SOLUTION TO 5070/42/M/J/20

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Q1

	ANSWER	NOTES
a	A. Burette B. Measuring cylinder C. Pipette	
b (i)	Dilute Sulfuric acid is used to provide H^+ ions for the reaction.	$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$
(ii)	MnO_4^-	Manganate ions are dark pink / purple in colour.
(iii)	↓	

titration number	1	2	3	4
final burette reading / cm^3	17.2	34.1	17.1	16.9
initial burette reading / cm^3	0.0	17.2	0.7	0.2
volume of 0.600 mol / dm^3 hydrochloric acid	17.2	16.9	16.4	16.7
best titration results (✓)		✓		✓

(iv)	Average volume = (16.9 + 16.7) ÷ 2 = 16.8 cm^3	The best titration results are the ones that are most close to each other.

Q1		
	ANSWER	**NOTES**
c (i)	Average titre value = 16.9 cm^3 = 0.0169 dm^3 n (MnO_4^-) = 0.00500 × 0.0169 = 0.0000845	Number of moles, n = Concentration × Volume
(ii)	mole ratio 1 MnO_4^- : 5 Fe^{2+} n (Fe^{2+}) = 5 × 0.0000845 = 0.0004225	
(iii)	mass of Fe^{2+} ions in 25.0 cm^3 sample of solution = 0.0004225 × 56 = 0.0237 g total mass of Fe^{2+} ions in the five tablets = 0.237 × 10 = 0.237 g	Mass of Fe^{2+} ion = Mass of Fe atom (electrons have a negligible mass which is considered to be zero for practical calculations) total mass of Fe^{2+} ions in the five tablets = mass of Fe^{2+} ions in 250.0 cm^3 of solution
(iv)	percentage, by mass, of iron in the tablets $= \frac{0.237}{1.83} \times 100$ = 12.9 %	

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Q2		
	ANSWER	**NOTES**
a (i)	Green precipitate	Fe^{2+} ions react with OH^- ions to form a green precipitate of $Fe(OH)_2$.
(ii)	The gas evolved is carbon dioxide. The solution contains carbonate ions.	Acid + carbonate → carbon dioxide gas Carbon dioxide gas turns limewater milky.
(iii)	The solution contains Sulfate ions.	Barium ions react with sulfate ions to form a white precipitate of Barium sulfate.
b	Dissolve the sample in distilled water. **test for Ca^{2+}** Add aqueous sodium hydroxide and warm. White ppt, insoluble in excess confirms Ca^{2+} **test for NH_4^+** Add aqueous sodium hydroxide and warm. Test gas evolved (Ammonia) with moist red litmus. If litmus turns blue presence of NH_4^+ is confirmed. **test for NO_3^-** Add aqueous sodium hydroxide and warm until no more gas (ammonia) is evolved. Add aluminium and warm. Test gas evolved with moist red litmus. If litmus turns blue presence of NO_3^- is confirmed.	**test for Ca^{2+}** Calcium ions react with hydroxide ions forming white precipitate of Calcium hydroxide, $Ca(OH)_2$. **test for NH_4^+** Sodium hydroxide can displace Ammonia from a solution containing Ammonium ions. This is a characteristic reaction of bases. **test for NO_3^-** Test for NO_3^- is similar to the test for NH_4^+. It is therefore essential to drive away the Ammonia from the solution before addition of Aluminium. In the presence of Ammonium ions, a false positive result will be obtained even if nitrate ions are absent.

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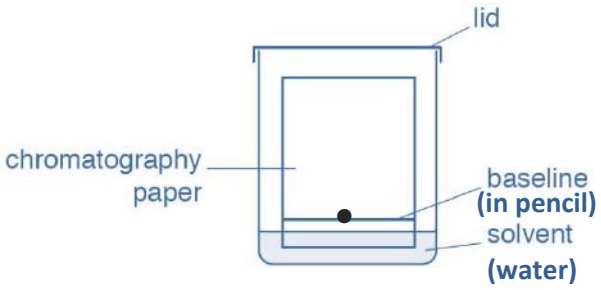
Q3		
	ANSWER	**NOTES**
a	Fractional distillation Ethanol and water have different boiling points. Ethanol boils off before water and can thus be separated from it.	A mixture of miscible liquids with different boiling points can be separated by fractional distillation. The boiling point of Ethanol is 78°C while that of water is 100°C.
b (i)	The mixture is added to sufficient quantity of distilled water taken in a beaker with stirring. The Sodium chloride dissolves while the sand doesn't. The mixture is filtered. The filtrate obtained is a solution of Sodium chloride while sand is the residue. The filtrate is heated in an evaporating dish till some solid appears. It is cooled for crystals to form. The crystals are dried by pressing between dry filter papers.	
(ii)	The food colouring can be separated from the mixture by chromatography. It is spotted onto a chromatography paper on a baseline made in pencil. The paper is immersed in water taken in a beaker with the baseline above the water level. The chromatogram is run till the water rises to upto ¾ ths of the chromatography paper. The different colouring have different solubilities in water and therefore travel different distances up the chromatography paper.	

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Q4		
	ANSWER	**NOTES**
a	Warm / heat the mixture gently.	
b	Keep adding solid Copper(II) oxide until in excess. Some of the black solid remains unreacted / does not dissolve in the acid.	Excess → more than required CuO is added until some of the black solid remains unreacted / does not dissolve in the acid.
c	The mixture needs to be filtered after step 2 to remove the excess (undissolved/unreacted) CuO.	
d	The student should heat the salt solution to the point of saturation (till some solid appears) for crystals to form. The saturated solution should then be allowed to cool slowly for the rest of the solvent to evaporate and for crystals to form. The crystals can be dried by pressing gently between dry filter papers.	
e	Observation 1: seen at step 2 The solution starts turning blue from colourless. Some black solid remains undissolved. Observation 2: seen at step 3 Blue crystals form.	Copper oxide is a black solid. It reacts with dilute Sulfuric acid to form Copper(II) sulfate which forms a blue-coloured solution. Once all of the acid has reacted, some of the Copper oxide remains unreacted and can be seen as a black solid. Blue crystals of Copper(II) sulfate form at step 3.

Q4		
	ANSWER	**NOTES**
f	The Sulfuric acid is corrosive. Eye protection must be used. Any spillage must be washed with copious quantities of water. The process involves heating. Hot apparatus must be handled using tongs / heat resistant gloves. Copper salts are toxic. A face mask must be worn to prevent accidental ingestion.	

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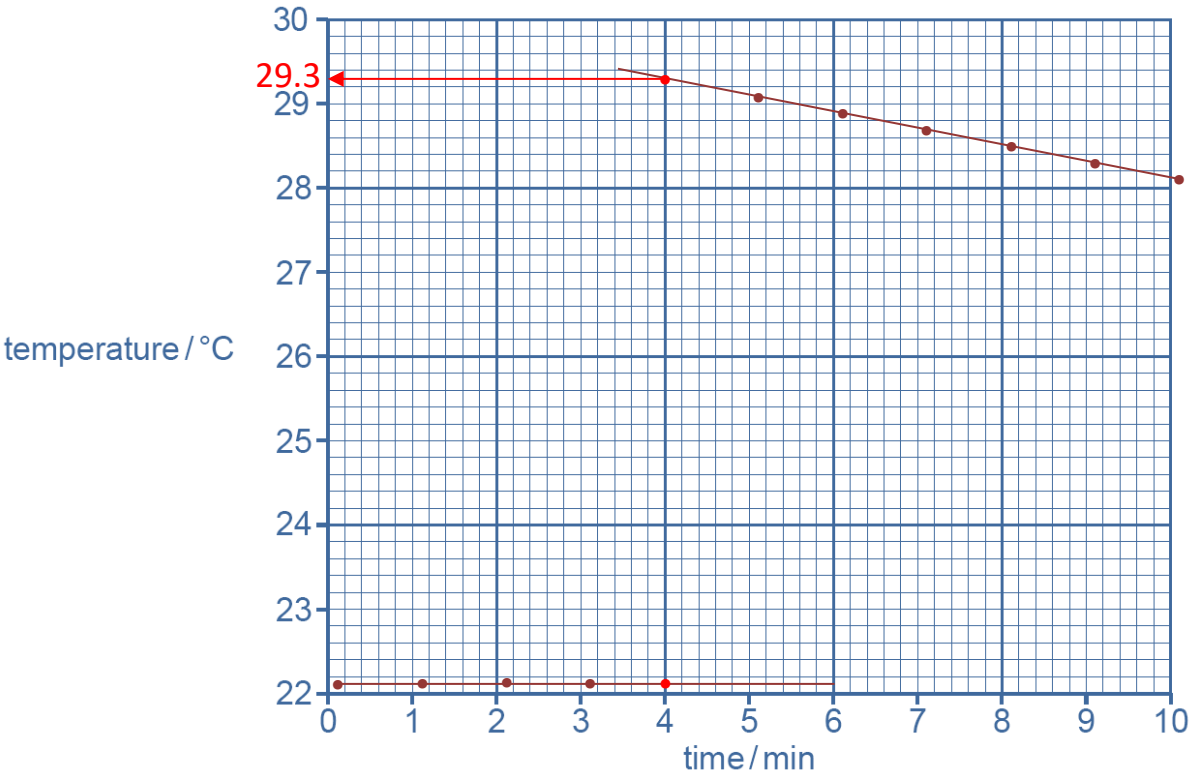
Q5		
	ANSWER	**NOTES**
a	The blue colour of the solution fades away. A pink-brown solid forms.	$CuSO_4$ (aq) is blue. $ZnSO_4$ (aq) is colourless. Cu is a pink-brown solid.
b (i)	15.18 – 14.23 = 0.95 g	
(ii)	The zinc was added at 4 minutes.	
(iii)	Powdered Zinc has a greater surface area. The rate of the reaction increases by using powdered Zinc.	Powdered Zinc has a greater surface area. This increases the number of reacting Zn particles per unit volume. The collision rate increases. More successful collisions occur resulting in faster reaction rate.
(iv)	Glass is not a very good insulator of heat. **Improvement:** A polystyrene cup with a lid can be used instead of a glass beaker.	Polystyrene or Styrofoam cup is a better insulator than glass.

Q5

	ANSWER	NOTES
b	↓	
(v)		
(vi)	Done on grid	
(vii)	Done on grid	
(viii)	29.3 – 22.1 = 7.2°C	
(ix)	q = mcΔT q = 25.0 × 4.2 × 7.2 = 756 J	
(x)	Volume of $CuSO_4$ = 25.0 cm^3 = 0.025 dm^3 n ($CuSO_4$) = 0.025 × 0.500 = 0.0125	

Q5 (continued from previous page)		
	ANSWER	**NOTES**
b (xi)	Enthalpy change = $\frac{q}{n}$ q = 756 J = 0.756 kJ Enthalpy change = $\frac{0.756}{0.0125}$ = –60.48 kJ /mol	The reaction is exothermic, hence enthalpy change is negative.
c	Loss of heat energy to the surroundings occurs. **OR** The reaction may be incomplete as some of the Zinc may have been coated by Copper.	

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