

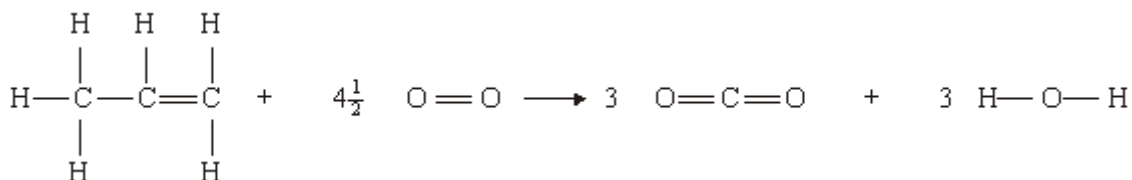
Q1. (a) Define the term *standard enthalpy of combustion*, ΔH_c^\ominus

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(3)

(b) Use the mean bond enthalpy data from the table and the equation given below to calculate a value for the standard enthalpy of combustion of propene. All substances are in the gaseous state.

Bond	C = C	C—C	C—H	O = O	O = C	O—H
Mean bond enthalpy/ kJ mol ⁻¹	612	348	412	496	743	463



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(3)

(c) State why the standard enthalpy of formation, ΔH_f^\ominus , of oxygen is zero.

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(1)

(d) Use the data from the table below to calculate a more accurate value for the standard enthalpy of combustion of propene.

Compound	C ₃ H ₆ (g)	CO ₂ (g)	H ₂ O(g)
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Standard enthalpy of formation, ΔH_f^\ominus / kJ mol ⁻¹	+20	-394	-242
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- (e) Explain why your answer to part (b) is a less accurate value than your answer to part (d).

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(2)

(Total 12 marks)

- Q2.** (a) Explain the meaning of the terms *mean bond enthalpy* and *standard enthalpy of formation*.

Mean bond enthalpy

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Standard enthalpy of formation

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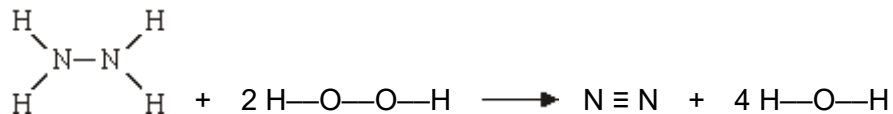
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(5)

(b) Some mean bond enthalpies are given below.

Bond	N-H	N-N	N≡N	H-O	O-O
Mean bond enthalpy/kJ mol ⁻¹	388	163	944	463	146

Use these data to calculate the enthalpy change for the following gas-phase reaction between hydrazine, N₂H₄, and hydrogen peroxide, H₂O₂



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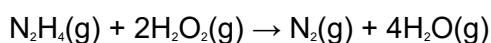
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(3)

(c) Some standard enthalpies of formation are given below.

	N ₂ H ₄ (g)	H ₂ O ₂ (g)	H ₂ O(g)
ΔH _f ^o /kJ mol ⁻¹	+75	-133	-242

These data can be used to calculate the enthalpy change for the reaction in part (b).



(i) State the value of ΔH_f^o for N₂(g).

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(ii) Use the ΔH_f^o values from the table to calculate the enthalpy change for this reaction.

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(4)

- (d) Explain why the value obtained in part (b) is different from that obtained in part (c)(ii).

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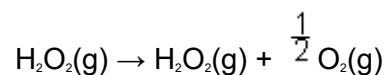
(1)

(Total 13 marks)

- Q3.** (a) The table below contains some mean bond enthalpy data.

Bond	H–O	O–O	O=O
Mean bond enthalpy/kJ mol ⁻¹	463	146	496

The bonding in hydrogen peroxide, H₂O₂, can be represented by H–O–O–H. Use these data to calculate the enthalpy change for the following reaction.



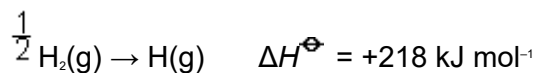
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(3)

- (b) The standard enthalpy of formation, ΔH_f^\ominus for methane, is $-74.9 \text{ kJ mol}^{-1}$. Write an equation, including state symbols, for the reaction to which this enthalpy change applies.

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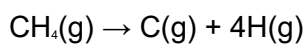
- (c) The enthalpy changes for the formation of atomic hydrogen and atomic carbon from their respective elements in their standard states are as follows.



- (i) By reference to its structure, suggest why a large amount of heat energy is required to produce free carbon atoms from solid carbon.

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- (ii) Parts (b) and (c) give enthalpy data for the formation of $\text{CH}_4(\text{g})$, $\text{H}(\text{g})$ and $\text{C}(\text{g})$. Use these data and Hess's Law to calculate the value of the enthalpy change for the following reaction.



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- (iii) Use your answer from part (c)(ii) to calculate a value for the mean bond enthalpy of a C–H bond in methane.

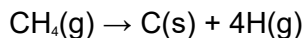
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(5)
(Total 10 marks)

Q4. Given the following data



which one of the following is the enthalpy change, in kJ mol^{-1} , of the reaction below?



A -947

B +511

C +797

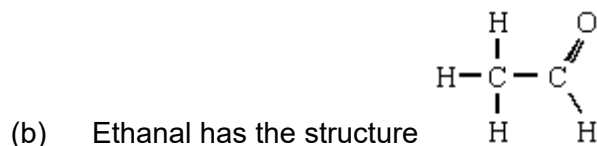
D +947

(Total 1 mark)

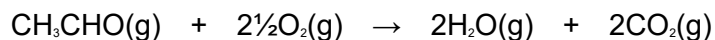
Q5. (a) State what is meant by the term *mean bond enthalpy*.

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(2)



Gaseous ethanal burns as shown by the equation



Use the mean bond enthalpy data given below to answer the following questions.

Bond	Mean bond enthalpy/ kJ mol^{-1}
C—H	+413
C—C	+347

C=O	+736
O=O	+498
O—H	+464

- (i) Calculate the enthalpy change which occurs when all the bonds in the reactants shown in the above equation are broken.

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- (ii) Calculate the enthalpy change which occurs when all the bonds in the products shown in the above equation are formed.

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- (iii) Hence, calculate the enthalpy change for the complete combustion of ethanal as shown in the equation above.

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(5)
(Total 7 marks)

Q6.The table below contains some mean bond enthalpy data.

Bond	H—H	C—C	C=C	N≡N	N—H
Mean bond enthalpy / kJ mol ⁻¹	436	348	612	944	388

(a) Explain the term *mean bond enthalpy*.

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(2)

(b) (i) Write an equation for the formation of one mole of ammonia, NH₃, from its elements.

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(ii) Use data from the table above to calculate a value for the enthalpy of formation of ammonia.

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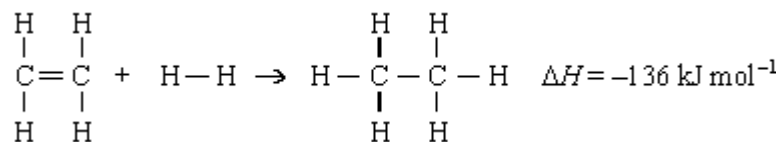
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(4)

(c) Use the following equation and data from the table above to calculate a value for the C—H bond enthalpy in ethane.



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(3)
(Total 9 marks)