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Level: CIE AS and A Level (9701)
Subject: Chemistry
Topic: CIE Chemistry
Type: Topic Question

Chemistry CIE AS & A Level
To be used for all exam preparation for 2025+

CHEMISTRY AS and A

This to be used by all students studying CIE AS and A level Chemistry (9701) But students of other boards may find it useful

Question 1.

i) State what is meant by partition coefficient.

[2]

Ammonia is soluble in both water and organic solvents.

An aqueous solution of ammonia is shaken with the immiscible organic solvent trichloromethane. The mixture is left to reach equilibrium.

Samples are taken from each layer and titrated with dilute hydrochloric acid.

- A 25.0 cm^3 sample from the trichloromethane layer requires 13.0 cm^3 of 0.100 mol dm^{-3} HCl to reach the end-point.
- A 10.0 cm^3 sample from the aqueous layer requires 12.5 cm^3 of 0.100 mol dm^{-3} HCl to reach the end-point.

ii) Calculate the partition coefficient, K_{pc}, of ammonia between trichloromethane and water.

Show your working.

K_{pc} = ...

[2]

iii) Butylamine, $C_4H_9NH_2$, is also soluble in both water and organic solvents.

Suggest how the numerical value of K_{pc} of butylamine between trichloromethane and water would compare to the value of K_{pc} calculated in **(a)(ii)**. Explain your answer.

[2]

[6 marks]

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Question 2.

Butanamide, $C_3H_7CONH_2$, is much less basic than butylamine. Explain why.

[1 mark]

Question 3.

The feasibility of a chemical reaction depends on the standard Gibbs free energy change, $\Delta G^{\ominus}$.
This is dependent on the standard enthalpy and entropy changes, and the temperature.

State and explain whether the following processes will lead to an increase or decrease in entropy.

i) the reaction of magnesium with hydrochloric acid

entropy change .....

explanation .....

[1]

ii) the dissolving of solid potassium chloride in water

entropy change .....

explanation .....

[1]

iii) the condensing of water from steam

entropy change .....

explanation .....

[1]

[3 marks]

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Question 4.

Magnesium carbonate can be decomposed on heating.

$$MgCO_3(s) \rightarrow MgO(s) + CO_2(g) \quad \Delta H^{\ominus} = +117 \text{ kJ mol}^{-1}$$

Standard entropies are shown in Table 2.1.

Table 2.1

substance	$MgCO_3(s)$	$MgO(s)$	$CO_2(g)$
$S^{\ominus}$ / J K^{-1} mol^{-1}	+65.7	+26.9	+214

i) Calculate $\Delta G^{\ominus}$ for this reaction at 298 K.

Show your working.

$\Delta G^{\ominus}$ = ... kJ mol^{-1}

[3]

ii) Explain why this reaction is feasible only at high temperatures.

[1]

[4 marks]

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Question 5.

Table 2.2 lists values of solubility products, K_{sp}, of some Group 2 carbonates.

Table 2.2

	solubility product in water at 298 K, K_{sp} / mol^2 dm^{-6}
$MgCO_3$	1.0×10^{-5}
$CaCO_3$	5.0×10^{-9}
$SrCO_3$	1.1×10^{-10}

Deduce the trend in the solubility of the Group 2 carbonates down the group. Justify your answer using the data given.

[1 mark]

Question 6.

i) Write an equation to show the equilibrium for the solubility product of $MgCO_3$. Include state symbols.

..... ⇌ .....

[1]

ii) With reference to your equation in **(d)(i)**, suggest what is observed when a few cm^3 of concentrated Na_2CO_3 (aq) are added to a saturated solution of $MgCO_3$. Explain your answer.

[2]

[3 marks]

Question 7.

Use the data in Table 2.2 to calculate the solubility of $MgCO_3$ in water at 298 K, in g dm^{-3}.

Show your working.

solubility of $MgCO_3$ = ... g dm^{-3}

[2 marks]

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Question 8.

Describe and explain the variation in the thermal stabilities ofthe carbonates ofthe Group 2 elements.

[3 marks]

Question 9.

This question is about solubility products

A 1.70×10^{-3} mol dm^{-3} solution of calcium nitrate is mixed with an equal volume of 1.50×10^{-3} mol dm^{-3} potassium sulfate.

Predict whether calcium sulfate ($K_{sp} = 2.00 \times 10^{-5}$) will precipitate. Show your working.

[3 marks]

Question 10.

Water with a manganese ion, Mn^{2+} (aq), concentration above 1.8×10^{-6} mol dm^{-3} will cause clothes to stain when being washed. The manganese can precipitate as $Mn(OH)_2$ (s) which has a K_{sp} of 4.5×10^{-14}. This reduces this concentration of Mn^{2+} (aq) by the addition of OH^- ions.

i) State the expression for K_{sp}

[1]

ii) Calculate the concentration of OH^- ions. Show your working.

$[OH^-]$ = ... mol dm^{-3}

[2]

iii) Calculate the minimum pH at 298 K required to prevent clothes from being stained.
($K_w = 1.00 \times 10^{-14}$ mol^2 dm^{-6} (at 298 K (25 °C))

pH = ...

[2]

[5 marks]

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Question 11.

Consider the following equilibrium containing a saturated solution of AgBr (s)

$$AgBr\,(s) \rightleftharpoons Ag^+\,(aq) + Br^-\,(aq)$$

Explain what will happen to the solubility of AgBr (s) if the following substances are added to the solution.

- $AgNO_3$

  .....

- NaBr

  .....

- $Pb(NO_3)_2$

  .....

[3 marks]

Question 12.

Explain why more $Mg(OH)_2$ dissolves when hydrochloric acid is added to a saturated solution of $Mg(OH)_2$.

[3 marks]

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