GCE A LEVEL CHEMISTRY

S21-A410

Assessment Resource A

Chemistry in Practice

1. Outline **two** simple reactions, including relevant observations, formulae and equations, to show that complexes of copper(II) ions can undergo ligand exchange.

You may choose from the following chemicals **ONLY**, not all of which need to be used.

- aqueous copper(II) sulfate
- aqueous potassium iodide
- aqueous sulfuric acid
- aqueous ammonia
- concentrated hydrochloric acid

[6 QER]

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2. A student was asked to identify four inorganic salts, labelled **P**, **Q**, **R** and **S**, by their reaction with aqueous sodium hydroxide and by the interactions between their solutions. The student was told that each solution contains

- a **different cation** and that the cations present are

  Mg^{2+} **Ba^{2+}** **Pb^{2+}** **Fe^{2+}**

- a **different anion** and that the anions present are

  I^- **Cl^-** **NO_3^-** **SO_4^{2-}**

The student tested approximately 2 cm^3 at a time of each solution with NaOH(aq) and then with a few drops of the other solutions in turn.

When no observable reaction happened, "NOR" was recorded in the results table below.

	P	**Q**	**R**	**S**
NaOH(aq)	white precipitate, insoluble in excess NaOH(aq)	white precipitate, soluble in excess NaOH(aq)	green precipitate, insoluble in excess NaOH(aq)	NOR
S	NOR	white precipitate	heavy white precipitate	
R	NOR	white precipitate		
Q	bright yellow precipitate			

Complete the table below.

- Identify the cation and anion present in each of the four inorganic salts **P**, **Q**, **R** and **S**.
- Give an **ionic** equation to show the formation of **any one** of the precipitates formed. Include state symbols. [10]

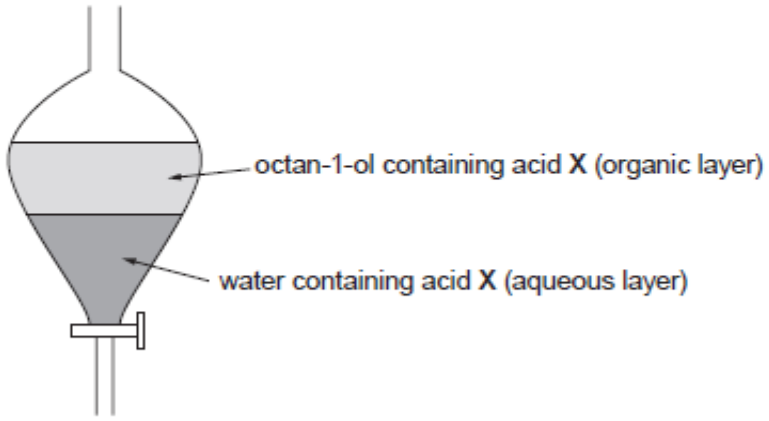
Inorganic salt	Cation	Anion
P		
Q		
R		
S		

Ionic equation

.....

3. A very weak carboxylic acid **X**, RCOOH, with a molar mass of 116 g mol^{-1} dissolves to some extent in **both** water and the organic solvent octan-1-ol. Water and octan-1-ol **do not mix**.

When a sample of pure **X** is shaken with water and octan-1-ol in a separating funnel and allowed to stand at a constant temperature of 298 K for one week, two layers are formed as shown below.



An equilibrium is established between the amount of **X** in the two solvents.

$$\mathbf{X}(\text{aqueous layer}) \rightleftharpoons \mathbf{X}(\text{organic layer})$$

Under these conditions at equilibrium the equilibrium constant K is given as

$$K = \frac{[\mathbf{X}(\text{organic layer})]}{[\mathbf{X}(\text{aqueous layer})]}$$

In an experiment to find the value for the equilibrium constant K, 15.0 g of pure **X** was shaken with 200 cm^3 of water and 200 cm^3 of octan-1-ol in a separating funnel and left until equilibrium had been established.

After separating the aqueous and organic layers, it was found that 25.0 cm^3 of the aqueous solution of **X** needed 23.50 cm^3 of aqueous sodium hydroxide of concentration 0.0200 mol dm^{-3} to neutralise the acid.

$$\text{RCOOH} + \text{NaOH} \longrightarrow \text{RCOO}^-\text{Na}^+ + \text{H}_2\text{O}$$

(a) (i) The six steps in the calculation to find the value for the equilibrium constant K are shown in a random order in the table below.

Number these steps in the correct order. The first step has already been numbered. [1]

Step	Correct order
Calculate the number of moles of **X** in the aqueous layer	
Calculate the mass of **X** in the organic layer and hence its concentration in mol dm^{-3}	
Calculate the number of moles of NaOH used in the titration	1
Calculate the value for the equilibrium constant K at 298 K	
Calculate the mass of **X** in the aqueous layer and hence its concentration in mol dm^{-3}	
Calculate the number of moles of **X** in 25.0 cm^3 of the aqueous layer	

(ii) Calculate the value of K. [5]

K = ...

(b) Calculate the total maximum percentage error in the volume of sodium hydroxide delivered from the burette, with a maximum error of half a division (±0.05 cm^3). [1]

Maximum percentage error = ... %

(c) (i) Calculate the pH of the aqueous solution of the weak carboxylic acid **X** at 298 K. [3]

(K_a for carboxylic acid **X** is 1.32×10^{-5} mol dm^{-3} at 298 K)

pH = ...

(ii) Sketch a curve to show the variation in pH when 50.0 cm^3 of 0.0200 mol dm^{-3} sodium hydroxide solution is gradually added to 25.0 cm^3 of the solution of carboxylic acid **X**. Label the axes and significant points on the curve. [5]