Answers and Solutions

Question	Answer and Solution	Mark allocation
A1		**[Total: 4]**
(a)	A	[1]
(b)	D	[1]
(c)	E	[1]
(d)	B	[1]
A2		**[Total: 9]**
(a)	$2Cu_2S\ (s) + 3O_2\ (g) \rightarrow 2Cu_2O\ (s) + 2SO_2\ (g)$	[1] correct equation [1] correct state symbols
(b)	Suggested solution: Test: Use acidified potassium manganate(VII) solution Observation: purple $KMnO_4$ turns colourless	[1] [1]
(c)	Harmful effect to health: Triggers asthma attacks, respiratory problems (breathing difficulty) Harmful effect to environment: Leads to production of acid rain	[1] [1]
(d)	moles of $SO_2 = \frac{22 \times 10^6}{64} = 343\ 750$ mole ratio SO_2 : CaO = 1:1 moles of CaO = 343 750 mass of CaO $= \frac{343\ 750 \times (40+16)}{1000} =$ **19250 kg**	[1] moles of SO_2 [1] moles of CaO [1] 19250 kg
A3		**[Total: 6]**
(a)	covalent	[1]
(b)	Y – oxygen; Z – carbon	[1]; [1]
(c)	COH_2	[1]
(d)	This compound... / has a low boiling point: true ✓ / has good electrical conductivity when molten: false ✓ / is very soluble in water: true (✓), false ✓ / is a crystalline solid at room temperature: false ✓	[½] per correct tick; subtotal [2] *Accept TRUE for 'soluble in water'*, for ethanoic acid

Question	Answer and Solution	Mark allocation
A4		**[Total: 5]**
(a)	C	[1]
(b)	C	[1]
(c)	D	[1]
(d)	C and E	[1], [1]
A5		**[Total: 10]**
(a)	bromine, chlorine, iodine	[1]
(b)(i)	Either one: chlorine or fluorine - more reactive than bromine (NOT 'above bromine in Group VII')	[1] [1]
(b)(ii)	Either one: $F_2 + 2Br^- \rightarrow 2F^- + Br_2$ $Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$	[1]
(c)(i)	Any metal above aluminium in the reactivity series: potassium / sodium / calcium / magnesium	[1]
(c)(ii)	$2\ Al\ (s) + Fe_2O_3\ (s) \rightarrow 2\ Fe\ (l) + Al_2O_3\ (s)$ 100 kg of Al = 3704 moles ∴ moles of Fe_2O_3 = 1852 mass of Fe_2O_3 = 296 kg **Limiting reactant: iron(III) oxide** OR 100 kg of Fe_2O_3 = 625 moles ∴ moles of Al = 1250 moles mass of Al = 33.75 kg **Reactant in excess : Al** Using 625 moles of Fe_2O_3, moles of Al_2O_3 = 625 (mole ratio $Fe_2O_3 : Al_2O_3$ = 1:1) theoretical yield of Al_2O_3 = 625 × 102 = 63 750 g (or 63.75 kg) % yield of Al_2O_3 = (50 kg / 63.75 kg) × 100 % = **78.4%** (to 3 s.f.)	[1] calculation to find either limiting reactant [Fe_2O_3] or reactant in excess [Al] **(allow ECF if Al is incorrectly determined to be the limiting reactant; award M1)** [M1] mole of Al_2O_3 = mole of Fe_2O_3 = 625 M_r of Al_2O_3 = 2(27) + 3(16) = 102 [M1] theoretical yield of Al_2O_3 [M1] %yield $= \frac{actual\ yield}{theoretical\ yield} \times 100\%$ [1] 78.4%

Question	Answer and Solution	Mark allocation
A6		[Total: 11]
(a)(i)	$2Cl^-$ (l) → Cl_2 (g) + 2e	[1] balanced equation [1] correct state symbols
(a)(ii)	test: moist blue litmus observations: blue litmus turns red and bleached	[1] accept red litmus [1] bleaching effect of chlorine
(b)(i)	Decreases amount of electrical energy needed to keep electrolyte molten.	[1] Lower energy demands
(b)(ii)	Calcium. Present as impurity in electrolyte and will also get discharged at cathode.	[1] [1]
(c)(i)	M is more reactive than copper and/or metal X.	[1] answer must show comparison between metals
(c)(ii)	Add (a piece of) copper into XSO_4 solution. If grey deposit (X) formed on copper and green solution fades / turns blue, copper is more reactive than X. If no observable change, then copper is less reactive than X. OR Add a piece of X into copper(II) sulfate solution. If pink deposit (Cu) is formed on X and blue solution fades / turns green, X is more reactive than copper. If no observable change, then X is less reactive than copper.	[1] addition of metal 1 into salt solution of metal 2 [1] correctly describes results (colour change of solution, appearance of deposit) to support order of reactivity [1] include observation for negative test
A7		[Total: 5]
(a)	Alloy is a mixture of a metal and one or more elements.	[1]
(b)	Protective layer / barrier; prevents oxygen and water from coming in contact and reacting with iron.	[1] [1]
(c)	Zinc is more reactive than iron, hence will corrode preferentially / corrodes in place of iron / provides sacrificial protection	[1] [1]
B8		[Total: 12]
(a)	(i) Oxidation state of N decreases from +5 in KNO_3 to 0 in N_2. Hence KNO_3 has gone through reduction. (ii) For every mole of KNO_3, 1.25 mole of O_2 produced. For every mole of $KClO_4$, 2 moles of O_2 produced. OR KNO_3 does not release all of its oxygen atoms as its forms K_2O, but $KClO_4$ does.	[1] [1] more (moles/amount) of oxygen for potassium perchlorate

Question	Answer and Solution	Mark allocation
B8		[Total: 12]
(b)	(i) *Energy profile diagram for exothermic reaction.* *Correct reactant(s) and product(s)* *Correct enthalpy change for either S or C*	[1] [1] [1]
	(ii) in 1 kg of black powder, mass of carbon = 15% of 1 kg = 150 g mass of sulfur = 10% of 1 kg = 100 g Energy produced for combustion of 1g of: carbon = (−393 ÷ 12) = − 32.75 kJ sulfur = (−2368 ÷ 32) = − 74 kJ Total energy released = (150 × 32.75) + (100 × 74) = 12,312.5 kJ > 10,000 kJ (shown)	[1] mass on carbon and mass of sulfur in 1 kg (based on percentage by mass) [1] energy produced per g of carbon and sulfur [1] calculation to show sum of energy released > 10,000 kJ
(c)	Mixture 1: orange/red flame, not so bright Mixture 2: blue/green, very bright flame	[1] [1]
(d)	Decomposition of KNO_3 produces oxygen, which reacts with atmospheric nitrogen or nitrogen produced during decomposition of KNO_3, at high temperature (due to highly exothermic reaction) to produce nitrogen oxides.	[1] [1]
B9		[Total: 8]
(a)	silver nitrate	[1]
(b)	**Experiment 1** Anode: $4OH^-$ (aq) → O_2 (g) + $2H_2O$ (l) + 4e Cathode: Ag^+ (aq) + e → Ag (s) **Experiment 2** Anode: Ag (s) → Ag^+ (aq) + e Cathode: Ag^+ (aq) + e → Ag (s)	[1] at least 3 correct state symbols [1] anode, **expt 1** [1] anode, **expt 2** [1] cathode, **expt 1 or 2**
(c)	**Experiment 1:** at anode mole ratio e: O_2 = 4 : 1 at cathode mole ratio e : Ag = 1 : 1 so for every 4 mol of electrons, **4 mol of Ag** is deposited hence overall, mole ratio O_2 : Ag = 1 : 4 100 cm^3 of O_2 = $\frac{100}{24000} \approx 0.004167$ mol gain in mass at cathode = mass of silver deposited = (0.004167 × 4) × 108 = **1.8 g**	[1] mole ratio of O_2 : Ag OR identifying moles of Ag = 4 × **moles of oxygen** [1] moles of oxygen gas [1]

Question	Answer and Solution	Mark allocation
B10	Either	[Total: 10]
(a)	(i) Group I (ii) By electrolysis. Group I metals highly reactive / forms very stable compounds that can only be decomposed by electrolysis.	[1] Group number must be in roman numeral [1] [1] reactivity of Group I or stability of Group I compounds
(b)	Titrate 25.0 cm^3 of aqueous M_2CO_3 with hydrochloric acid, HCl, with use of a suitable indicator (e.g. methyl orange), to find volume of acid needed for neutralisation. Add 25.0 cm^3 of aqueous M_2CO_3 and determined volume of acid to produce MCl solution. Evaporate some water to saturate the MCl solution. Cool the saturated solution for crystals to form.	[1] use of hydrochloric acid [1] method – titration [1] saturated salt solution [1] cooling the solution
(c)	moles of chlorine atoms = (1.42 ÷ 35.5) = 0.04 mass of M = 6.72 g – 1.42 g = 5.3 g mole ratio M : Cl = 1 : 1 / moles of M = 0.04 A_r of M = (5.3 ÷ 0.04) = 132.5	[1] [1] [1]
B10	OR	[Total: 10]
(a)	Rate increases. Higher pressure, more reacting particles per unit volume, higher frequency / number of effective collisions per unit time. NOT: more reacting particles possessing activation energy / ↑ pressure = particles move faster / gain K.E. (wrong concept)	[1] [1]
(b)	(i) enthalpy is negative/ reaction is exothermic (ii) powdered catalyst (smaller particle size) provides greater surface area for a faster reaction	[1] [1]
(c)	ammonia is alkaline; pH of the solution in reacting vessel should decrease as ammonia gas is used up.	[1] [1]
(d)	moles of NO = 720 ÷ 24 = 30 mole ratio of NO : HNO_3 = 1 : 1 maximum mass of HNO_3 = 30 × (63) = **1890 g**	[1] [1] [1]
(e)	$4NH_3 (g) + 8O_2 (g) \rightarrow 4HNO_3 (aq) + 4H_2O (g)$ OR $NH_3 (g) + 2O_2 (g) \rightarrow HNO_3 (aq) + H_2O (g)$	[1]
	End of Answers and Marking Scheme	

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PRELIMINARY EXAM 2020 PAPER 1 MARK SCHEME

Question	Answer	Question	Answer
1	A	21	B
2	A	22	D
3	C	23	C
4	D	24	D
5	B	25	A
6	C	26	D
7	B	27	A
8	C	28	B
9	B	29	B
10	D	30	A
11	C	31	D
12	A	32	B
13	C	33	C
14	D	34	C
15	B	35	D
16	D	36	A
17	D	37	C
18	B	38	C
19	C	39	A
20	D	40	B