(i) Write the equation for the complete combustion of either one of the alcohol. [2M]

(iii) Compare the heat of combustion between propanol and butanol. Explain your answer. [4M]

(c) Describe a laboratory experiment to determine the heat of combustion of a named alcohol. [10M]

Your answer should include:

- a labelled diagram
- procedure

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[SBPtrial09-10]

(a) Diagram 10 show the energy level of Reaction I and Reaction II.

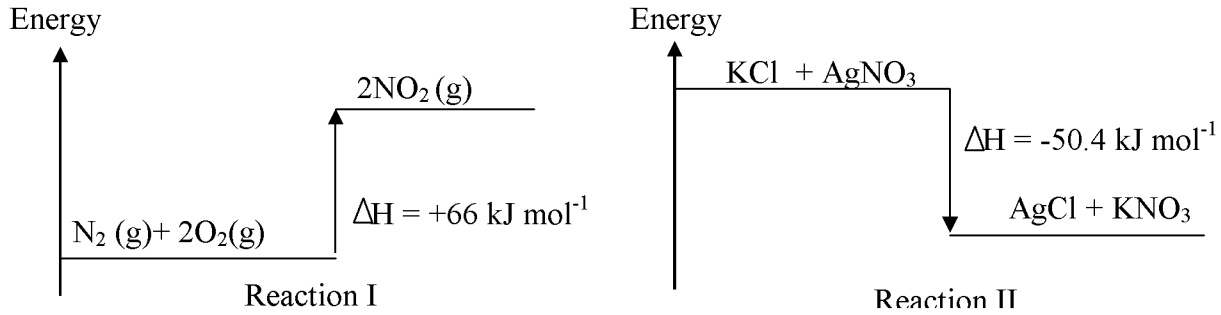

Diagram 10

Based on Diagram 10, compare the energy level diagram between Reaction I and Reaction II. [3M]

(b) Table 10 shows the molecular formula and the heat of combustion for propanol and butanol.

Alcohol	**Molecular Formula**	**Heat of combustion/ kJ mol^{-1}**
Propanol	C_3H_7OH	-2100
Butanol	C_4H_9 OH	-2877

Table 10

Based on the information in Table 10, compare the heat of combustion between propanol and butanol. Explain why there is a difference in the values of the heat of combustion between propanol and butanol. [3M]

(c) By using a named example of an alcohol, describe a laboratory experiment to determine the heat of combustion.

In your description, include a labelled diagram and the calculations involved. [10M]
[Relative atomic mass: C=12, O=16, H=1, Specific heat capacity of solution = 4.2 J g^{-1} °C^{-1}, Density of solution=1 g cm^{-3}]

(d) In an experiment to determine the heat of displacement, excess zinc is added to 100 cm^3 of 0.5 mol dm^{-3} silver nitrate solution. Calculate the temperature change if the heat of displacement is –105 kJmol^{-1}. [4M]
[Specific heat capacity of the solution=4.2 J g^{-1} °C^{-1}; Density of the solution=1 g cm^{-3}]

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[MRSM05-10]

Table 3 shows examples of chemical reactions.

	Reaction	**ΔH value**
I	Combustion of ethanol in excess oxygen	-1376 kJ/mol
II	Combustion of propanol in excess oxygen	- 2015 kJ/mol
III	Dissociation of calcium carbonate	+ 570 kJ/mol

(a) (i) Write the thermochemical equations of reaction I and III. [2M]

(ii) Explain why does the heat of combustion of ethanol is different compared to propanol [2M]

(b) State the differences between reaction I and reaction III based on the information above. [6M]

(c) Describe an experiment to determine the heat of combustion of ethanol, in your explanation includes the following. [10M]

- Diagram of the apparatus
- List of reagents and apparatus used
- Procedure
- Precautionary steps taken.

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[MRSM09-10]

Diagram 10 shows energy level diagram for two reactions.

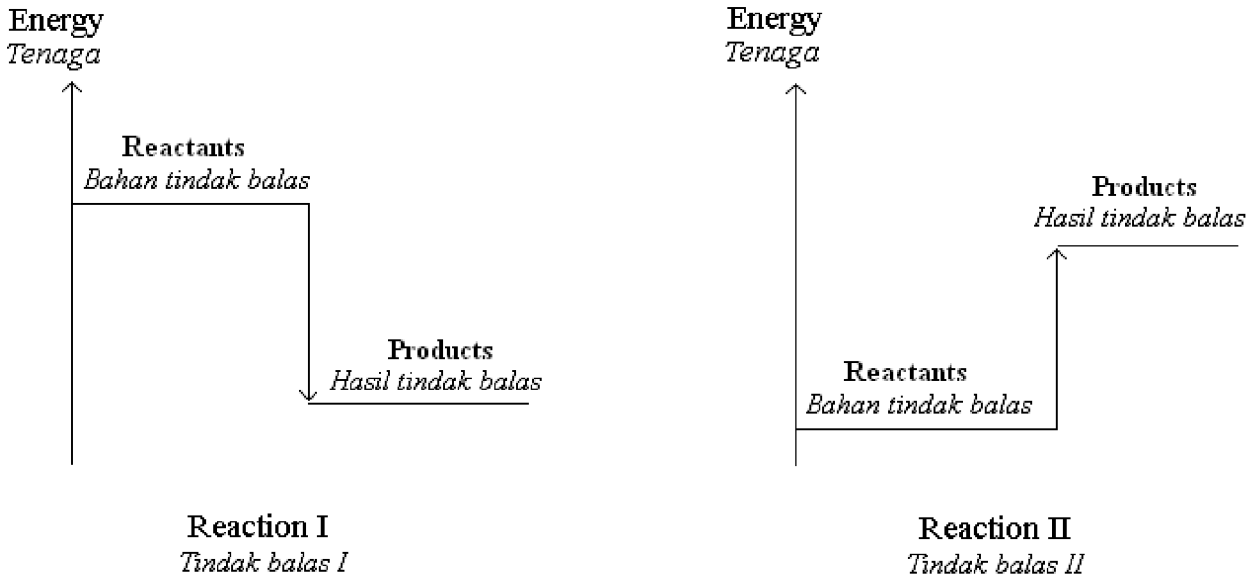


Diagram 10

(a) Explain the differences between the energy level diagrams for Reaction I and Reaction II. [5M]

(b) The heat of combustion of butanol can be determined in the laboratory. Describe how to determine the heat of combustion of butanol.

Your answer should include the following: [10M]

- Diagram of apparatus set-up
- Procedure of the experiment
- Precautionary steps to get better results

(c) The heat of combustion of butanol is -2678 kJ mol-1. 3.7 g of butanol is used to heat 500 cm^3 of water. Calculate the maximum temperature of water if the initial temperature of water is 28.0 °C. [5M]
[Relative atomic mass: H=1, C=12, O=16, Specific heat of water 4.2 Jg^{-1} $°C^{-1}$]

[MRSM04-08]

(a) A student holding an ice cube discovers that ice turned into water after a few minutes. Explain this phenomenon. [2M]

(b) Methane is the main component in liquid natural gas while butane is the main component in liquid petroleum gas. Both gases are used as fuel.

The complete combustion of methane and butane can be shown by the following equations:

$$CH_4 + 2O_2 \text{ -- > } CO_2 + 2H_2O \quad ; \Delta H = -890 \text{ kJ mol}^{-1}$$
$$C_4H_{10} + 13/2O_2 \text{ -- > } 4CO_2 + 5H_2O \quad ; \Delta H = -2882 \text{ kJ mol}^{-1}$$

(i) A student heats up 1 dm^3 of water at 1 atmosphere from room temperature (30°C) till it started boiling. Calculate the minimum mass of butane gas needed to heat the water. [3M]
[Specific heat capacity of water; 4.2 $Jg^{-1}°C^{-1}$, Density of water 1 gcm^{-3}, Relative Atomic Mass: C=12; H=1]

(ii) Calculate the amount of heat released by each gram of methane and butane. Based on your answer compare the efficiency of these two substances as a fuel. [4M]
[Molar mass: methane=16 $gmol^{-1}$, butane=58 $gmol^{-1}$]

(c) A student carried out two experiments to determine the heat of precipitation. Table 3 shows the results of the experiments.

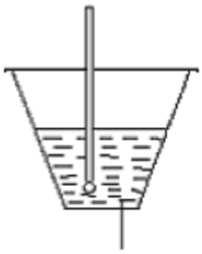
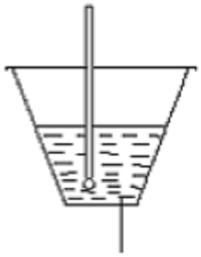
Experiment	I	II
	 sodium sulphate + lead(II) nitrate	 calcium nitrate + sodium carbonate
Set-up of apparatus	sodium sulphate + lead(II) nitrate	calcium nitrate + sodium carbonate
Initial temperature of solutions	Sodium sulphate : 27 °C Lead(II) nitrate : 27 °C	Calcium nitrate : 27 °C Sodium carbonate : 27 °C
Maximum temperature of mixture	38 °C	24 °C

Table 3

(i) Write the chemical equations for both reactions in experiments I and II. [2M]

(ii) Compare the changes in temperature for both experiments I and II. Using the energy level diagram, explain why there are differences in the observation. [5M]

(iii) The 'ice pack' that is commonly used by sportsmen is made based on the thermo chemical principle. This pack requires suitable chemical.
Name the chemical used and explain how this pack function. [4M]

[SBPtrial06-10] {Translate}

(a) Diagram 10 shows the set-up apparatus of experiment to determine heat of combustion for liquid of hydrocarbon M.
[Relative atomic mass for M =86, specific heat of water 4.2 Jg^{-1} $°C^{-1}$, Density of water 1 gcm^{-3}]

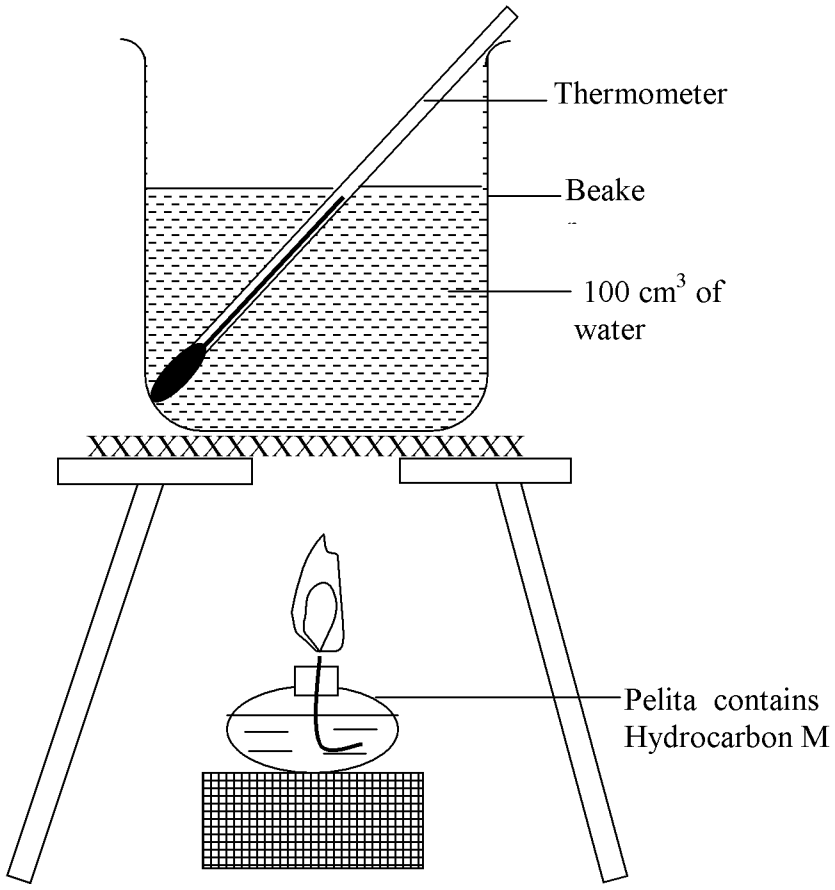


Diagram 10

(i) State 2 mistake for the arrangement of apparatus at the diagram above. [2M]

(ii) If the temperature of water increase 50 °C, calculate the heat released from combustion of liquid hydrocarbon M. [1M]

(iii) The mass of liquid hydrocarbon M used in combustion is 1.72 g. By used information at (a)(i) calculate he of combustion of liquid hydrocarbon M. [3M]

(b) Alcohol as one alternative source of combustion to replace petrol for the future. The example of alcohols is methanol, ethanol, propanol and butanol.
Describe one experiment in laboratory to determine heat of combustion one of example of alcohol was named. Include in your description the apparatus and materials, the diagram set-up, procedure and calculation heat of combustion of alcohol. [14M]
[Relative atomic mass: C=12, H=1, O=16]

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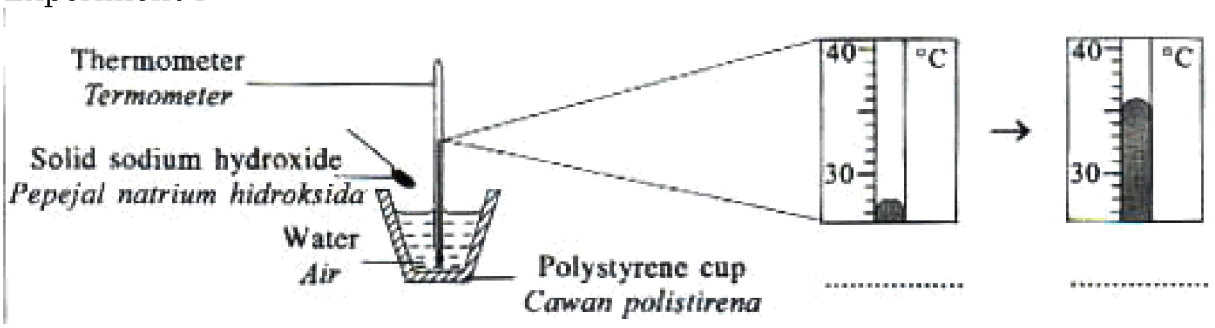
Structure {Paper03}

[SPM07-01]

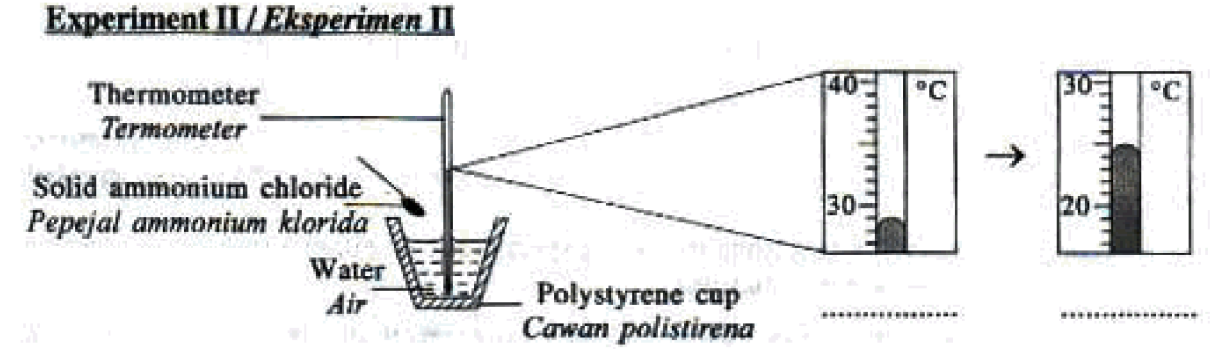
Diagram 1.1 shows the apparatus set-up for Experiment I, II, III and IV.
The magnification of the thermometer shows the readings of the initial temperature and the highest or lowest temperatures in each experiment.

(a) (i) Record the temperature readings in the spaces provided in Diagram 1.1 [3M]

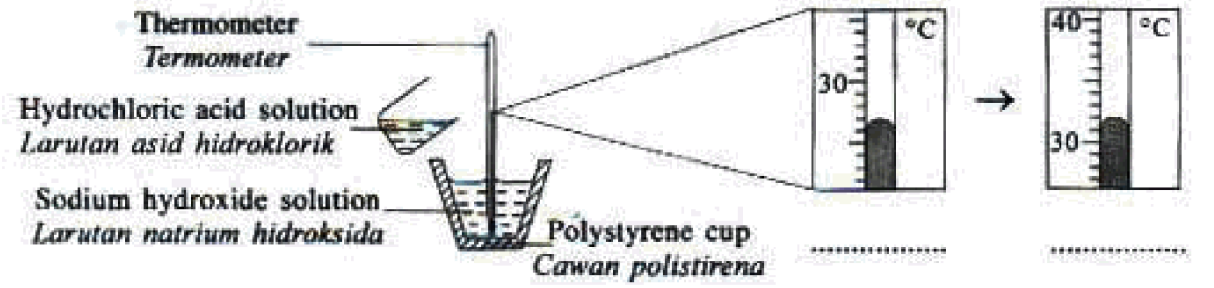
Experiment I



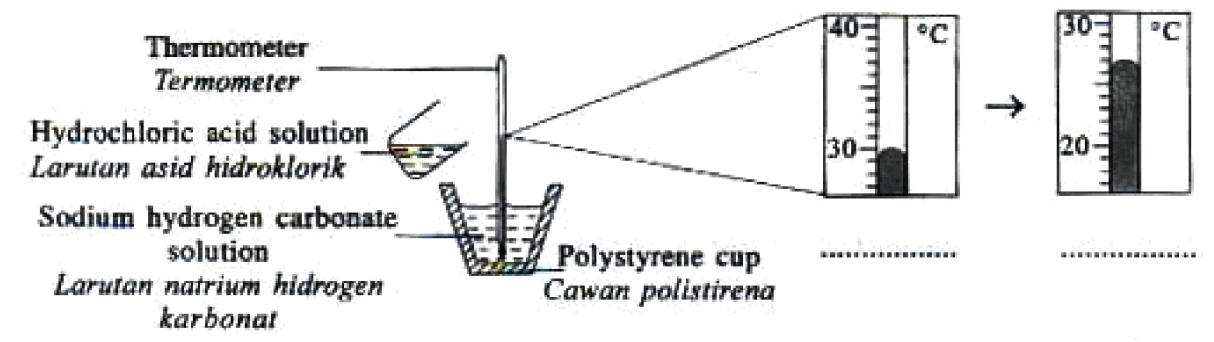
Experiment II



Experiment III



Experiment IV



(ii) Construct a table to show all the data in each of these experiments. [3M]

(iii) Classify the reactions in these experiments as either exothermic reactions or endothermic reactions. [3M]

Exothermic reaction	**Endothermic reaction**

(b) A student repeated Experiment I several times.

(i) State three things that must be kept constant in these experiments. [3M]

1. .....

2. .....

3. .....

(ii) State the hypothesis for Experiment I. [3M]

.....

.....

.....

(c) Based of Experiment II:

(i) State the temperature change and give two reasons for the change. [3M]

Temperature Change: .....

Reason 1 : .....

Reason 2 : .....

(ii) State the operational definition for the reaction that takes place. [3M]

.....

.....

.....

(d) The reaction in Experiment III is neutralisation reaction.
Other acids can be substituted for hydrochloric acid in experiment III.
Predict the temperature in the neutralisation reactions of these acids. [3M]

1. Sulphuric acid : .....°C

2. Nitric acid : .....°C

3. Ethanoic acid : .....°C

(e) Diagram 1.2 shows some observations in Experiment IV.

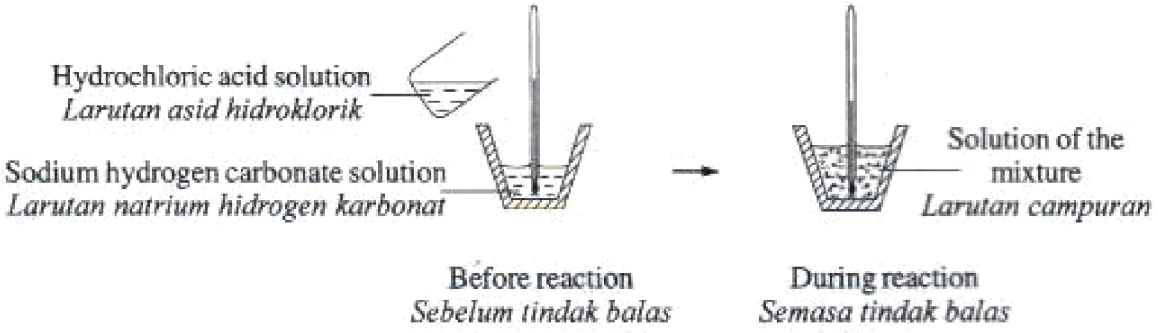


Diagram 1.2

(i) State three observations shown in Diagram 1.2. [3M]

1. .....

2. .....

3. .....

(ii) The following chemical equation represents the reaction in Experiment IV.

$HCl\ (aq) + NaHCO_3\ (aq) \text{ -- > } NaCl\ (aq) + CO_2(g) + H_2O(l)$

Based on the chemical equation, and the answer in 1 (e)(i), what inference can be made from Experiment IV? [3M]

.....

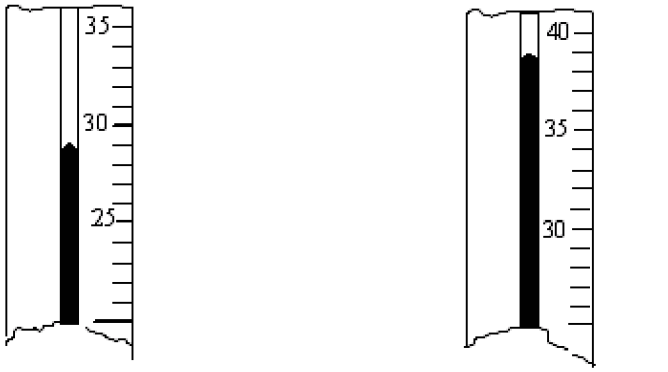
.....

.....

(iii) Sketch a graph to show the change in the volume of carbon dioxide gas produced against time. [3M]

[MRSM03-02]

An experiment was carried out by a student to determine the heat of displacement of copper. In the experiment 25.0 cm^3 of 0.2 mol dm^{-3} aqueous copper(II) chloride was added to excess zinc powder. The initial and the maximum reading are illustrated in Figure 1.



Initial reading Maximum reading

Figure 1

(a) State three observations from the experiment.

.....

.....

.....

(b) With reference to Figure 1 determine the following temperature:

Initial temperature : .....

Maximum temperature : .....

Temperature change : .....

(c) Determine the heat evolved in the experiment.
[Specific Heat Capacity, c = 4.2 J g^{-1} $°C^{-1}$, Density of solution, 1 gcm^{-3}]

(d) State the inference based on the observation and the temperature readings in 2(a) and 2(b).

.....

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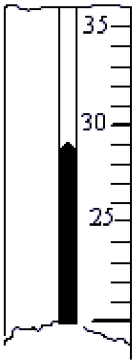
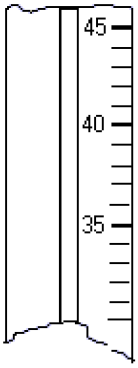
(e) In another experiment zinc powder was replaced with magnesium powder while the concentration of copper(II) chloride was similar as in previous experiment. Draw the mercury level of the thermometer in Figure 2 to show **the maximum** reading expected for the mixture.



Initial reading



Maximum reading

Figure 2

(f) Why is the reading in 2(b) and 2(e) different? Explain.

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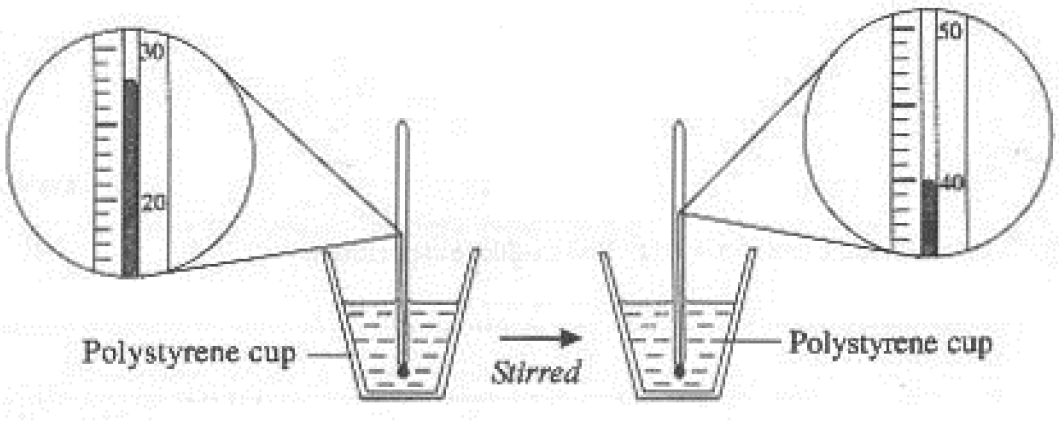
[SPM06-01]

Diagram 1.1 shows two experiments to determine the heat of neutralization.

Experiment I

Reaction between 25 cm^3 of sodium hydroxide solution, NaOH, 2.0 mol dm^{-3} and 25 cm^3 of ethanoic acid, CH_3COOH, 2.0 mol dm^{-3}.



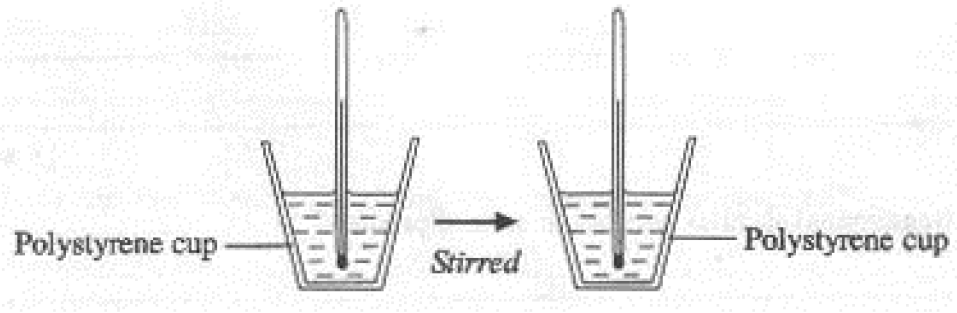
Initial temperature of mixture : ..... °C

Highest temperature of mixture : ..... °C

Change in temperature : ..... °C

Reactant II

Reaction between 25 cm^3 of sodium hydroxide solution, NaOH, 2.0 mol dm^{-3} and 25 cm^3 of hydrochloric acid, HCl, 2.0 mol dm^{-3}.



Initial temperature of mixture : T_1 °C

Highest temperature of mixture : T_2 °C

Change in temperature : T_3 °C

Diagram 1.1

(a) Write the initial and the highest temperature of the mixture and change in temperature for experiment I in diagram 1.1. [3M]

(b) Construct a table that can be used to record the data from both experiments. [3M]

(c) State **one** hypothesis for both experiments. [3M]

.....

.....

.....

(d) Based on the temperatures in Experiment I, predict the change in temperature in experiment II. [3M]

.....

.....

.....

(e) Why must the initial temperature and the highest temperature be recorded in these experiments? [3M]

.....

.....

.....

(f) How can the value of the change in temperature be obtained? [3M]

.....

.....

.....

(g) State **three** observations that you could obtain in Experiment I other than the change in temperature. [3M]

1. .....

2. .....

3. .....

(h) State **three** constant variables in this experiment. [3M]

1. .....

2. .....

3. .....

(f) Diagram 1.2 shows the calculation to determine the heat of neutralization for the reactions in Experiments I and II.

Experiment I	Experiment II
Heat released = mcθ = 50 g x 4.2 Jg-1C-1 x .....C = x J Heat of neutralization = $\frac{\text{x kJ}}{\text{Number of mole of water produced}}$	Heat released = mcθ = 50 g x 4.2 Jg-1C-1 x T_3 C = y J Heat of neutralization = $\frac{\text{y kJ}}{\text{Number of mole of water produced}}$

Diagram 1.2

Based of diagram 1.2:

(i) Give the operational definition for the heat of neutralization. [3M]

.....

.....

.....

(ii) It was found that the value of y is greater than the value of x. explain why. [3M]

.....

.....

(j) The experiment is repeated using methanoic acid. The values of the heat of neutralization of these acids are given in Table 1.
Complete table 1 by classifying the acids as strong acid or weak acid.

Name of acid	**Heat of neutralization / kJ mol^{-1}**	**Type of acid**
Ethanoic acid	- 50.3	----------
Hydrochloric acid	- 57.2	----------
Methanoic acid	- 50.5	----------

Essay {Paper03}

[MRSM05-03]

The neutralization reaction between sodium hydroxide and hydrochloric acid releases 57 kJ mol^{-1} of heat while the neutralization reaction between sodium hydroxide and ethanoic acid releases 55 kJ mol^{-1} of heat.

Based on the above statement, you are required to design an experiment to determine and compare the heat of neutralization between sodium hydroxide and a named strong acid and a weak acid.

In designing your experiment it must include the following items: [17M]

(a) Problem statement
(b) Statement of hypothesis
(c) Lists of substances and apparatus
(d) Procedure of the experiment
(e) Tabulation of data

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[SBPtrial11-03]

Brazil, the fifth largest country in the world imports no oil, since half its cars run on alcohol fuel made from sugarcane. Diagram 3 shows an alcohol fuel station in Brazil.

Different types of alcohols produce different heat of combustions. The value of the heat of combustion is depended on the number of carbon atoms per alcohol molecule. Plan a laboratory experiment to compare the heat combustion of methanol, ethanol and propan-1-ol. [17M]

Your planning should include the following aspects:

(a) Aim of the experiment
(b) All the variables
(c) Statement of the hypothesis
(d) List of substances and apparatus
(e) Procedure of the experiment
(f) Tabulation of data

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[SBPtrial04-03-p3]

A student did an experiment to compare combustion heat for different types of alcohol, which are methanol, ethanol, propanol and butanol.

Plan the experiment to compare the heat of combustion for four types of alcohol.

Your planning should include the following aspects: [17M]

(a) Statement of the problem
(b) Statement of the hypothesis
(c) List of substance and apparatus
(d) Procedure of the experiment
(e) Tabulating data

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[SBPtrial08-03]

Diagram 3 shows spirit lamps that contain different types of alcohols.

Diagram 3

Different types of alcohols produce different heat of combustions. When the number of carbon per molecule of the alcohol increases, the heat of combustion increases.

Table 3 shows the heat of combustion of ethanol, propanol and butanol.

Alcohol	Molecular formula	Heat of combustion/kJ mol^{-1}
Ethanol	C_2H_5OH	- 1376
Propanol	C_3H_7OH	- 2016
Butanol	C_4H_9OH	- 2678

Table 3

Plan an experiment to compare the heat combustion of the alcohols.

Your planning should include the following aspects: [17M]

(a) Statement of the problem
(b) All the variables
(c) Statement of the hypothesis
(d) List of substance and apparatus
(e) Procedure of the experiment
(f) Tabulating data

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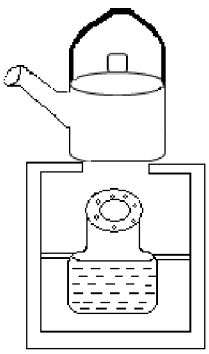
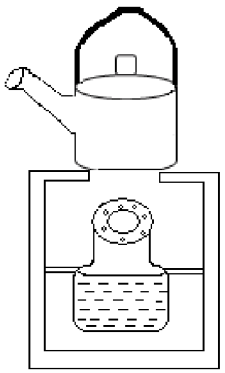
[MRSM07-02]

Equal volume of water is heated in two different kettles by a scout during camping.

Kettle 1 is heated by using alcohol X while kettle 2 is heated by using alcohol Y as shown in Diagram 2. The size and type of both kettles are the same.



Kettle 1



Kettle 2

It was discovered that the mass of alcohol X needed to boil the water is more compared to alcohol Y.

Plan a laboratory experiment to compare the heat of combustion between alcohol X and Y based on the above situation.

Your planning should include the following aspects: [17M]

(a) Problem statement
(b) All the variables
(c) Statement of hypothesis
(d) List of substances and apparatus
(e) Procedure of the experiment
(f) Tabulation of data