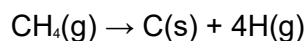


Q1. Given the following data



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



A -947

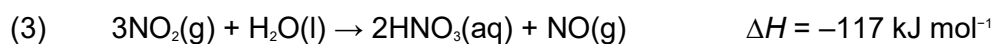
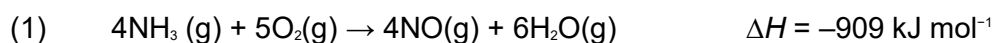
B +511

C +797

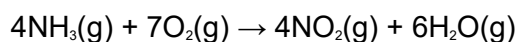
D +947

(Total 1 mark)

Q2. Nitric acid is produced industrially from ammonia, air and water using the following sequence of reactions:



Which is the enthalpy change (in kJ mol^{-1}) for the following reaction?



A -679

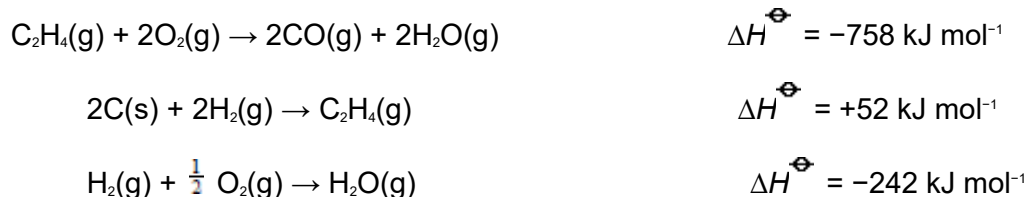
B -794

C -1024

D -1139

(Total 1 mark)

Q3. Consider the reactions



The enthalpy of formation of carbon monoxide is

- A -111 kJ mol^{-1}
- B -163 kJ mol^{-1}
- C -222 kJ mol^{-1}
- D -464 kJ mol^{-1}

(Total 1 mark)

Q4. (a) Write an equation for the complete combustion of propanone, C_3H_6O , to form carbon dioxide and water.

.....

(1)

(b) In a laboratory experiment, 1.45 g of propanone were burned completely in oxygen. The heat from this combustion was used to raise the temperature of 100 g of water from 293.1 K to 351.2 K.

(i) Calculate the number of moles of propanone in the 1.45 g.

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(ii) Calculate the heat energy required to raise the temperature of 100 g of water from 293.1 K to 351.2 K.
 (The specific heat capacity of water is $4.18 \text{ J K}^{-1} \text{ g}^{-1}$)

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- (iii) Hence, calculate a value, in kJ mol^{-1} , for the enthalpy of combustion of propanone.

.....

(5)

- (c) In a similar experiment, the enthalpy of combustion of butanone, $\text{C}_4\text{H}_8\text{O}$, was found to be $-1290 \text{ kJ mol}^{-1}$. A data book value for the same reaction is $\Delta H_c^\ominus = -2430 \text{ kJ mol}^{-1}$.

- (i) Suggest one reason why the experimental value is very different from the data book value.

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- (ii) This data book value of ΔH_c^\ominus for butanone ($-2430 \text{ kJ mol}^{-1}$) refers to the formation of carbon dioxide gas and water in the gaseous state. How would this value differ if it referred to the formation of water in the liquid state? Explain your answer.

Difference

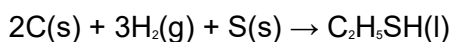
Explanation

.....

(3)

- (d) Calculate a value for the standard enthalpy of formation for liquid ethanethiol, $\text{C}_2\text{H}_5\text{SH}$. Use the equation given below and enthalpy of combustion data from the following table.

Substance	$\text{C}_2\text{H}_5\text{SH}(\text{l})$	$\text{C}(\text{s})$	$\text{H}_2(\text{g})$	$\text{S}(\text{s})$
$\Delta H_c^\ominus / \text{kJ mol}^{-1}$	-1170	-394	-286	-297



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.....
(3)
(Total 12 marks)

Q5.When ethanamide (CH_3CONH_2) burns in oxygen the carbon is converted into carbon dioxide, the hydrogen is converted into water and the nitrogen forms nitrogen gas.

Substance	ethanamide	carbon dioxide	water
Enthalpy of formation (ΔH_f^\ominus) / kJ mol^{-1}	-320	-394	-286

Using the data above, which one of the following is a correct value for the enthalpy of combustion of ethanamide?

- A** $-1823 \text{ kJ mol}^{-1}$
- B** $-1183 \text{ kJ mol}^{-1}$
- C** $-1000 \text{ kJ mol}^{-1}$
- D** -360 kJ mol^{-1}

(Total 1 mark)

Q6.Using the data below, which is the correct value for the standard enthalpy of formation for $\text{TiCl}_4(\text{l})$?



- A** $-1538 \text{ kJ mol}^{-1}$

- B -1094 kJ mol⁻¹
- C -750 kJ mol⁻¹
- D +286 kJ mol⁻¹

(Total 1 mark)

Q7. (a) Define the term *standard molar enthalpy of formation*, ΔH_f^\ominus .

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(3)

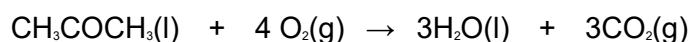
(b) State Hess's law.

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(1)

(c) Propanone, CH₃COCH₃, burns in oxygen as shown by the equation



Use the data given below to calculate the standard enthalpy of combustion of propanone.

	CO ₂ (g)	H ₂ O(l)	CH ₃ COCH ₃ (l)
$\Delta H_f^\ominus/\text{kJ mol}^{-1}$	-394	-286	-248

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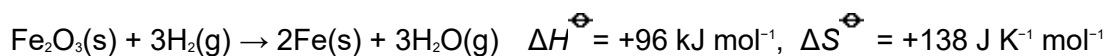
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(3)

(Total 7 marks)

Q8. Using the information below, answer this question.



	Fe₂O₃(s)	H₂(g)	Fe(s)
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	-822.0	0	0
$\Delta S^\ominus / \text{J K}^{-1} \text{ mol}^{-1}$	90.0	131.0	27.0

The standard enthalpy of formation of steam is

- A** +286 kJ mol⁻¹
- B** +242 kJ mol⁻¹
- C** -242 kJ mol⁻¹
- D** -286 kJ mol⁻¹

(Total 1 mark)

Q9. The table below contains some standard enthalpy of formation data.

Substance	C(s)	N ₂ (g)	H ₂ O(g)	CO ₂ (g)	NH ₄ NO ₃ (s)
$\Delta H_f^\ominus / \text{kJ mol}^{-1}$	0	0	-242	-394	-365

- (a) Why are the values of the standard enthalpy of formation for carbon and nitrogen zero?

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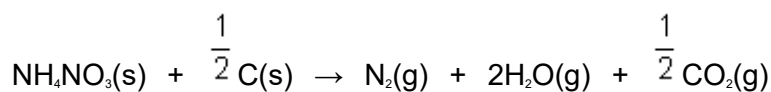
(1)

(b) State Hess's Law.

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(2)

(c) Use ΔH_f^\ominus data from the table to calculate a value for the enthalpy change for the following reaction.



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(3)

(Total 6 marks)

Q10. (a) What is the meaning of the term *enthalpy change*?

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.....

(2)

(b) (i) Define the term *standard enthalpy of formation* of a compound.

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- (ii) Write an equation, including state symbols, for the formation from its elements of solid sodium sulphate, Na_2SO_4

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(5)

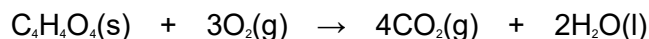
- (c) State Hess's Law.

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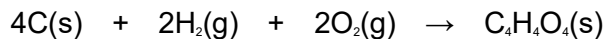
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(1)

- (d) Some standard enthalpy changes are difficult to measure directly but can be determined from standard enthalpies of combustion.
Maleic acid, $\text{C}_4\text{H}_4\text{O}_4$, reacts with oxygen to form carbon dioxide and water as shown by the following equation.



Use the standard enthalpy of combustion data given below to calculate a value for the standard enthalpy change for the following reaction.



	$\text{C}_4\text{H}_4\text{O}_4(\text{s})$	$\text{C}(\text{s})$	$\text{H}_2(\text{g})$
$\Delta H_c^\ominus / \text{kJ mol}^{-1}$	-1356	-393.5	-285.8

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(3)
(Total 11 marks)