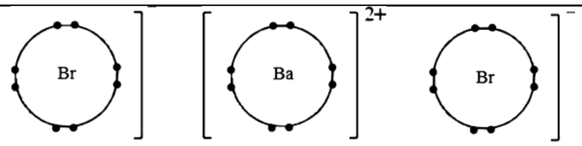
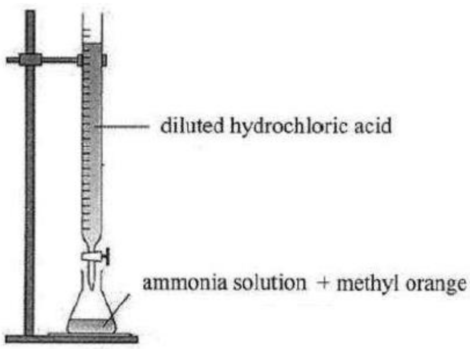
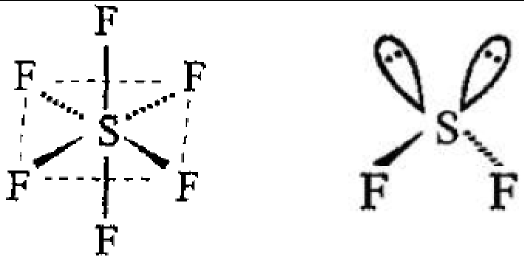
Chem mock 2022 Answer

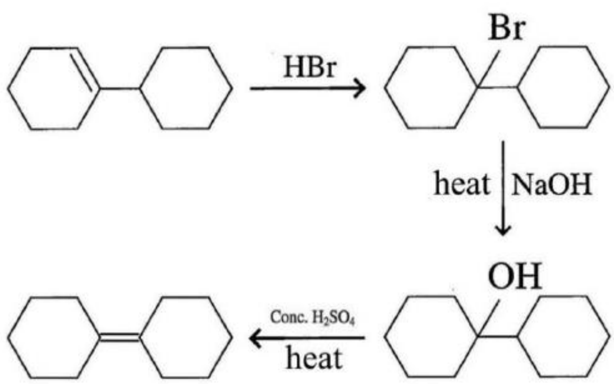
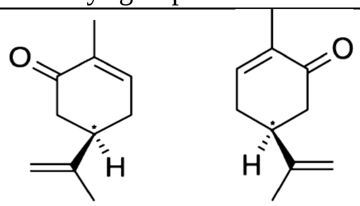
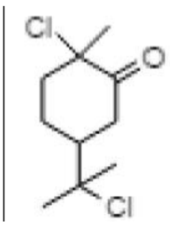
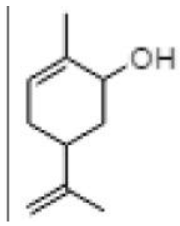
1. C	2. D	3. A	4. D	5. C	6. B	7. C	8. D	9. D	10. A
11. D	12. B	13. B	14. B	15. D	16. B	17. C	18.C	19. A	20. C
21. A	22. B	23. A	24. C	25. D	26. A	27. B	28. C	29. D	30. C
31. C	32. A	33. D	34. B	35. B	36. B				

Section 1B

1	a	2,8,18,7	1
	b		1
	c	Barium can conducts electricity, but barium bromide cannot. It is because barium contains delocalized electrons whereas barium bromide does not contain delocalized electrons and ions are not mobile in solid state.	1 1
			(4)
2	a	Na2CO3 / H2O Mass: 24.92-24.35 = 0.57 ; 25.47-24.92 = 0.55 Mole mol: 0.57 / 106 = 0.005377 ; 0.55 / 18 = 0.03056 Simplest ratio: 5.68 value of x= 5.68	1 1
	b	Failure to drive off all the water. OR Failure to heat for long enough. OR Not heated to constant mass.	1
	c	Heat to constant mass / heat for longer / use a smaller mass so that it can be sure all / more of the water has been driven off.	1
			(4)
3	a	methyl orange Colour changes from yellow to orange.	1 1
	b	Use 10.0 cm^3 pipette to transfer sample of glass cleaner to a 250.0 cm^3 volumetric flask. Add distilled water until the solution level reaches the graduation mark. Stopper the volumetric flask and shake well.	1 1
	Ci	[(40.00 — 26.50) + (45.50 — 31.75) + (30.50-16.80)]/3 = 13.65 cm^3	1
	cii	No. of moles of HCl = 13.65/1000 x 0.17 = 2.3205 x 10^{-3} mol NH3 + HCl → NH_4Cl Mole ratio of NH_3 : HCl = 1 : 1 No. of moles of NH_4 in 25.0 cm^3 diluted solution = 2.3205 x 10^{-3} mol No. of moles of NH_4 in 250.0 cm3 diluted solution = No. of moles of 10.0 cm^3 diluted solution = 2.3205 x 10^{-3} x 10 = 2.3205 x 10^{-2} mol Concentration of NH4 in sample solution = [2.3205 x 10^{-2}/(10.0 x 10^{-3})] x (14 + 1 x 3) = 39.45 g dm^{-3}	1* 1
	d	 (1 mark for correct set-up; 1 mark for correct labels)	2
			(9)

4	a	At some instant, the electrons are unevenly distributed within the molecules/ Electron movement causes more electrons on one side of the molecule than on the other side. This would induce a dipole/ a partial positive charge and a partial negative charge on the neighbouring molecules, resulting in (induced-temporary) attraction.	1 1
	b	(methanol) hydrogen bonds / hydrogen bonding (methanethiol) dipole-dipole forces or van der Waals' forces H-bonds are a stronger / are the strongest intermolecular forces	1 1
	c	(Methaneselenol is a) bigger molecule / larger Molecule size / larger no of electrons / Se bigger atom with stronger / more van der Waals' forces between molecules	1
	d	(i) Shape  (ii) Name of shape Octahedral V-shaped	(9)
5		[Suggested tests and expected observations / conclusions] Add dilute HCl(aq) or HNO_3(aq) to all 3 solid samples, the sample that gives out bubbles is Na_2CO_3. On the remaining 2 solid samples, Add water to make into a solution and then add acidified $AgNO_3$ (aq), the sample that gives white precipitate with $AgNO_3$ is NaCl and the sample that shows no observable change / no precipitate is NaF. [For reference - equations and state symbols] Na_2CO_3 (s) + 2HNO_3 (aq) —> 2$NaNO_3$ (aq) + CO_2(g) + H_2O(l) NaCl(aq) + $AgNO_3$ (aq) —> AgCl(s) + $NaNO_3$ (aq)	 1 1 1 1
		Effective Communication (only award for Chemical Knowledge > 3 or 4)	1
6	a	Store in dry place It reacts with moisture to form explosive hydrogen gas	1 1
	bi	An enthalpy change ΔH is the heat change in a system under constant pressure	1
	bii	Cycle Standard enthalpy change of the hydrolysis of $LiAlH_4$ = [-487.5 + (-1277) – (-116.3) – 4 x (-285.8)] $kJmol^{-1}$ = -505.0 kJmol-1	1 1
	c	Number of moles of 0.5 kg of H_2 = 500g÷(1.0×2)g mol^{-1} =250 mol From the given equation, mole ratio of $LiAlH_4$ to H_2 = 1 : 4 ∴ Number of moles of $LiAlH_4$ required = 250÷4 mol = 62.5 mol Mass of $LiAlH_4$ required = 62.5 mol x (6.9 + 27.0 + 1.0 x 4) g mol^{-1} = 2369g Volume of $LiAlH_4$ required = 2369g÷0.92g cm^{-3} = 2575 cm^3	 1 1
			(7)
7	a	Electrode B: $2H^+$ (aq) + $2e^-$ —> H_2(g) Electrode C: $4OH^-$ (aq) —> O_2 (g) + $2H_2O$ (l) + $4e^-$	l 1
	b	The electrode dissolves / becomes smaller / becomes thinner gradually	1
	c	Glucose solution does not contain mobile ions / cannot conduct electricity / not an electrolyte and so no current flows through the electric wires and across both vessels / no observable change on all electrodes.	1

	di	From the graph, mass of copper deposited after 15 min = 30.3 — 30.0 = 0.3 g No. of mol of copper deposited = 0.3/ 63.5 = 0.0047 Original no. of mol of Cu^{2+} = 2.5 / (63.5 + 32 + 4 x 16 + 5 x 18) = 2.5 / 249.5 = 0.01 No. of mol of Cu^{2+} left in solution = 0.01 — 0.0047 = 0.0053 Molarity of solution at 15 min = 0.0053/ 2.0 = 0.0027 M	1 1* 1
	dii	At 30 min, all the Cu^{2+} ions in the solution would have discharged. The intensity of the blue solution will decrease with being electrolyzed. [At 40 min, the solution is colourless as there are no more Cu^{2+} ions in the solution.] However, electrolysis will still continue for the acidified water and gas bubbles will then evolve at both electrodes C and D.	1 1
	diii	Molarity of the $CuSO_4$ (aq) remains unchanged as each Cu^{2+} ion discharged at the cathode is being replaced by formation of one Cu^{2+} ion at the anode.	1
			(10)
8	a	The total enthalpy change of a chemical reaction is independent of the pathway between the initial and final states.	1
	b	$2AgClO_3(s) + Cl_2(g) \longrightarrow 2AgCl(s) + 2ClO_2(g) + O_2(g)$ $\Delta H^{\varnothing} = \Sigma\Delta H^{\varnothing}_{[products]} - \Sigma\Delta H^{\varnothing}_{[reactants]}$ $+10\ kJ\ mol^{-1} = 2\Delta H^{\varnothing}_f[AgCl] + 2\Delta H^{\varnothing}_f[ClO_2] + \Delta H^{\varnothing}_f[O_2] - (2\Delta H^{\varnothing}_f[AgClO_3] + \Delta H^{\varnothing}_f[Cl_2])$ $+10 = 2(-127) + 2\Delta H^{\varnothing}_f[ClO_2] - 2(-30)$ $\Delta H^{\varnothing}_f[ClO_2] = (10 + 2 \times 127 - 2 \times 30) / 2 = +102\ kJ\ mol^{-1}$	1 1 1
	c	Since the standard enthalpy change of formation of ClO_2 (g) is positive, the formation is endothermic and hence ClO_2 (g) is unstable with respect to O_2 (g) and Cl_2 (g) under standard conditions.	1
	d	$Ag(s) + 2HNO_3(aq) \longrightarrow AgNO_3(aq) + NO_2(g) + H_2O(l)$ / $Ag(s) + 2H^+(aq) + NO_3^-(aq) \longrightarrow Ag^+(aq) + NO_2(g) + H_2O(l)$ Silver metal dissolves Brown gas evolved	1 1 1
			(8)
9	a	Equal volume of all gases under the same temperature and pressure contain the same number of gas molecules.	1
	b	Volume of O_2 reacted = 120 - 40 = 80 cm^3 Volume of CO_2 formed = 100 - 40 = 60 cm^3	1
	c	$C_xH_{2x}O_y + (x + x/2 - y/2)O_2 \longrightarrow xCO_2 + xH_2O$ $C_xH_{2x}O_y + [(3x/2) - (y/2)]O_2 \longrightarrow xCO_2 + xH_2O$ Volume of $C_xH_{2x}O_y$, reacted / volume of CO_2 formed = 1 / x 20 / 60 = 1 / x x = 3 Volume of $C_xH_{2x}O_y$, reacted / Volume of O_2 reacted = 1 / (3x / 2 - y / 2) 20 / 80 = 1 / (3x / 2 — y / 2) as x = 3 Y = 1 So, molecular formula of compound A is C_3H_6O	1 1
			(4)
10	a	Let y be the change of no. of mole 2y= 0.8 , y= 0.4 No. of mole of E = 2.0 - y= 1.60 No. of mole of F = 1.0 - 2y= 0.20	1
	b	$K_c = \dfrac{[G]^2}{[E][F]^2}$	1
	c	$K_c = \dfrac{(0.85/1.5)^2}{(2.50/1.5)(1.20/1.5)^2} = 0.301\ mol^{-1}\ dm^3$ (allow 0.299-0.304)	1 1

	d	***T_1*** Forward reaction is exothermic OR Backward reaction is endothermic (at ***T_2*** or lower temperature) (Equilibrium) shifted / moved to oppose reduction in temperature OR at ***T_1*** or higher temp, (Equilibrium) shifted / moved to oppose (increase in temp)	1 1
			(6)
11	ai	Any ONE Iron powder dissolved. / Gas bubbles evolved. / The solution pale green.	
	aii	$2Fe(s) + 3Cl_2(g) \rightarrow 2FeCl_3(s)$ / $Fe(s) + Cl_2(g) \rightarrow FeCl_2(s)$	1
	bi	An amphoteric compound can behave as an acid or as a base.	1
	bii	Aluminium oxide can react with acids. $Al_2O_3(s) + 6H^+(aq) — 2Al^{3+}(aq) + 3H_2O(l)$ Aluminium oxide also reacts with sodium hydroxide solution to give a complex salt. $Al_2O_3(s) + 2OH^-(aq) + 3H_2O(l) \longrightarrow 2[Al(OH)_4]^-(aq)$ / $Al_2O_3(s) + 2NaOH(aq) \longrightarrow 2NaAlO_2(s) + H_2O(l)$	1 1
			(5)
12			3
			(3)
13	a	carbonyl group and carbon-carbon double bond. / alkene and ketone	1
	b	 1 M for correct drawing of 3D structure; 1 M for correct indication of the *chiral carbon	2
	ci	ci  cii 	1
			(5)
14		A known volume of standard $Na_2S_2O_3$ solution is placed in a beaker inside a thermostatic bath at a certain temperature. A fixed volume of standard hydrochloric acid (also at temperature T) is then added to $Na_2S_2O_3$ solution. The mixture is swirled immediately and the stop watch is started. The beaker is placed on a white cardboard with a black cross so that the black cross can be easily viewed from the top. The formation of colloidal sulphur can blur out the black cross. The time taken for the complete disappearance of the black cross is inversely proportional to the rate. $average\ rate \propto \frac{1}{time\ taken\ for\ the\ black\ cross\ to\ blot\ out}$ The above procedure can be repeated at different temperatures and a graph of 1/t (s-1) (rate of reaction) against temperature (°C) of the reaction mixture can be plotted and monitored.	1 1 1 1

		Effective communication (only award for Chemical Knowledge > 3 or 4)	1
			(5)

Paper 2

1.(a) From Experiments 1 and 2, under the same initial concentration of Y(g), initial rate quadruple when the initial concentration of X(g) was doubled. Therefore, the reaction is second order with respect to X(g). [1]

From Experiments 1 and 3, under the same initial concentration of X(g), initial rate doubled when the initial concentration of Y(g) was doubled. Therefore, the reaction is first order with respect to Y(g). [1]

The rate equation for the reaction is rate = k[X(g)]^2[Y(g)]. Use the [1]

information given from Experiment 1,

$$k = \frac{6.20 \times 10^{-3}\ \text{mol dm}^{-3}\text{s}^{-1}}{(0.800/2\ \text{mol dm}^{-3})^2 \times (4.00/2\ \text{mol dm}^{-3})} [1]$$

$$= 0.0194\ \text{mol}^{-2}\ \text{dm}^{6}\ \text{s}^{-1} \qquad [1]$$

(must convert into conc. before substation if you need to find k)

W

b) i) $2NH_3(g)$ <-----> $3H_2(g)$ + $N_2(g)$ AH = +23kJ mol^{-1} [1]

(The Q asked you to write a thermochemical eqn of the tungsten catalysed reaction, so the catalyst W must be indicated on the eqn, besides ΔH = +23kJ mol^{-1} must be written on the R.H.S. of the eqn)

ii) Yes, since experiment showed that after adding Tungsten surface, ***an alternative pathway with a lower activation energy*** is obtained, hence Tungsten can speed up the rate of reaction. [1]

(Remember Don't say A suitable catalyst will not lower the activation energy of a reaction)

iii) There is no change in the yield of product formed [1] since catalysts will change the forward rate and backward rate to the same extent, hence no shift in equilibrium position. [1]

iv) By Arrhenius equation:

log k = log A - Ea/(2.3RT) [1]

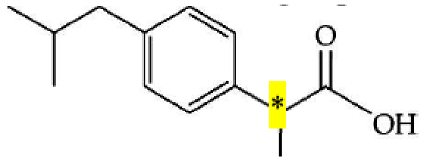
log 2 = log A– 35 x 1000/(2.3 x 8.31 x (273+125)) [1]

log 2= logA- 4.6

4.9 = log A

A = 79621.4 M^{-1} s^{-1} [1] with correct value and unit

c) (i)(I) It exhibits enantiomerism [1] because it has a chiral carbon (see * on the figure) which is attached to four different atoms or groups of atoms. [1]



(II) The enantiomers can be distinguished by using polarimetry. [1] (Don't write polarimeter which is the instrument's name)

lt is because the enantiomers rotate the plane polarized light to the same extent but to opposite directions. [1]

(C=C in benzene ring will never lead to cis-trans isomerism)

(ii) By green chemistry principle "Reducing derivatives": [1/2]

Method (I) involves six steps while the method (II) involves three steps only. [1/2] Therefore, method (I) will generate more derivatives and waste and require more reagents. [1/2]

By green chemistry principle "Using catalysts": [1/2]

Method (II) involves the use of palladium and nickel catalysts in 2 steps [1/2] while the method (I) involves only one catalyst A1Cl3 in one of the steps. [1/2] The use of catalyst can speed up the chemical reaction and get more products in a relatively shorter period of time.

By green chemistry principle "Waste Prevention":

Method (I) use more reagents in various steps which will generate more waste. Method (II) involves less reagents and chemicals and hence produce less waste

As a conclusion, method(II) is a greener method.[1]

(Don't forget to mention the principle name, start a new principle with a new paragraph);
and have a comparison sence by saying something on both methods;
and also a very simple sentence to elaborate what is the advantage of this principle)

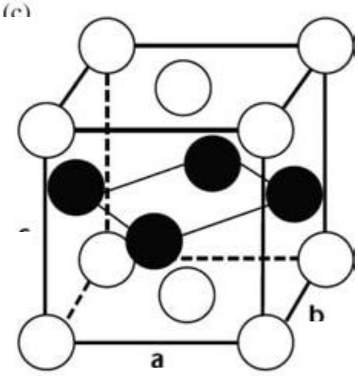
2. (a) (i) (1) A nanomaterial is an organic or inorganic material that has a particle size up to 100 nm. [1]
(2) Nanomaterials can provide a larger surface area for catalytic reactions. [1]

(ii) The liquid crystal molecules are oriented along the same direction and lie parallel to one another. They have no positional order. [1]

(iii) Compression moulding [1]

(iv) The hydroxyl groups in cellulose can attract water molecules by hydrogen bonds.[1]

(b) (i)



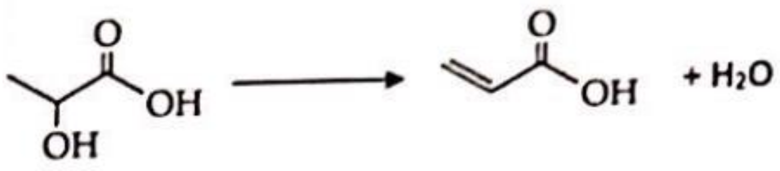
(ii) Body-centred cubic structure [1]

(iii) Cubic close-packed structure has a higher packing efficiency than body-centred cubic structure. At room temperature, the atoms are packed less closely. Hence, iron has a lower density at room temperature. [1]

(iv) In body-centred cubic structure number of iron atoms
= 8÷8+1 =2
Let Y cm be the length of a unit cell of iron.
Density = mass of atoms in a unit cell ÷ volume of the unit cell

$7.92 gcm^{-1} = (55.8 gmol^{-1} \div 6.02 x 10^{23} mol^{-1}) x 2 \div Y^3$
$Y = 2.86 \times 10^{-8} cm$

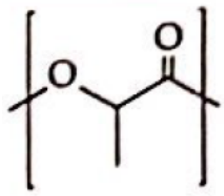
(c) (i)



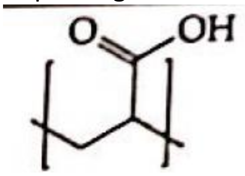
[1]

(c) (ii) (1)

Repeating unit of X [1]



Repeating unit of Y [1]



(c) (ii) (2)

Polymer X undergoes alkaline hydrolysis slowly. [1]

Polymer Y undergoes neutralization at once to form a sodium salt. [1]

(c) (ii) (3)

Polymer X is biodegradable [1]

Because it can be broken down by the enzymatic action of micro-organisms in nature [1]

(d) (i)

The atoms of transition metals in the same period have similar sizes. [1]

(d) (ii)

Brass is an alloy of copper and zinc. [1]

It is harder / more resistant to corrosion than copper. [1]

(Accept other reasonable answer)

3 (a)

Distinguish pentane from the rest:

Add water to all the 4 liquids separately . (1)

The one which is immiscible with water is pentane. (0.5)

The other 3 liquids are miscible with water (0.5)

Distinguish butan-1-amine from ethanal and propanone:

Treat each of the remaining 3 liquids separately with 2,4-dinitrophenylhydrazine.(1)

The ones which give an orange/red/yellow precipitate are ethanal and propanone.(0.5)

The one which does not give orange/ red/ yellow precipitate is butane-I-amine. (0.5)

Distinguish between ethanal and propanone:

Warm each of the above two liquids separately with an acidified aqueous solution of potassium dichromate. (1)

The one that turns the dichromate solution from orange to green is ethanal. (0.5)

The one with no observable change is propanone . (0.5)

(b) (i)For X : Rf= 0.6 = 4.5/solvent front

Solvent front =4.5/0.6 =7.5 (1)

For Y: The spot has moved 4.5 +1 = 5.5 cm

Rf= 5.5/7.5 = 0.733 (1)

(ii) Gas chromatograph-mass spectrometry (1)

(Mass spectrometry is not accepted. Since separation of a particular protein from other protein is needed before conducting mass spectrometry, hence gas chromatography is performed right before mass spectrometry)

(c) (i) The molecular ion peak at m/e = 122 indicates the molecular mass of X = 122

Since the empirical formula of solid X is $C_7H_6O_2$.

Let the molecular formula of X be $(C_7H_6O_2)n$

(12 x 7 + 6 + 2 x16) n = 122 (1/2) (but not $(C_7H_6O_2)n = 122$)

n = 1

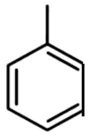
molecular formula is $C_7H_6O_2$ (1/2)

(ii) X does not react with 2,4-dinitrophenylhydrazine, it has no carbonyl group [1/2]

The peak at m/e = 77 is due to $C_6H_5^+$ ion (1)

After stripping off the C_6H_5 — fragment **from the molecular ion,** CHO_2 — remains . (1/2)

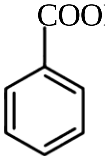
Or The peak at m/e = 105 (M-17) is due to CO+ which is formed by



stripping off a —O H group from the molecular ion.

(Can only write stripping off a group or fragment but Never write stripping off an ions)

Hence X is COOH (1)



iii) Any ONE of the following: (1)

Solid X has a high solubility in the solvent while the impurities do not. The solubility of solid X in the solvent is high at high temperatures but low at room temperature. The solvent does not react with solid X.

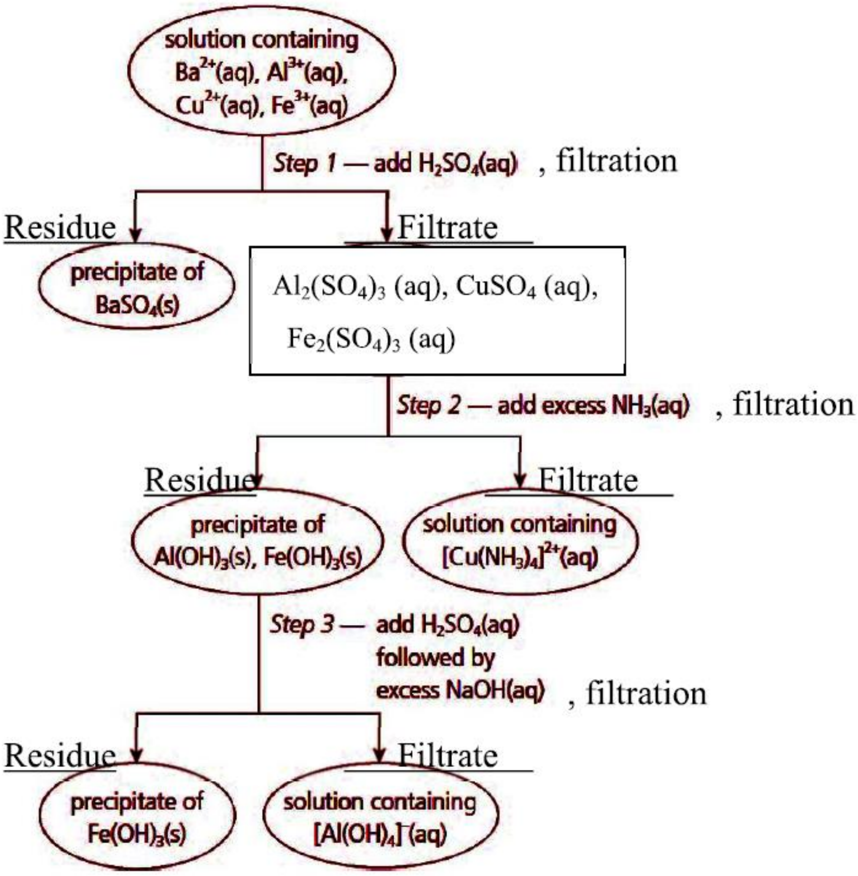
(d) "Hint: Look into the properties of the cations:

Ba^{2+} (aq) ions form an insoluble sulphate.

Al^{3+}(aq) ions form an insoluble hydroxide with aqueous solution of sodium hydroxide and the hydroxide is soluble in an excess of the alkali.

Cu^{2+}(aq) ions form an insoluble hydroxide with aqueous ammonia and the hydroxide is soluble in an excess of the alkali.

Fe^{3+}(aq) ions form an insoluble hydroxide with both aqueous solution of sodium hydroxide and aqueous ammonia."



(1/2 mark for each step and each correct resulting species stated; appropriate steps in a different order is also acceptable) x 10