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CHEMISTRY

Physical Chemistry

Level & Board	AQA (A-LEVEL)
TOPIC:	ENERGETICS
PAPER TYPE:	QUESTION PAPER 3
TOTAL QUESTIONS	10
TOTAL MARKS	44

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Energetics - 3

1. Methanol, CH_3OH , is a convenient liquid fuel.

(a) An experiment was conducted to determine the enthalpy of combustion of liquid methanol.

The energy obtained from burning 2.12 g of methanol was used to heat 150 g of water.

The temperature of the water rose from 298 K to 362 K.
(The specific heat capacity of water is $4.18 \text{ J K}^{-1} \text{ g}^{-1}$)

i. Define the term standard enthalpy of combustion.

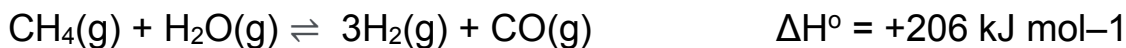
(2)

ii. Use the data above to calculate a value for the enthalpy of combustion of one mole of liquid methanol.

(5)

(b) Methanol can be synthesised from methane and steam by a process that occurs in two stages.

Stage 1



Stage 2



The standard enthalpies of combustion of carbon monoxide and of hydrogen are -283 kJ mol^{-1} and -286 kJ mol^{-1} , respectively.

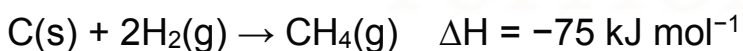
Use these data and the enthalpy change for Stage 2 to calculate a value for the standard enthalpy of combustion of gaseous methanol.

(3)

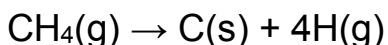
2. Define the term standard enthalpy of hydration.

(2)

3. 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

(1)

4. In which one of the following reactions is the standard enthalpy change equal to the standard enthalpy of formation of lithium fluoride?

- A. $\text{Li(g)} + \text{F(g)} \rightarrow \text{LiF(s)}$
- B. $\text{Li}^+(\text{g}) + \text{F}^-(\text{g}) \rightarrow \text{LiF(s)}$
- C. $\text{Li}^+(\text{aq}) + \text{F}^-(\text{g}) \rightarrow \text{LiF(s)}$
- D. $\text{Li(s)} + \frac{1}{2} \text{F}_2(\text{g}) \rightarrow \text{LiF(s)}$

(1)

5. 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.

(2)

(b)

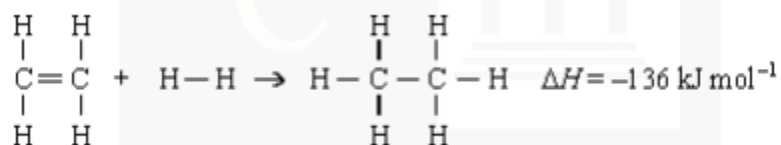
- i. Write an equation for the formation of one mole of ammonia, NH₃, from its elements.

(2)

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

(2)

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



(3)

6. A vessel and its contents of total heat capacity 120 J K^{-1} were heated using a methane burner.

Calculate the maximum theoretical temperature rise when 0.10 g of methane was completely burned.

The standard enthalpy of combustion of methane is -890 kJ mol^{-1} .

(4)

7.

(a) Define the term standard molar enthalpy of formation, ΔH_f .

(2)

(b) State Hess's law.

(1)

8. Explain the meaning of the terms mean bond enthalpy and standard enthalpy of formation.

(2)

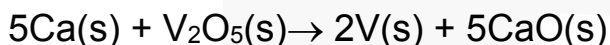
9. Vanadium is an important metal. Ferrovandium, an alloy of iron and vanadium, is used to make a strong type of vanadium-steel. Pure vanadium is used in nuclear reactors.

I am Sorry !!!!!

(a) The table shows some standard enthalpy of formation data.

	$V_2O_5(s)$	$CaO(s)$
$\Delta H_f^\theta / \text{kJ mol}^{-1}$	-1560	-635

In the oldest method of extraction of vanadium, V_2O_5 is reacted with calcium at a high temperature.



Use data from the table and the equation to calculate the standard enthalpy change for this reaction.

State the type of reaction that V_2O_5 has undergone.

Suggest one major reason why this method of extracting vanadium is expensive, other than the cost of heating the reaction mixture.

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(5)

(b) Ferrovandium is produced by the reaction of aluminium with a mixture of V_2O_5 and iron(III) oxide.

Write an equation for the reaction of aluminium with iron(III) oxide. State the change in oxidation state of aluminium in this reaction.

(2)

(c) Pure vanadium, for nuclear reactors, is formed by the reaction of hydrogen with purified VCl_2 . Write an equation for this reaction in which the only other product is HCl gas.

Identify two hazards in this process, other than the fact that it operates at a high temperature.

Deduce why this process produces pure vanadium, other than the fact that purified VCl_2 is used.

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(4)

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10. When 0.10 g of propane was burned the quantity of heat evolved was 5.0 kJ.

The enthalpy of combustion of propane in kJ mol^{-1} is

- A. -800
- B. -1500
- C. -2200
- D. -2900

(1)



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