Bond Enthalpy

Question 1
Define bond enthalpy

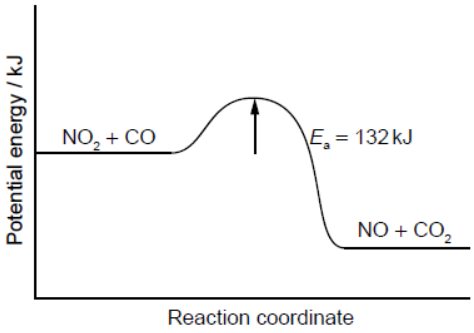
Question 2
Find the change for the electrophilic addition of hydrogen bromide to ethene to form bromoethane.
Use Section 11 of your data booklet.

$C_2H_4(g) + HBr(g) \rightarrow C_2H_5Br(g)$

Question 3
Nitrogen dioxide and carbon monoxide react according to the following equation:

$NO_2(g) + CO(g) \rightleftharpoons NO(g) + CO_2(g)$ $\Delta H = -226$ kJ

a) Calculate the activation energy for the reverse reaction.
b) State the equation for the reaction of NO_2 in the atmosphere to produce acid deposition.



Question 4
Which equation represents the average bond enthalpy of the Si−H bond in SiH_4?

A. $SiH_4(g) \rightarrow SiH_3(g) + H(g)$
B. $\frac{1}{4}SiH_4(g) \rightarrow \frac{1}{4}Si(g) + H(g)$
C. $SiH_4(g) \rightarrow SiH_3(g) + \frac{1}{2}H_2(g)$
D. $SiH_4(g) \rightarrow Si(g) + 4H(g)$

Question 5

Which equation corresponds to the bond enthalpy of the H–I bond?

A. $HI(g) \rightarrow \frac{1}{2}H_2(g) + \frac{1}{2}I_2(g)$
B. $HI(g) \rightarrow \frac{1}{2}H_2(g) + \frac{1}{2}I_2(s)$
C. $HI(g) \rightarrow H^+(g) + I^-(g)$
D. $HI(g) \rightarrow H(g) + I(g)$

Question 6

Which enthalpy changes can be calculated using **only** bond enthalpy data?

I. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
II. $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$
III. $CH_4(g) + Cl_2(g) \rightarrow CH_3Cl(g) + HCl(g)$

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

Question 7

The following equation represents a combustion reaction of propane, $C_3H_8(g)$ when the oxygen supply is limited.

$$C_3H_8(g) + 3\tfrac{1}{2}O_2(g) \rightarrow 3CO(g) + 4H_2O(g)$$

Determine the enthalpy change of the reaction, in kJ mol^{-1}, using average bond enthalpy data from Table 11 of the Data Booklet. The bond enthalpy for the carbon-oxygen bond in carbon monoxide, CO, is 1072 kJ mol^{-1}.

Question 8

Ethane-1,2-diol, $HOCH_2CH_2OH$, has a wide variety of uses including the removal of ice from aircraft and heat transfer in a solar cell.

Ethane-1,2-diol can be formed according to the following reaction.

$$2CO\ (g) + 3H_2\ (g) \rightleftharpoons HOCH_2CH_2OH\ (g)$$

a) Calculate the enthalpy change, ΔH^{θ}, in kJ, for this reaction using section 11 of the data booklet. The bond enthalpy of the carbon–oxygen bond in CO (g) is 1077 kJ mol^{-1}.
b) The enthalpy change, ΔH^{θ}, for the following similar reaction is –233.8 kJ.
$$2CO(g) + 3H_2(g) \rightleftharpoons HOCH_2CH_2OH\ (l)$$
Deduce why this value differs from your answer to a).
c) Suggest why the value of the enthalpy of combustion of ethanol quoted in table 12 of the data booklet is different to that calculated using bond enthalpies.
d) Explain why the reaction is exothermic in terms of the bonds involved.

Question 9

In December 2010, researchers in Sweden announced the synthesis of N,N–dinitronitramide, $N(NO_2)_3$. They speculated that this compound, more commonly called trinitramide, may have significant potential as an environmentally friendly rocket fuel oxidant.

Methanol reacts with trinitramide to form nitrogen, carbon dioxide and water. Deduce the coefficients required to balance the equation for this reaction.

$$\_\_\_\ N(NO_2)_3(g) + \_\_\_\ CH_3OH(l) \rightarrow \_\_\_\ N_2(g) + \_\_\_\ CO_2(g) + \_\_\_\ H_2O(l)$$

a) Calculate the enthalpy change, in kJ mol^{-1}, when one mole of trinitramide decomposes to its elements, using bond enthalpy data from Table 11 of the Data Booklet. Assume that all the N–O bonds in this molecule have a bond enthalpy of 305 kJ mol^{-1}.
b) Outline how the length of the N–N bond in trinitramide compares with the N–N bond in nitrogen gas.
c) Deduce the N–N–N bond angle in trinitramide and explain your reasoning.
d) Predict, with an explanation, the polarity of the trinitramide molecule.
e) Methanol can also be burnt as a fuel. Describe an experiment that would allow the molar enthalpy change of combustion to be calculated from the results.
f) Explain how the results of this experiment could be used to calculate the molar enthalpy change of combustion of methanol.
g) Predict, with an explanation, how the result obtained would compare with the value in Table 13 of the Data Booklet.

Question 10

Chloroethene, $H_2C{=}CHCl$, the monomer used in the polymerization reaction in the manufacture of the polymer poly(chloroethene), PVC, can be synthesized in the following two-stage reaction pathway. Stage 1 is shown here.

$$C_2H_4(g) + Cl_2(g) \rightarrow ClCH_2CH_2Cl\ (g)$$

a) Determine the enthalpy change, ΔH, in kJ mol^{-1}, for stage 1 using average bond enthalpy data from Table 11 of the Data Booklet.
b) State whether the reaction given in stage 1 is exothermic or endothermic.

c