Topic 5 Questions

1. What energy changes occur when chemical bonds are formed and broken?

A. Energy is absorbed when bonds are formed and when they are broken.

B. Energy is released when bonds are formed and when they are broken.

C. Energy is absorbed when bonds are formed and released when they are broken.

D. Energy is released when bonds are formed and absorbed when they are broken.

2. The temperature of a 2.0 g sample of aluminium increases from 25°C to 30°C.
How many joules of heat energy were added? (Specific heat of Al = 0.90 J $g^{-1}K^{-1}$)

A. 0.36

B. 2.3

C. 9.0

D. 11

3. Using the equations below:

$C(s) + O_2(g) \rightarrow CO_2(g)$ $\quad \Delta H = -390$ kJ
$Mn(s) + O_2(g) \rightarrow MnO_2(s)$ $\quad \Delta H = -520$ kJ

what is ΔH (in kJ) for the following reaction?

$MnO_2(s) + C(s) \rightarrow Mn(s) + CO_2(g)$

A. 910

B. 130

C. –130

D. –910

4. Which statements about exothermic reactions are correct?

I. They have negative ΔH values.

II. The products have a lower enthalpy than the reactants.

III. The products are more energetically stable than the reactants.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

5. A sample of a metal is heated. Which of the following are needed to calculate the heat absorbed by the sample?

I. The mass of the sample

II. The density of the sample

III. The specific heat capacity of the sample

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

6. The average bond enthalpies for O—O and O==O are 146 and 496 kJ mol^{-1} respectively. What is the enthalpy change, in kJ, for the reaction below?

$$H—O—O—H(g) \rightarrow H—O—H(g) + ½O==O(g)$$

A. – 102 B. + 102

C. + 350 D. + 394

7. When the solids $Ba(OH)_2$ and NH_4SCN are mixed, a solution is produced and the temperature drops.

$$Ba(OH)_2(s) + 2NH_4SCN(s) \rightarrow Ba(SCN)_2(aq) + 2NH_3(g) + 2H_2O(l)$$

Which statement about the energetics of this reaction is correct?

A. The reaction is endothermic and ΔH is negative.

B. The reaction is endothermic and ΔH is positive.

C. The reaction is exothermic and ΔH is negative.

D. The reaction is exothermic and ΔH is positive.

8. Using the equations below

$$Cu(s) + \tfrac{1}{2}O_2(g) \rightarrow CuO(s) \Delta H^{\ominus} = -156 \text{ kJ}$$

$$2Cu(s) + \tfrac{1}{2}O_2(g) \rightarrow Cu_2O(s) \Delta H^{\ominus} = -170 \text{ kJ}$$

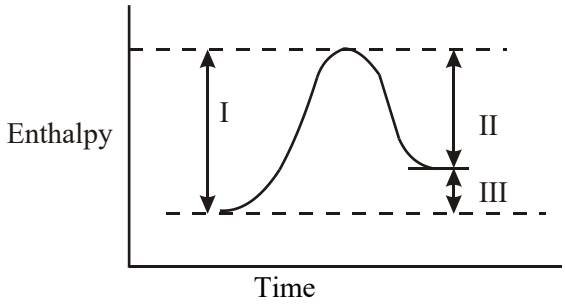
what is the value of $\Delta H^{\ominus}$ (in kJ) for the following reaction?

$$2CuO(s) \rightarrow Cu_2O(s) + \tfrac{1}{2}O_2(g)$$

A. 142 B. 15

C. –15 D. –142

9. Which of the quantities in the enthalpy level diagram below is (are) affected by the use of a catalyst?



A. I only

B. III only

C. I and II only

D. II and III only

10. Consider the following equations.

$$Mg(s) + \tfrac{1}{2} O_2(g) \rightarrow MgO(s) \qquad \Delta H^\ominus = -602 \text{ kJ}$$
$$H_2(g) + \tfrac{1}{2} O_2(g) \rightarrow H_2O(g) \qquad \Delta H^\ominus = -242 \text{ kJ}$$

What is the $\Delta H°$ value (in kJ) for the following reaction?

$$MgO(s) + H_2(g) \rightarrow Mg(s) + H_2O(g)$$

A. –844 B. –360

C. +360 D. +844

11. For which of the following is the sign of the enthalpy change different from the other three?

A. $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

B. $Na(g) \rightarrow Na^+(g) + e^-$

C. $CO_2(s) \rightarrow CO_2(g)$

D. $2Cl(g) \rightarrow Cl_2(g)$

12. Separate solutions of HCl(aq) and H_2SO_4(aq) of the same concentration and same volume were completely neutralized by NaOH(aq). X kJ and Y kJ of heat were evolved respectively. Which statement is correct?

A. $X = Y$ B. $Y = 2X$

C. $X = 2Y$ D. $Y = 3X$

13. Which statements are correct for an endothermic reaction?

I. The system absorbs heat.

II. The enthalpy change is positive.

III. The bond enthalpy total for the reactants is greater than for the products.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

14. The mass m (in g) of a substance of specific heat capacity c (in J g^{-1} K^{-1}) increases by t°C. What is the heat change in J?

A. mct

B. $mc(t + 273)$

C. $\frac{mct}{1000}$

D. $\frac{mc(t + 273)}{1000}$

15. The average bond enthalpy for the C—H bond is 412 kJ mol^{-1}. Which process has an enthalpy change closest to this value?

A. $CH_4(g) \rightarrow C(s) + 2H_2(g)$

B. $CH_4(g) \rightarrow C(g) + 2H_2(g)$

C. $CH_4(g) \rightarrow C(s) + 4H(g)$

D. $CH_4(g) \rightarrow CH_3(g) + H(g)$

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16. The following equation shows the formation of magnesium oxide from magnesium metal.

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s) \qquad \Delta H^{\ominus} = -1204kJ$$

Which statement is correct for this reaction?

A. 1204 kJ of energy are released for every mol of magnesium reacted.

B. 602 kJ of energy are absorbed for every mol of magnesium oxide formed.

C. 602 kJ of energy are released for every mol of oxygen gas reacted.

D. 1204 kJ of energy are released for every two mol of magnesium oxide formed.

17. The following equations show the oxidation of carbon and carbon monoxide to carbon dioxide.

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H^{\ominus} = -x \text{ kJ mol}^{-1}$$

$$CO(g) + \tfrac{1}{2} O_2(g) \rightarrow CO_2(g) \qquad \Delta H^{\ominus} = -y \text{ kJ mol}^{-1}$$

What is the enthalpy change, in kJ mol^{-1}, for the oxidation of carbon to carbon monoxide?

$$C(s) + \tfrac{1}{2} O_2(g) \rightarrow CO(g)$$

A. $x + y$ B. $-x - y$

C. $y - x$ D. $x - y$

18. A simple calorimeter was used to determine the enthalpy of combustion of ethanol. The experimental value obtained was –920 kJ mol^{-1}. The Data Booklet value is –1371 kJ mol^{-1}. Which of the following best explains the difference between the two values?

A. incomplete combustion of the fuel

B. heat loss to the surroundings

C. poor ventilation in the laboratory

D. inaccurate temperature measurements

19. For the reaction

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

the bond enthalpies (in kJ mol^{-1}) are

H–H	x
O=O	y
O–H	z

Which calculation will give the value, in kJ mol^{-1}, of $\Delta H^{\ominus}$ for the reaction?

A. $2x + y - 2z$

B. $4z - 2x - y$

C. $2x + y - 4z$

D. $2z - 2x - y$

20. Which statement about bond enthalpies is correct?

A. Bond enthalpies have positive values for strong bonds and negative values for weak bonds.

B. Bond enthalpy values are greater for ionic bonds than for covalent bonds.

C. Bond breaking is endothermic and bond making is exothermic.

D. The carbon–carbon bond enthalpy values are the same in ethane and ethene.

21. An equation for a reaction in which hydrogen is formed is

$$CH_4 + H_2O \rightarrow 3H_2 + CO \qquad \Delta H^{\ominus} = +210 \text{ kJ}$$

Which energy change occurs when 1 mol of hydrogen is formed in this reaction?

A. 70 kJ of energy are absorbed from the surroundings.

B. 70 kJ of energy are released to the surroundings.

C. 210 kJ of energy are absorbed from the surroundings.

D. 210 kJ of energy are released to the surroundings.

22. The equations and enthalpy changes for two reactions used in the manufacture of sulfuric acid are:

$$S(s)\ O_2(g) \rightarrow SO_2(g) \qquad \Delta H^{\ominus} = -300 \text{ kJ}$$

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g) \qquad \Delta H^{\ominus} = -200 \text{ kJ}$$

What is the enthalpy change, in kJ, for the reaction below?

$$2S(s) + 3O_2(g) \rightarrow 2SO_3(g)$$

A. –100

B. –400

C. –500

D. –800

23. Approximate values of the average bond enthalpies, in kJ mol^{-1}, of three substances are:

H–H	430
F–F	155
H–F	565

What is the enthalpy change, in kJ, for this reaction?

$$2HF \rightarrow H_2 + F_2$$

A. +545

B. +20

C. –20

D. –545

24. The standard enthalpy change of formation values of two oxides of phosphorus are:

$$P_4(s) + 3O_2(g) \rightarrow P_4O_6(s) \qquad \Delta H^{\ominus}_f = -1600 \text{ kJ mol}^{-1}$$

$$P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s) \qquad \Delta H^{\ominus}_f = -3000 \text{ kJ mol}^{-1}$$

What is the enthalpy change, in kJ mol^{-1}, for the reaction below?

$$P_4O_6(s) + 2O_2(g) \rightarrow P_4O_{10}(s)$$

A. +4600

B. +1400

C. –1400

D. –4600

25. Which statement is correct for an endothermic reaction?

A. The products are more stable than the reactants and ΔH is positive.

B. The products are less stable than the reactants and ΔH is negative.

C. The reactants are more stable than the products and ΔH is positive.

D. The reactants are less stable than the products and ΔH is negative.

26. Which statement is correct about the reaction shown?

$$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g) \qquad \Delta H = -196 \text{ kJ}$$

A. 196 kJ of energy are released for every mole of $SO_2(g)$ reacted.

B. 196 kJ of energy are absorbed for every mole of $SO_2(g)$ reacted.

C. 98 kJ of energy are released for every mole of $SO_2(g)$ reacted.

D. 98 kJ of energy are absorbed for every mole of $SO_2(g)$ reacted.

27. Which statements are correct for all exothermic reactions?

I. The enthalpy of the products is less than the enthalpy of the reactants.

II. The sign of ΔH is negative.

III. The reaction is rapid at room temperature.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

28. Consider the specific heat capacity of the following metals.

Metal	Specific heat capacity / J kg^{-1} K^{-1}
Cu	385
Ag	234
Au	130
Pt	134

Which metal will show the greatest temperature increase if 50 J of heat is supplied to a 0.001 kg sample of each metal at the same initial temperature?

A. Cu

B. Ag

C. Au

D. Pt

29. Consider the following reactions.

$$S(s) + 1\tfrac{1}{2}\,O_2(g) \rightarrow SO_3(g) \qquad \Delta H^{\ominus} = -395 \text{ kJ mol}^{-1}$$

$$SO_2(s) + \tfrac{1}{2}\,O_2(g) \rightarrow SO_3(g) \qquad \Delta H^{\ominus} = -98 \text{ kJ mol}^{-1}$$

What is the $\Delta H^{\ominus}$ value (in kJ mol^{-1}) for the following reaction?

$$S(s) + O_2(g) \rightarrow SO_2(g)$$

A. –297

B. +297

C. – 493

D. +493

30. Which statement is correct for an endothermic reaction?

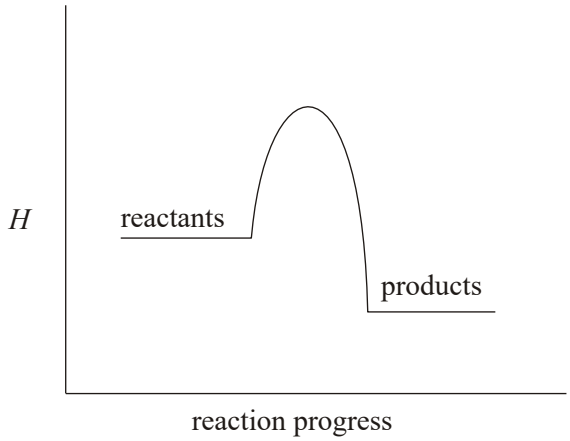
A. Bonds in the products are stronger than the bonds in the reactants.

B. Bonds in the reactants are stronger than the bonds in the products.

C. The enthalpy of the products is less than that of the reactants.

D. The reaction is spontaneous at low temperatures but becomes non-spontaneous at high temperatures.

31. According to the enthalpy level diagram below, what is the sign for ΔH and what term is used to refer to the reaction?



	ΔH	reaction
A.	positive	endothermic
B.	negative	exothermic
C.	positive	exothermic
D.	negative	endothermic

32. When 40 joules of heat are added to a sample of solid H_2O at –16.0°C the temperature increases to –8.0°C. What is the mass of the solid H_2O sample?

[Specific heat capacity of $H_2O(s) = 2.0\ J\ g^{-1}K^{-1}$]

A. 2.5 g

B. 5.0 g

C. 10 g

D. 160 g

33. The $\Delta H^{\ominus}$ values for the formation of two oxides of nitrogen are given below.

$$\tfrac{1}{2}N_2(g) + O_2(g) \rightarrow NO_2(g) \qquad \Delta H^{\ominus} = -57\ kJ\ mol^{-1}$$

$$N_2(g) + 2O_2(g) \rightarrow N_2O_4(g) \qquad \Delta H^{\ominus} = +9\ kJ\ mol^{-1}$$

Use these values to calculate $\Delta H^{\ominus}$ for the following reaction (in kJ):

$$2NO_2(g) \rightarrow N_2O_4(g)$$

A. –105

B. – 48

C. +66

D. +123

34. How much energy, in joules, is required to increase the temperature of 2.0 g of aluminium from 25 to 30°C? (Specific heat of Al = 0.90 J g^{-1} K^{-1}).

A. 0.36

B. 4.5

C. 9.0

D. 54

35. Which combination is correct for a chemical reaction that absorbs heat from the surroundings?

	Type of reaction	**Δ*H* at constant pressure**
A.	Exothermic	Positive
B.	Exothermic	Negative
C.	Endothermic	Positive
D.	Endothermic	Negative

36. Using the equations below:

$$C(s) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H^{\ominus} = -394 \text{ kJ mol}^{-1}$$

$$Mn(s) + O_2(g) \rightarrow MnO_2(s) \qquad \Delta H^{\ominus} = -520 \text{ kJ mol}^{-1}$$

What is Δ*H*, in kJ, for the following reaction?

$$MnO_2(s) + C(s) \rightarrow Mn(s) + CO_2(g)$$

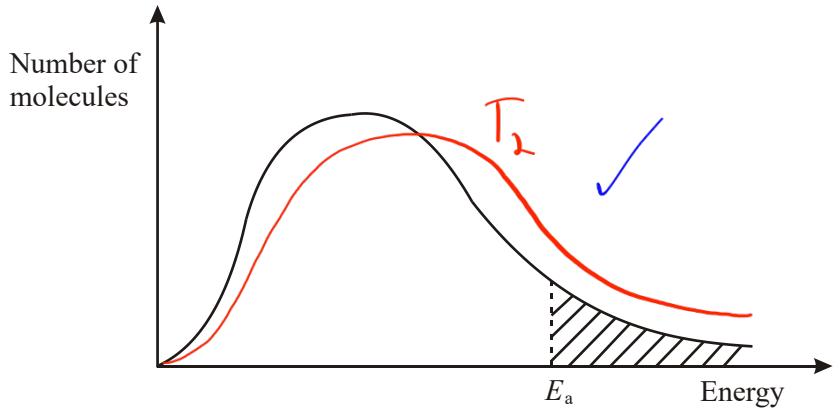
A. 914

B. 126

C. –126

D. –914

37.



The diagram shows the distribution of energy for the molecules in a sample of gas at a given temperature, T_1.

(a) In the diagram E_a represents the *activation energy* for a reaction. Define this term.

The minimum energy needed for two colliding particles to react.

(1)

(b) On the diagram above draw another curve to show the energy distribution for the same gas at a higher temperature. Label the curve T_2.

(2)

(c) With reference to your diagram, state and explain what happens to the rate of a reaction when the temperature is increased.

Increases; more particles meet energy requirement to react.

(2)

(Total 5 marks)

38. (a) Define the term *average bond enthalpy*, illustrating your answer with an equation for methane, CH_4.

The average energy used to break every C-H bond in CH_4.

$CH_4(g) \rightarrow C(g) + 4H(g)$

(3)

(b) The equation for the reaction between methane and chlorine is

$$CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$$

Use the values from Table 10 of the Data Booklet to calculate the enthalpy change for this reaction.

$414(4) + 248 = \Delta H_r$

$414(3) + 324 + 431 = \Delta H_p$

$\Delta H = \Delta H_r - \Delta H_p = -99\ kJ\ mol^{-1}$

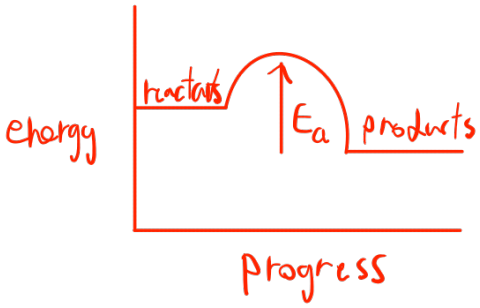
(3)

(c) Explain why no reaction takes place between methane and chlorine at room temperature unless the reactants are sparked, exposed to UV light or heated.

Particles lack sufficient kinetic energy to react, so collisions fail to produce reactions.

(2)

(d) Draw an enthalpy level diagram for this reaction.



(2)
(Total 10 marks)

39. In aqueous solution, potassium hydroxide and hydrochloric acid react as follows.

$$KOH(aq) + HCl(aq) \rightarrow KCl(aq) + H_2O(l)$$

The data below is from an experiment to determine the enthalpy change of this reaction.

50.0 cm^3 of a 0.500 mol dm^{-3} solution of KOH was mixed rapidly in a glass beaker with 50.0 cm^3 of a 0.500 mol dm^{-3} solution of HCl.

Initial temperature of each solution = 19.6°C
Final temperature of the mixture = 23.1°C

(a) State, with a reason, whether the reaction is exothermic or endothermic.

Exothermic, product has higher temperature from reaction.

(1)

(b) Explain why the solutions were mixed rapidly.

To avoid loss of heat during the reaction ~~when measuring the final temperature~~

$1\ g\ cm^{-3} = 1\ kg\ dm^{-3}$

(1)

(c) Calculate the enthalpy change of this reaction in kJ mol^{-1}. Assume that the specific heat capacity of the solution is the same as that of water.

$Q = (50+50)\ g \times 4.18\ J\ g^{-1}\ K^{-1} \times 3.5\ K = 1463\ kJ$

$\Delta H = \frac{1463}{0.500 \times 0.05} = 58.52\ kJ\ mol^{-1}$

(4)

(d) Identify the **major** source of error in the experimental procedure described above. Explain how it could be minimized.

uncontrolled heat dissipation to surroundings. Minimized by ~~mixing the solutions for a controlled amount of strokes.~~ using a lid to close the system.

(2)

(e) The experiment was repeated but with an HCl concentration of 0.510 mol dm^{-3} instead of 0.500 mol dm^{-3}. State and explain what the temperature change would be.

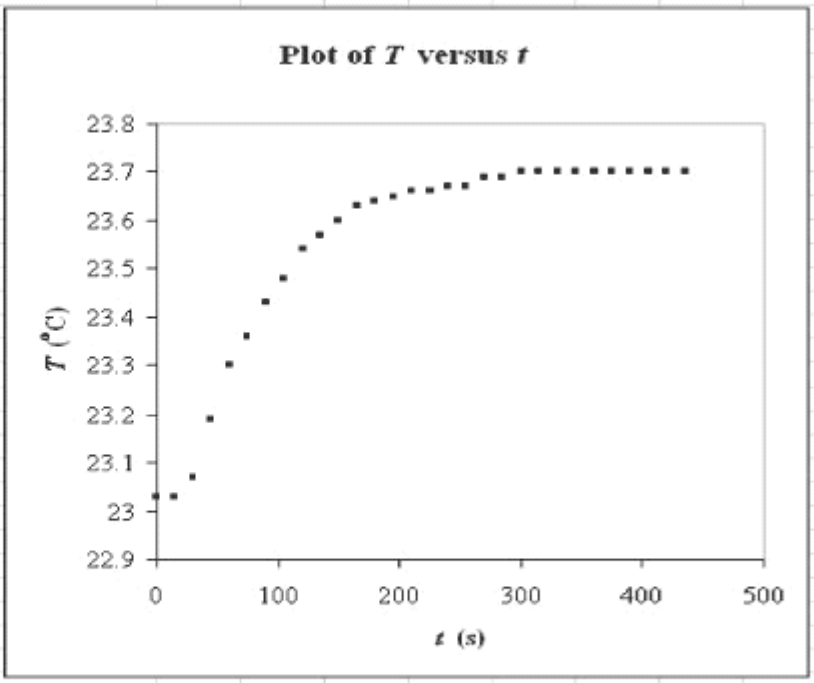
Lower temperature change because the reaction energy is used by more reactants. 3.5°C; no change; KOH is the limiting reactant so extra HCl is in excess and goes unused.

(2)

(Total 10 marks)

40. The data below is from an experiment used to measure the enthalpy change for the combustion of 1 mole of sucrose (common table sugar), $C_{12}H_{22}O_{11}(s)$. The time-temperature data was taken from a data-logging software programme.

	A	B
1	Time (s)	Temperature (°C)
2	0	23.03
3	15	23.03
4	30	23.07
5	45	23.19
6	60	23.3
7	75	23.36
8	90	23.43
9	105	23.48
10	120	23.54
11	135	23.57
12	150	23.6
13	165	23.63
14	180	23.64
15	195	23.65
16	210	23.66
17	225	23.66
18	240	23.67
19	255	23.67
20	270	23.69
21	285	23.69
22	300	23.7
23	315	23.7
24	330	23.7
25	345	23.7
26	360	23.7
27	375	23.7
28	390	23.7
29	405	23.7
30	420	23.7
31	435	23.7



Sheet1 / Sheet2 / Sheet3

Mass of sample of sucrose, m = 0.4385 g

Heat capacity of the system, C_{system} = 10.114 kJ K^{-1}

(a) Calculate ΔT, for the water, surrounding the chamber in the calorimeter.

0.63°C

(1)

(b) Determine the amount, in moles, of sucrose.

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(1)

(c) (i) Calculate the enthalpy change for the combustion of 1 mole of sucrose.

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(1)

(ii) Using Table 12 of the Data Booklet, calculate the percentage experimental error based on the data used in this experiment.

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(1)

(d) A hypothesis is suggested that TNT, 2-methyl-1,3,5-trinitrobenzene, is a powerful explosive because it has:

- a large enthalpy of combustion
- a high reaction rate
- a large volume of gas generated upon combustion

Use your answer in part (c)(i) and the following data to evaluate this hypothesis:

	Equation for combustion	**Relative rate of combustion**	**Enthalpy of combustion / kJ mol^{-1}**
Sucrose	$C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(g)$	Low	
TNT	$2C_7H_5N_3O_6(s) \rightarrow 7CO(g) + 7C(s) + 5H_2O(g) + 3N_2(g)$	High	3406

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(3)

(Total 7 marks)

41. (a) Define the term *average bond enthalpy*.

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(2)

(b) Use the information from Table 10 of the Data Booklet to calculate the enthalpy change for the complete combustion of but-1-ene, according to the following equation.

$$C_4H_8(g) + 6O_2(g) \rightarrow 4CO_2(g) + 4H_2O(g)$$

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(3)
(Total 5 marks)

42. Given the following data:

$C(s) + F_2(g) \rightarrow CF_4(g)$; $\Delta H_1 = -680$ kJ mol^{-1}
$F_2(g) \rightarrow 2F(g)$; $\Delta H_2 = +158$ kJ mol^{-1}
$C(s) \rightarrow C(g)$; $\Delta H_3 = +715$ kJ mol^{-1}

calculate the average bond enthalpy (in kJ mol^{-1}) for the C—F bond.

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(Total 4 marks)

43. Two reactions occurring in the manufacture of sulfuric acid are shown below:

reaction I $S(s) + O_2(g) \rightarrow SO_2(g)$ $\Delta H^{\ominus} = -297$ kJ

reaction II $SO_2(g) + \frac{1}{2} O_2(g) \rightleftharpoons SO_3(g)$ $\Delta H^{\ominus} = -92$ kJ

(i) State the name of the term $\Delta H^{\ominus}$. State, with a reason, whether reaction I would be accompanied by a decrease or increase in temperature.

(3)

(ii) At room temperature sulfur trioxide, SO_3, is a solid. Deduce, with a reason, whether the $\Delta H^{\ominus}$ value would be more negative or less negative if $SO_3(s)$ instead of $SO_3(g)$ were formed in reaction II.

(2)

(iii) Deduce the $\Delta H^{\ominus}$ value of this reaction:

$$S(s) + 1\tfrac{1}{2} O_2(g) \rightarrow SO_3(g)$$

(1)
(Total 6 marks)

44. (i) Define the term *average bond enthalpy*.

(3)

(ii) Explain why Br_2 is not suitable as an example to illustrate the term *average bond enthalpy*.

(1)

(iii) Using values from Table 10 of the Data Booklet, calculate the enthalpy change for the following reaction:

$$CH_4(g) + Br_2(g) \rightarrow CH_3Br(g) + HBr(g)$$

(3)

(iv) Sketch an enthalpy level diagram for the reaction in part (iii).

(2)

(v) Without carrying out a calculation, suggest, with a reason, how the enthalpy change for the following reaction compares with that of the reaction in part (iii):

$$CH_3Br(g) + Br_2(g) \rightarrow CH_2Br_2(g) + HBr(g)$$

(2)
(Total 11 marks)

45. But–1–ene gas, burns in oxygen to produce carbon dioxide and water vapour according to the following equation.

$$C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$$

(a) Use the data below to calculate the value of $\Delta H^{\ominus}$ for the combustion of but-1-ene.

Bond	C–C	C=C	C–H	O=O	C=O	O–H
Average bond enthalpy / kJ mol^{-1}	348	612	412	496	743	463

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(3)

(b) State and explain whether the reaction above is endothermic or exothermic.

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(1)
(Total 4 marks)

46. Calculate the enthalpy change, ΔH_4 for the reaction

$$C + 2H_2 + \tfrac{1}{2}O_2 \rightarrow CH_3OH \qquad \Delta H_4$$

using Hess's Law and the following information.

$$CH_3OH + 1\tfrac{1}{2}O_2 \rightarrow CO_2 + 2H_2O \qquad \Delta H_1 = -676 \text{ kJ mol}^{-1}$$
$$C + O_2 \rightarrow CO_2 \qquad \Delta H_2 = -394 \text{ kJ mol}^{-1}$$
$$H_2 + \tfrac{1}{2}O_2 \rightarrow H_2O \qquad \Delta H_3 = -242 \text{ kJ mol}^{-1}$$

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(Total 4 marks)

47. Methylamine can be manufactured by the following reaction.

$$CH_3OH(g) + NH_3(g) \rightarrow CH_3NH_2(g) + H_2O(g)$$

(a) Define the term *average bond enthalpy*.

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(b) Use information from Table 10 of the Data Booklet to calculate the enthalpy change for this reaction.

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(4)
(Total 6 marks)

48. (a) Define the term *average bond enthalpy*.

.....

.....

.....

.....

(2)

(b) Use the information from Table 10 in the Data Booklet to calculate the enthalpy change for the complete combustion of but-1-ene according to the following equation

$$C_4H_8(g) \rightarrow 4CO_2(g) + 4H_2O(g)$$

.....

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.....

.....

(3)

(c) Predict, giving a reason, how the enthalpy change for the complete combustion of but-2-ene would compare with that of but-1-ene based on average bond enthalpies.

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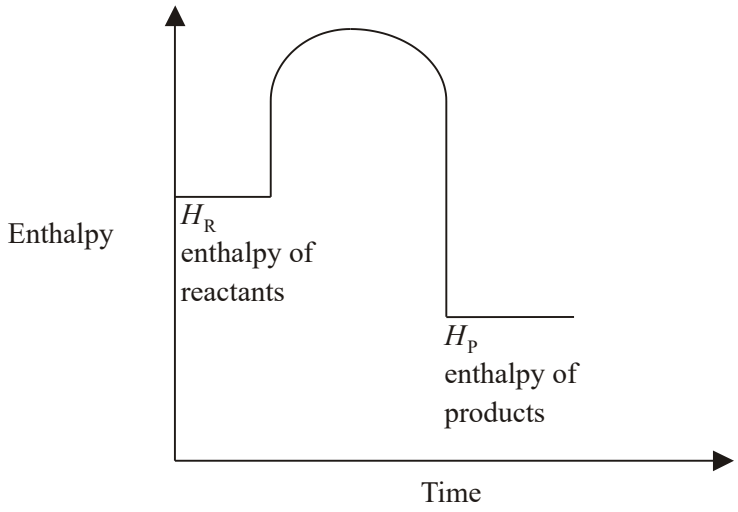
.....

(1)

(d) The enthalpy level diagram for a certain reaction is shown below.



State and explain the relative stabilities of the reactants and products.

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.....

(2)
(Total 8 marks)

49. The reaction between ethene and hydrogen gas is exothermic.

(i) Write an equation for this reaction.

(1)

(ii) Deduce the relative stabilities and energies of the reactants and products.

(2)

(iii) Explain, by referring to the bonds in the molecules, why the reaction is exothermic.

(2)
(Total 5 marks)

50. (i) Define the term *average bond enthalpy*.

(2)

(ii) The equation for the reaction of ethyne and hydrogen is:

$$C_2H_2(g) + 2H_2(g) \rightarrow C_2H_6(g)$$

Use information from Table 10 of the Data Booklet to calculate the change in enthalpy for the reaction.

(2)

(iii) State and explain the trend in the bond enthalpies of the C–Cl, C–Br and C–I bonds.

(2)
(Total 6 marks)