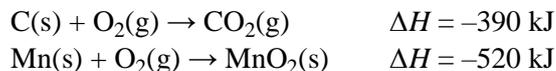


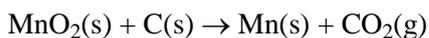


**IB Chemistry SL**  
**Topic 5 Questions**

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<sup>-1</sup>K<sup>-1</sup>)
- A. 0.36  
B. 2.3  
C. 9.0  
D. 11
3. Using the equations below:



what is  $\Delta H$  (in kJ) for the following reaction?



- A. 910  
B. 130  
C. -130  
D. -910
4. Which statements about exothermic reactions are correct?
- I. They have negative  $\Delta H$  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<sup>-1</sup> respectively. What is the enthalpy change, in kJ, for the reaction below?



A. - 102

B. + 102

C. + 350

D. + 394

7. When the solids Ba(OH)<sub>2</sub> and NH<sub>4</sub>SCN are mixed, a solution is produced and the temperature drops.



Which statement about the energetics of this reaction is correct?

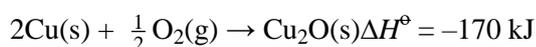
A. The reaction is endothermic and  $\Delta H$  is negative.

B. The reaction is endothermic and  $\Delta H$  is positive.

C. The reaction is exothermic and  $\Delta H$  is negative.

D. The reaction is exothermic and  $\Delta H$  is positive.

8. Using the equations below



what is the value of  $\Delta H^\ominus$  (in kJ) for the following 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.

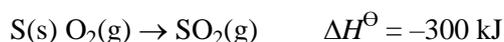
21. An equation for a reaction in which hydrogen is formed is



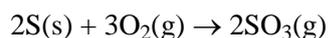
Which energy change occurs when 1 mol of hydrogen is formed in this reaction?

- 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:



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



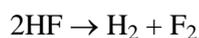
- A. -100
- B. -400
- C. -500
- D. -800

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



H-H	430
F-F	155
H-F	565

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

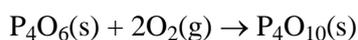


- A. +545
- B. +20
- C. -20
- D. -545

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



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



- 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  $\Delta H$  is positive.
  - B. The products are less stable than the reactants and  $\Delta H$  is negative.
  - C. The reactants are more stable than the products and  $\Delta H$  is positive.
  - D. The reactants are less stable than the products and  $\Delta H$  is negative.
26. Which statement is correct about the reaction shown?





- A. 196 kJ of energy are released for every mole of SO<sub>2</sub>(g) reacted.
- B. 196 kJ of energy are absorbed for every mole of SO<sub>2</sub>(g) reacted.
- C. 98 kJ of energy are released for every mole of SO<sub>2</sub>(g) reacted.
- D. 98 kJ of energy are absorbed for every mole of SO<sub>2</sub>(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  $\Delta H$  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

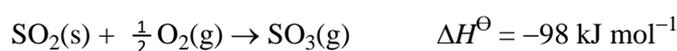
28. Consider the specific heat capacity of the following metals.

Metal	Specific heat capacity / J kg <sup>-1</sup> K <sup>-1</sup>
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?

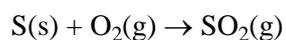
- A. Cu
- B. Ag
- C. Au
- D. Pt

29. Consider the following reactions.





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

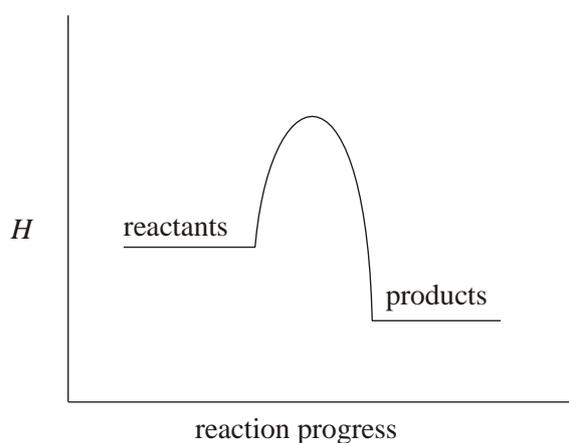


- A.  $-297$
- B.  $+297$
- C.  $-493$
- D.  $+493$

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  $\Delta H$  and what term is used to refer to the reaction?



	$\Delta H$	reaction
A.	positive	endothermic
B.	negative	exothermic
C.	positive	exothermic



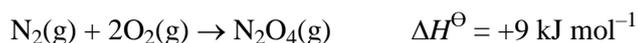
D. 

negative	endothermic
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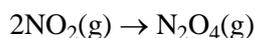
32. When 40 joules of heat are added to a sample of solid  $\text{H}_2\text{O}$  at  $-16.0^\circ\text{C}$  the temperature increases to  $-8.0^\circ\text{C}$ . What is the mass of the solid  $\text{H}_2\text{O}$  sample?

[Specific heat capacity of  $\text{H}_2\text{O}(\text{s}) = 2.0 \text{ J g}^{-1} \text{ K}^{-1}$ ]

- 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.



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



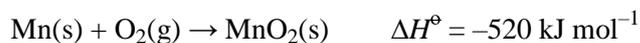
- A. -105  
B. -48  
C. +66  
D. +123
34. How much energy, in joules, is required to increase the temperature of 2.0 g of aluminium from 25 to  $30^\circ\text{C}$ ? (Specific heat of Al =  $0.90 \text{ J g}^{-1} \text{ K}^{-1}$ ).
- A. 0.36  
B. 4.5  
C. 9.0  
D. 54
35. Which combination is correct for a chemical reaction that absorbs heat from the surroundings?

	Type of reaction	$\Delta H$ at constant pressure
A.	Exothermic	Positive
B.	Exothermic	Negative
C.	Endothermic	Positive

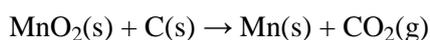


D.	Endothermic	Negative
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36. Using the equations below:

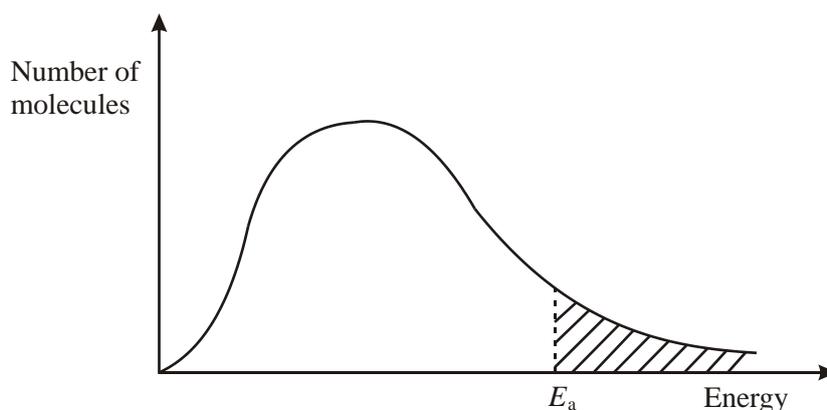


What is  $\Delta H$ , in kJ, for the following reaction?



- 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.

.....  
.....

(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.



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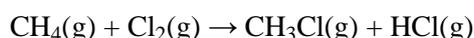
(2)  
(Total 5 marks)

38. (a) Define the term *average bond enthalpy*, illustrating your answer with an equation for methane, CH<sub>4</sub>.

.....

(3)

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



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

.....  
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(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.

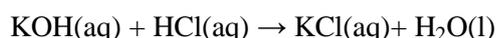
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(2)

- (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.



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

50.0 cm<sup>3</sup> of a 0.500 mol dm<sup>-3</sup> solution of KOH was mixed rapidly in a glass beaker with 50.0 cm<sup>3</sup> of a 0.500 mol dm<sup>-3</sup> solution of HCl.

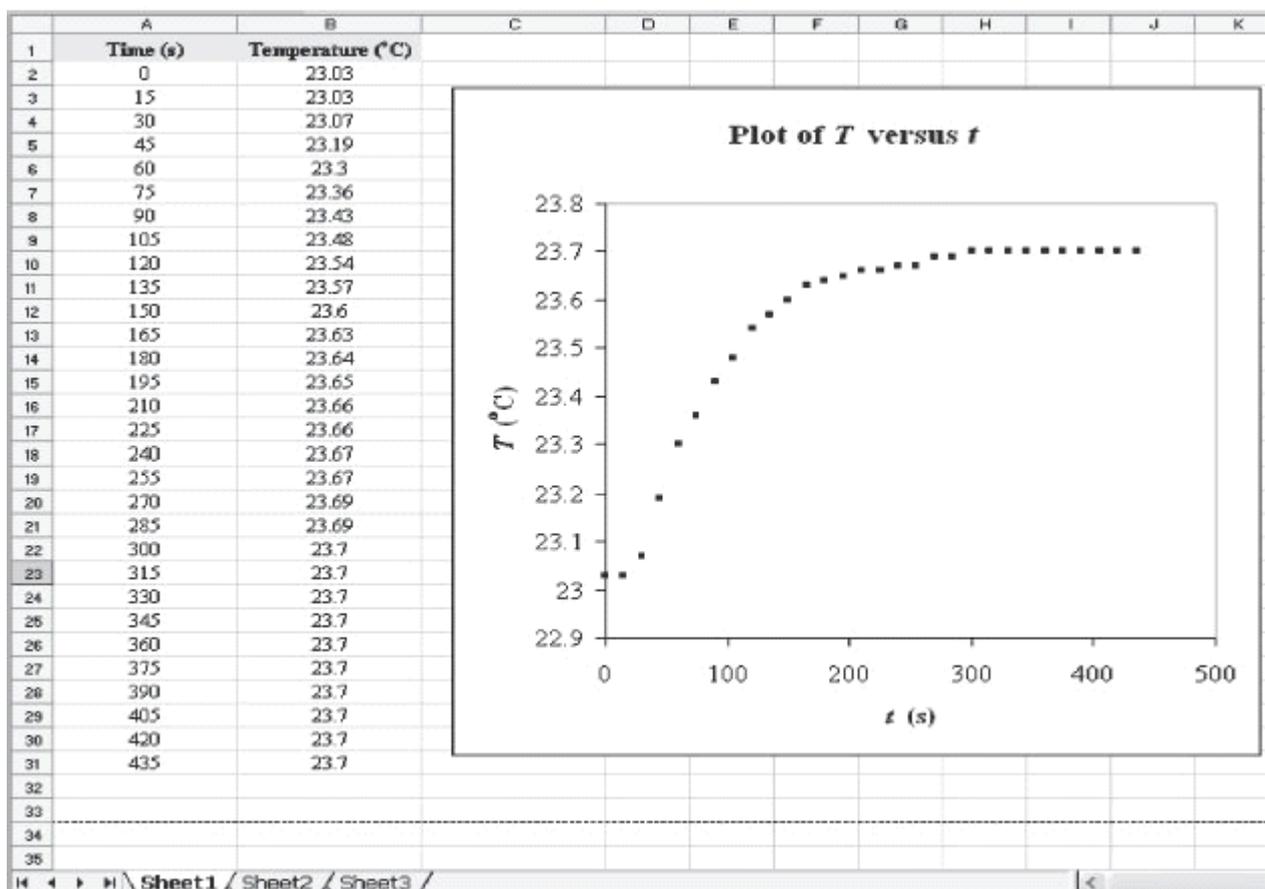
Initial temperature of each solution = 19.6°C

Final temperature of the mixture = 23.1°C



- (a) State, with a reason, whether the reaction is exothermic or endothermic.  
..... (1)
- (b) Explain why the solutions were mixed rapidly.  
..... (1)
- (c) Calculate the enthalpy change of this reaction in  $\text{kJ mol}^{-1}$ . Assume that the specific heat capacity of the solution is the same as that of water.  
.....  
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..... (4)
- (d) Identify the **major** source of error in the experimental procedure described above. Explain how it could be minimized.  
.....  
..... (2)
- (e) The experiment was repeated but with an HCl concentration of  $0.510 \text{ mol dm}^{-3}$  instead of  $0.500 \text{ mol dm}^{-3}$ . State and explain what the temperature change would be.  
.....  
..... (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),  $\text{C}_{12}\text{H}_{22}\text{O}_{11}(\text{s})$ . The time-temperature data was taken from a data-logging software programme.



Mass of sample of sucrose,  $m = 0.4385 \text{ g}$

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

(a) Calculate  $\Delta T$ , for the water, surrounding the chamber in the calorimeter.

..... (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.

.....  
..... (1)



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

.....  
.....

(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 / $\text{kJ mol}^{-1}$
Sucrose	$\text{C}_{12}\text{H}_{22}\text{O}_{11}(\text{s}) + 12\text{O}_2(\text{g}) \rightarrow 12\text{CO}_2(\text{g}) + 11\text{H}_2\text{O}(\text{g})$	Low	
TNT	$2\text{C}_7\text{H}_5\text{N}_3\text{O}_6(\text{s}) \rightarrow 7\text{CO}(\text{g}) + 7\text{C}(\text{s}) + 5\text{H}_2\text{O}(\text{g}) + 3\text{N}_2(\text{g})$	High	3406

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(3)

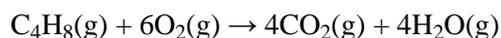
(Total 7 marks)

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.



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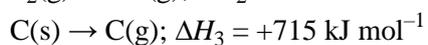
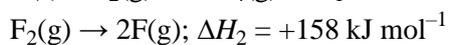
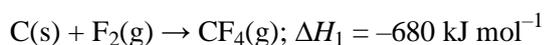
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(3)  
(Total 5 marks)

42. Given the following data:



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

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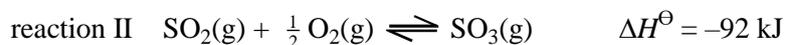
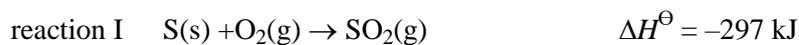
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(Total 4 marks)

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



(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,  $\text{SO}_3$ , is a solid. Deduce, with a reason, whether the  $\Delta H^\ominus$  value would be more negative or less negative if  $\text{SO}_3(\text{s})$  instead of  $\text{SO}_3(\text{g})$  were formed in reaction II.

(2)

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



(1)

(Total 6 marks)

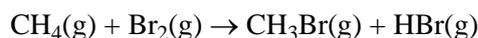
44. (i) Define the term *average bond enthalpy*.

(3)

- (ii) Explain why  $\text{Br}_2$  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:

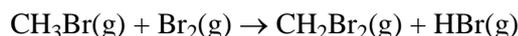


(3)

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

(2)

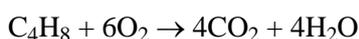
- (v) Without carrying out a calculation, suggest, with a reason, how the enthalpy change for the following reaction compares with that of the reaction in part (iii):



(2)

(Total 11 marks)

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



- (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 / $\text{kJ mol}^{-1}$	348	612	412	496	743	463

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(3)

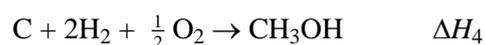
(b) State and explain whether the reaction above is endothermic or exothermic.

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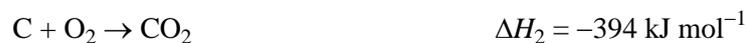
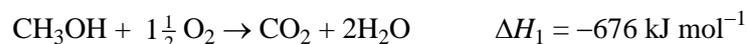
(1)

(Total 4 marks)

46. Calculate the enthalpy change,  $\Delta H_4$  for the reaction



using Hess's Law and the following information.



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(Total 4 marks)

47. Methylamine can be manufactured by the following reaction.



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

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.....



..... (2)

- (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*.

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.....  
..... (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



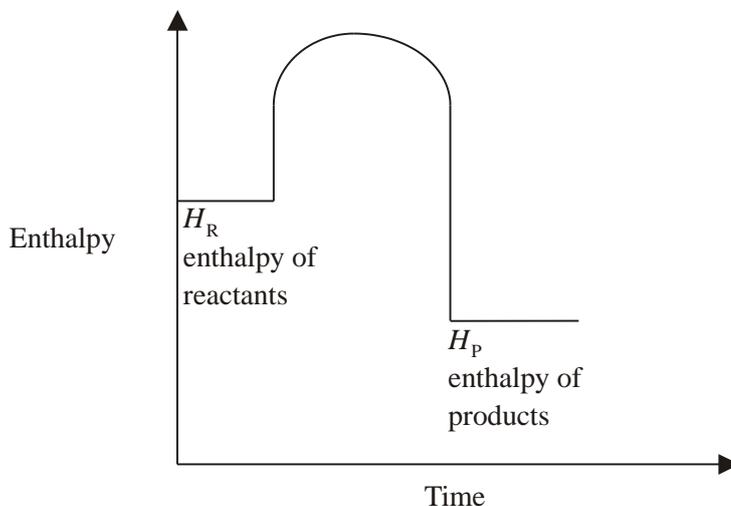
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..... (3)

- (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.

.....  
..... (1)



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



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

.....  
.....

(2)  
(Total 8 marks)

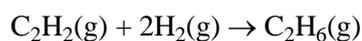
49. The reaction between ethene and hydrogen gas is exothermic.

- (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:



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)