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CHEMISTRY

PHYSICAL CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	THERMODYNAMICS
PAPER TYPE:	QUESTION PAPER - 2
TOTAL QUESTIONS	10
TOTAL MARKS	24

Thermodynamics - 2

1. The data below apply to a gas phase reversible reaction.

Standard enthalpy change, $\Delta H = +208$ kJ mol^{-1}
Standard entropy change, $\Delta S = +253$ J K^{-1} mol^{-1}

(a) Deduce the effect of an increase in temperature on the position of the equilibrium in this reaction.

Use Le Chatelier's principle to explain your answer.

(4)

(b) Calculate the minimum temperature at which this reaction is feasible.

(3)

2. The compound lithium tetrahydridoaluminate(III), $LiAlH_4$, is a useful reducing agent. It behaves in a similar fashion to $NaBH_4$.

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Carbonyl compounds and carboxylic acids are reduced to alcohols.

However, $LiAlH_4$ also reduces water in a violent reaction so that it must be used in an organic solvent.

Which one of the following concerning the violent reaction between $LiAlH_4$ and water is false?

A. Gas is produced.
B. The activation energy for the reaction is relatively high.
C. The reaction has a negative free-energy change.
D. Aqueous lithium ions are formed.

(1)

3. Alkanes are important hydrocarbons since they are used as fuels in homes and in industry.

It is important that the enthalpy changes involved in alkane reactions are known.

(a) Define the term enthalpy change of formation of a compound.

(2)

(b) Write the equation, including state symbols, that accompanies the enthalpy change of formation of hexane, $C_6H_{14}(l)$.

(2)

(c) What conditions of temperature and pressure are used when measuring the standard enthalpy change of formation?

(1)

4. Which one of the following best explains why the lattice enthalpy of magnesium chloride is much larger than that of lithium chloride?

A. Magnesium has a greater electronegativity than lithium.
B. Magnesium ions have a greater polarising power than lithium ions.
C. Magnesium ions have a greater ionic radius than lithium ions.
D. Magnesium ions have a greater charge than lithium ions.

(1)

5. Propane, C_3H_8, is a gas at room temperature and pressure.

It is used in blow torches to melt the bitumen needed to apply the felt to flat roofs.

Write the equation for the complete combustion of propane.

(2)

6. In which one of the following reactions is there a decrease in entropy?

A. $[Fe(H_2O)_6]^{3+}(aq) + 3C_2O_4^{-2}\ (aq) \rightarrow [Fe(C_2O_4)_3]^{3-}\ (aq) + 6H_2O(l)$
B. $[Cu(H_2O)_6]^{2+}(aq) + EDTA^{4-}\ (aq) \rightarrow [Cu(EDTA)]^{2-}\ (aq) + 6H_2O(l)$
C. $[CoCl_4]^{2-}\ (aq) + 6H_2O(l) \rightarrow [Co(H_2O)_6]^{2+}(aq) + 4Cl^-\ (aq)$
D. $Na_2CO_3(s) + 2H^+\ (aq) \rightarrow 2Na^+\ (aq) + CO_2(g) + H_2O(l)$

(1)

7. Write an equation, including state symbols, representing the standard enthalpy change of formation of PbO.

(2)

8. Which one of the following statements is not correct?

A. The first ionisation energy of iron is greater than its second ionisation energy.
B. The magnitude of the lattice enthalpy of magnesium oxide is greater than that of barium oxide.
C. The oxidation state of iron in $[Fe(CN)_6]^{3-}$ is greater than the oxidation state of copper in $[CuCl_2]^-$
D. The boiling point of C_3H_8 is lower than that of CH_3CH_2OH

(1)

9. The equations for the combination of gaseous atoms of carbon and hydrogen to form methane, CH_4, and ethane, C_2H_6, are shown below.

$(g) + 4H(g) \rightarrow CH_4(g)$ $\quad \Delta H = -1652 \text{ kJ mol}^{-1}$
$2C(g) + 6H(g) \rightarrow C_2H_6(g)$ $\quad \Delta H = -2825 \text{ kJ mol}^{-1}$

Use these data to calculate:

(a) The bond enthalpy of a C−H bond.

(1)

(b) The bond enthalpy of a C−C bond.

(2)

10. Which one of the following reactions in aqueous solution has the most positive change in entropy?

A. $[Cu(H_2O)_6]^{2+} + 4NH_3 \rightarrow [Cu(NH_3)_4(H_2O)_2]^{2+} + 4H_2O$
B. $[Cu(H_2O)_6]^{2+} + 4Cl^- \rightarrow [CuCl_4]^{2-} + 6H_2O$
C. $[Cu(H_2O)_6]^{2+} + EDTA^{4-} \rightarrow [Cu(EDTA)]^{2-} + 6H_2O$
D. $[Cu(H_2O)_6]^{2+} + 2H_2NCH_2CH_2NH_2 \rightarrow [Cu(H_2NCH_2CH_2NH_2)_2(H_2O)_2]^{2+} + 4H_2O$

(1)

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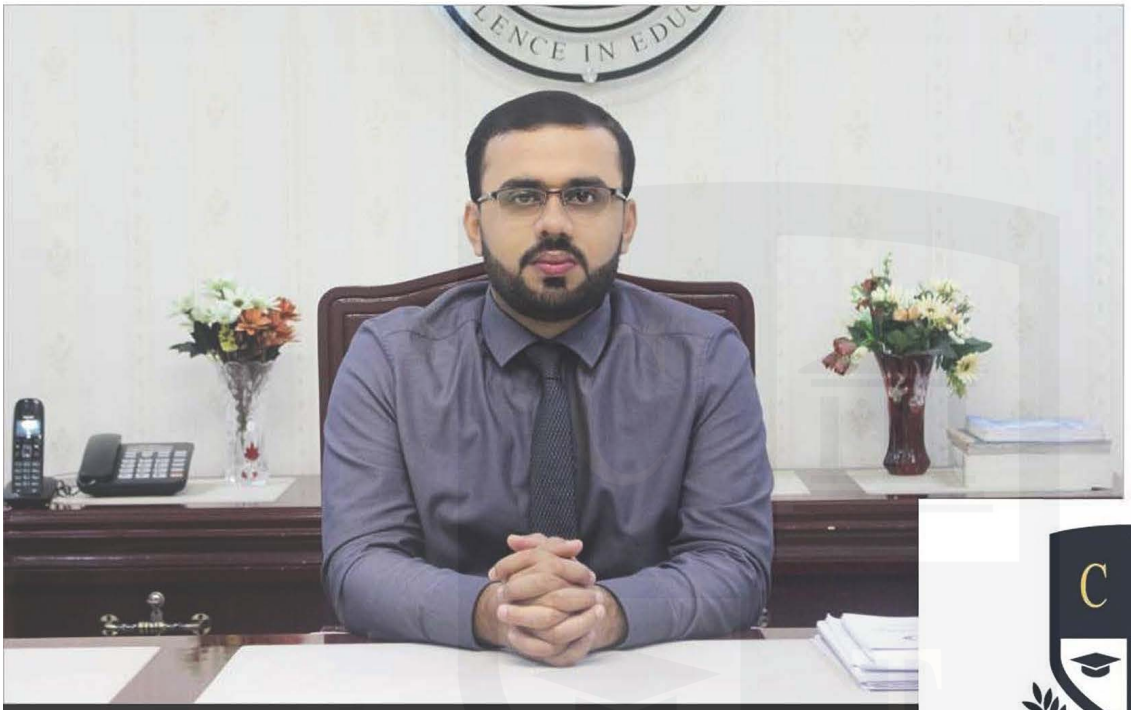

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