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Mark Scheme (Results)
January 2010

GCE O

GCE O Chemistry (7081) Paper 02

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January 2010

Question Number		Acceptable Answers	Mark
1	(a)	any carbonate / $NaHCO_3$ / $KHCO_3$ *(name or formula)*	(1)
		<u>conc</u> H_2SO_4 / <u>anhydrous</u> $CaCl_2$ / silica gel /P_2O_5	(1)
		gas syringe / downward delivery / upward displacement of air	(1)
			(3)
	(b)	white precipitate / milky precipitate / goes milky / goes cloudy	(1)
		$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$	(1)
		precipitate dissolves / colourless solution formed / cloudiness disappears / milkyness goes	(1)
		$CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$	(1)
			(4)
	(c)	carbon monoxide / CO	(1)
		$C + CO_2 \rightarrow 2CO$	(1)
		$2CO + O_2 \rightarrow 2CO_2$	(1)
		(equations dependent on correct identity of CO)	**(3)**

(Total 10 Marks)

Question Number			Acceptable Answers	Mark
2	(a)	(i)	$Mg \rightarrow Mg^{2+} + 2e$ OR $Mg - 2e \rightarrow Mg^{2+}$	(1)
			$S + 2e \rightarrow S^{2-}$ *(do not allow $S \rightarrow S^{2-} - 2e$)*	(1)
		(ii)	formation of Mg^{2+} because it is loss of electrons / oxidation state of Mg increases *(part (ii) dependent on correct answer to Mg equation)*	(1)
				(3)
	(b)	M1	Sulphur	(1)
		M2	$S + O_2 \rightarrow SO_2$ OR $2S + 3O_2 \rightarrow 2SO_3$	(1)
		M3	$SO_2 + H_2O \rightarrow H_2SO_3$ OR $SO_3 + H_2O \rightarrow H_2SO_4$	(1)
			(if Mg given, allow) *M2* *$2Mg + O_2 \rightarrow 2MgO$ (1)* *M3* *$MgO + H_2O \rightarrow Mg(OH)_2$ (1)*	**(3)**
	(c)	M1	At least 2 orderly rows of 'circles'	(1)
		M2	labelled Mg^{2+} ions in 'circles'	(1)
		M3	labelled delocalised / sea of electrons / electron cloud between 'circles'	(1)
		M4	electrons move / flow / are mobile (and carry current) *(M4 not just free electrons)* *(allow M1 for 2 orderly row of circles if labelled incorrectly for eg with Mg atoms or Mg^{2-} ions,* *do not allow M1 if diagrams are for ionic Mg compounds* *allow M3 if electrons labelled on diagrams or appear as - signs and delocalisation mentioned in M4)*	(1)
				(4)

(Total 10 Marks)

This question tests practical knowledge not theoretical.

Question Number			Acceptable Answers		Mark
3	(a)	M1	conditions	pass mixture over **heated/hot** copper	(1)
		M2	Apparatus	using two gas syringes with copper in a tube between them / use a combustion tube (or similar) with gas passing over copper	(1)
		M3	Collection	collect nitrogen in syringe / over water / (upward/downward) displacement of water *(if syringe expt used, allow N_2 remains in syringe)*	(1)
		M4	Equation	$2Cu + O_2 \rightarrow 2CuO$ *(fractional distillation scores zero)*	(1)
					(4)
	(b)	M1	Conditions/apparatus	bubble gases through **aqueous** NaOH / through solid NaOH in a U-tube or drying tower	(1)
		M2	Collection	collect oxygen in syringe / over water (upward/downward) displacement of water	(1)
		M3	Equation	$2NaOH + SO_2 \rightarrow Na_2SO_3 + H_2O$ OR $NaOH + SO_2 \rightarrow NaHSO_3$	(1)
					(3)
	(c)	M1	Conditions	heat	(1)
		M2	Apparatus	in test-tube (or similar) / evaporating basin	(1)
		M3	Collection	collect I_2 / condense I_2 on a <u>cool</u> surface	(1)
					(3)

(Total 10 Marks)

the equation marks in (i) and (ii) are stand alone marks

Question Number			Acceptable Answers	Mark
4	(a)	M1	P = 56.4/31 O = 43.6/16 *(divide by A_r)*	(1)
		M2	= 1.82 = 2.73 = 2 = 3	(1)
		M3	Formula P_2O_3 *(M3 **not** consequential on M2)* *(M1 divide by atomic number scores zero)*	(1)
				(3)
	(b)	(i)	bond between two non-metals / there is e^- sharing	(1)
				(1)
		(ii)M1	3 bond pairs correct	(1)
		M2	all outer electrons correct (M2 dependant on M1)	(1)
				(2)
	(c)	(i)	bond between a metal and non-metal / there is e^- transfer <u>from Na to Cl</u>	(1)
		(ii) M1	**strong** attraction between Na^+ and Cl^- / ions *(any reference to intermolecular forces or molecules loses M1)*	(1)
		M2	**weak intermolecular forces**, etc in PCl_3. *(any reference to breaking of covalent bonds or molecules contain weak covalent bonds loses M2)*	(1)
		M3	much energy / heat needed to loosen / separate particles in NaCl (or converse for PCl_3) intermolecular forces are easy to break *(M3 dependent on M1 and M2)* *(ionic bonds stronger than covalent bonds scores zero)*	(1)
				(4)

(Total 10 Marks)

Question Number			Acceptable Answers	Mark
5	(a)		potassium nitrate/KNO_3	(1)
	(b)		in range 75-85^{0}C	(1)
	(c)		21 g	(1)
	(d)		50^{0}C	(1)
	(e)	M1	50^{0}C 49ºC *(penalise incorrect units)* *(allow 50º)*	(1)
		M2	solution becomes saturated / maximum amount dissolved at this temperature / solubility is 17 g/100 g / 17g dissolve in 100 g water solubility is 8.5 g/50g / 8.5g dissolve in 50g water saturated solution formed at 50 ^{0}C *(M2 dependent on M1)*	(1)
	(f)	(i) M1	30 g / all NaCl dissolves *(do not allow 35g)*	(1)
		M2	21 g / some of KNO_3 dissolves / 9 g KNO_3 undissolved	(1)
		(ii) M3	all dissolved *(allow KNO_3 dissolves completely if M1 scored in part (i))*	(1)
		(iii) M4	NaCl crystallises out	(1)

(Total 10 Marks)

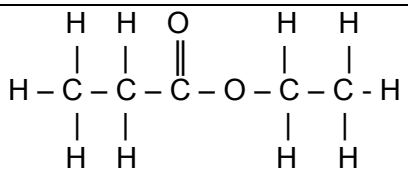
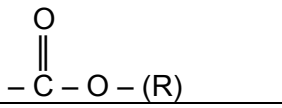
SECTION B

Question Number			Acceptable Answers	Mark
6	(a)	(i) M1	Reaction 1 blue solution	(1)
		M2	Brown / red-brown / orange-brown gas	(1)
		M3	Reaction 2 black solid / deposit	(1)
		M4	Brown / red-brown / orange-brown gas	(1)
				(4)
		(ii) M1	add **excess** copper to nitric acid	(1)
		M2	filter off (excess copper) *(M2 dependent on M1)* *(filter off excess Cu scores M1 and M2)*	(1)
		M3	evaporate solution to crystallising point / partially evaporate *(allow evaporate to dryness but lose M4/M5)*	(1)
		M4	Cool	(1)
		M5	(remove crystals and) dry using filter paper / leave in a warm place / leave to dry / dry	(1)
				(5)
		(iii) M1	63.5 g Cu → 79.5 g CuO *(recognition of 1 : 1 ratio)*	(1)
		M2	Mass of CuO = $\frac{12.7 \times 79.5}{63.5}$	(1)
		M3	Answer = 15.9 g *(see NB! below for ans = 16)*	(1)
				(3)
			ALTERNATIVE METHOD	
		M1	Moles of Cu = 12.7/63.5 = 0.20	(1)
		M2	Moles of CuO = 0.20 *(M2 = M1)*	(1)
		M3	Mass of CuO = 0.20 x 79.5 = 15.9g *(M2 x 79.5)* NB! *(if A_r of Cu taken as 64, max (2) ie answer 16.0g)*	(1)

	(b)	M1	mass w. of c. = 1.08 g	(1)
		M2	M_r $Cu(NO_3)_2$ = 187.5	(1)
		M3	$Cu(NO_3)_2$ = 3.75/187.5 = 0.02 H_2O = 1.08/18 = 0.06	(1)
		M4	Ratio 1 : 3 x = 3	(1)
			ALTERNATIVE METHOD for M3/M4	**(4)**
		M3	Mass of xH_2O = $\frac{187.5 \times 1.08}{3.75}$ = 54 g	(1)
		M4	x = 54 / 18 = 3	(1)
	(c)	M1	Type redox / acid-base / neutralisation	(1)
		M2	Observation blue solution	(1)
		M3	brown / red-brown / pink-brown / pink solid / deposit*(do not allow red)*	(1)
		M4	Separation filter off copper	(1)
		M5	Test Cu conducts electricity	(1)
				(5)
	(d)	M1	<u>blue ppt</u>.	(1)
		M2	$Cu^{2+} + 2OH^- \rightarrow Cu(OH)_2$	(1)
		M3	(dissolves in excess) to form a deep blue solution	(1)
		M4	$[Cu(NH_3)_4(H_2O)_2]^{2+}$ OR $[Cu(NH_3)_4(H_2O)_2]SO_4$ *(do not allow $[Cu(NH_3)_4.2H_2O]$.*	(1)
				(4)

(Total 25 Marks)

Question Number			Acceptable Answers				Mark
7	(a)	(i) M1	Name fractional distillation				(1)
		M2	crude oil heated to **vaporise** / evaporate crude oil is vaporised / evaporate				(1)
		M3	use of <u>fractionating column</u> / <u>fractionating tower</u> *(do not allow furnace)*				(1)
		M4	fractions condense at different boiling points / separation according to boiling points *(do not allow at different temperatures)*				(1)
		M5	lowest b.pt. / shortest chain / smallest /most volatile lighter molecules at top of column OR distils off first *(could score M4 if stated that low bp at top and high bp at bottom)*				(1) **(5)**
		(ii) M1	Name cracking				(1)
		M2	high temperature / 400 - 900°				(1)
		M3	high pressure / catalyst				(1)
		M4	name / formula of alkane to be cracked *(can be scored on left in equation, M5)*				(1)
		M5	an equation showing formation of ethene				(1)
							(5)
			NB! If type of cracking is specified				
			M1 Thermal cracking		M1 Catalytic cracking		
			M2 high temperature / 450 - 900°C		M2 high temperature / 400 - 500°C		
			M3 high pressure		M3 (zeolite / alumino Silicate / Al_2O_3 + SiO_2 / Al_2O_3) catalyst		
		(iii) M1	Name hydration / addition / hydrolysis				(1)
		M2	(ethene) + water / steam				(1)
		M3	temperature of 250-500^{0}C				(1)
		M4	pressure of 40-100atm				(1)
		M5	(phosphoric / H_3PO_4) acid catalyst				(1)
		M6	$C_2H_4 + H_2O \rightarrow C_2H_5OH$ *(accept $CH_2=CH_2$ and CH_3CH_2OH, but NOT CH_2CH_2 nor C_2H_6O)*				(1) **(6)**

	(b)	(i)	sodium ethoxide / C_2H_5ONa / CH_3CH_2ONa	(1)
		(ii)	ethanoic acid / CH_3COOH / ethanal / CH_3CHO	(1)
		(iii)	(1-)(mono)chloroethane / ethyl chloride / C_2H_5Cl / CH_3CH_2Cl *(if name and formula given, both must be correct to score* *ignore any inorganic products)*	(1)
				(3)
	(c)	M1	Heat (under reflux / over water bath) / warm / *(not high T)*	(1)
		M2	**conc.** H_2SO_4 (catalyst) *(not catalyst alone)*	(1)
		M3	ethyl propanoate *(must be spelt correctly)*	(1)
		M4	$CH_3CH_2COOH + CH_3CH_2OH \rightarrow CH_3CH_2COOCH_2CH_3 + H_2O$ *(accept, C_2H_5COOH and C_2H_5OH and $C_2H_5COOC_2H_5$)*	(1)
		M5	 *(M5 can be scored in the equation)*	(1)
		M6	circle around ester linkage  *(can be scored in the equation)*	(1)
				(6)

(Total 25 Marks)

Question Number			Acceptable Answers		Mark
8	(a)	(i) M1	$2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$		(1)
		M2	$ZnO + C \rightarrow Zn + CO$ $2ZnO + C \rightarrow 2Zn + CO_2$ $ZnO + CO \rightarrow Zn + CO_2$		(1)
		M3	high temperature / 1000-1500^{0}C / red hot *(not heat)*		(1)
		M4	zinc distils off / Zn condensed / Zn vaporises / comes off as gas *(look for (g) phase)*		(1)
		M5	coke (carbon) is a reducing agent / reduces ZnO		(1)
		M6	coke (carbon) removes oxygen / reacts with oxygen causes the oxidation state of Zn to decrease		(1)
		M7	SO_2 forms acid rain / toxic / CO toxic or forms carboxy haemoglobin / CO_2 causes global warming or greenhouse effect *(penalise contradictions do not allow general statements, eg CO is harmful)*		(1)
					(7)
		(ii) M1	SO_2 + **air** *(not O_2)*		(1)
		M2	300-500^{0}C		(1)
		M3	1-3 atm pressure		(1)
		M4	vanadium(V) oxide catalyst *(do not allow other oxidation states of vanadium)*		(1)
		M5	$2SO_2 + O_2 \rightarrow 2SO_3$ (reversed arrows not essential)		(1)
		M6	dissolve SO_3 in (97%) 98% / conc. H_2SO_4		(1)
		M7	add water / dilute (to required concentration)		(1)
		M8	$SO_3 + H_2O \rightarrow H_2SO_4$	$SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$ $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$	(1)
					(8)

	(b)	(i) M1	bubbles / effervescence *(not gas given off)*	(1)
		M2	gas is hydrogen / H_2	(1)
		M3	gas + lighted splint gives 'pop' / gas burns with a 'pop' *(not glowing splint)*	(1)
		M4	$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$ / $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$	(1)
		M5	$2H_2 + O_2 \rightarrow 2H_2O$	(1)
				(5)
		(ii) M1	(iron +) water and air / oxygen	(1)
		M2	**NAME** (hydrated) iron(III) oxide	(1)
		M3	galvanise / coat with zinc	(1)
		M4	zinc more reactive than iron / higher in reactivity series / zinc is a stronger reducing agent	(1)
		M5	Zn reacts before iron / Zn is a sacrificial metal / Zn oxidises preferentially / Zn corrodes before Fe	(1)
				(5)

(Total 25 Marks)

Question Number			Acceptable Answers	Mark
9	(a)	M1	white ring is ammonium chloride / NH_4Cl	(1)
		M2	closer to HCl end	(1)
		M3	because NH_3(g) diffuses faster than HCl(g) / NH_3(g) molecules / particles move more / travel faster than HCl(g) *(allow ammonia and hydrogen chloride)* *(not travels faster alone / not aq NH_3 diffuses faster)*	(1)
		M4	because NH_3 is less dense / has lower molecular mass / lighter *(dependent on gaseous phase in M3)*	(1)
		M5	$NH_3 + HCl \rightarrow NH_4Cl$	(1)
				(5)
	(b)	M1	gas is hydrogen	(1)
		M2	HCl reacts faster	(1)
		M3	HCl is a stronger acid than CH_3COOH / HCl contains a greater concentration of / more H^+(aq) ions	(1)
		M4	so more **frequent** / **effective** collisions with magnesium	(1)
		M5	$Mg + 2H^+ \rightarrow Mg^{2+} + H_2$ formulae (1), balance (1) **OR** $Mg + 2HCl \rightarrow MgCl_2 + H_2$ (1) $Mg + 2CH_3COOH \rightarrow (CH_3COO)_2Mg + H_2$ (1)	(2)
				(6)
	(c)	M1	(white ppt from sodium sulphite is) barium sulphite / $BaSO_3$	(1)
		M2	$Na_2SO_3 + BaCl_2 \rightarrow BaSO_3 + 2NaCl$ OR $Ba^{2+} + SO_3^{2-} \rightarrow BaSO_3$	(1)
		M3	(white ppt from sodium sulphate is) barium sulphate / $BaSO_4$	(1)
		M4	$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$ OR $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$	(1)
		M5	barium sulphite reacts with HCl to give sulphur dioxide / only $BaSO_3$ dissolves in HCl	(1)
		M6	$BaSO_3 + 2HCl \rightarrow BaCl_2 + SO_2 + H_2O$ OR $SO_3^{2-} + 2H^+ \rightarrow SO_2 + H_2O$	(1)
				(6)

	(d)	M1	$CH_3CH_2CH_2Cl$ / 1-chloropropane	(1)
		M2	$CH_3CHClCH_3$ / 2-chloropropane *(in M1 and M2, if name and formula given, both must be correct as a result, if no marks scored allow (1) for 2 correct formulae)*	(1)
		M3	the two products are (structural) isomers / isomerism shown / have different structures or structural formulae	(1)
		M4	$C_3H_8 + Cl_2 \rightarrow C_3H_7Cl + HCl$	(1)
				(4)
	(e)	M1	bromine displaces iodine / iodine is formed	(1)
		M2	because bromine is more reactive than iodine / or converse bromine is a stronger oxidising agent than I_2 / or converse bromine oxidises iodide (ion) *(in statements do not allow bromide or iodide when the halogen is required)*	(1)
		M3	$Br_2 + 2NaI \rightarrow 2NaBr + I_2$ OR $Br_2 + 2I^- \rightarrow 2Br^- + I_2$	(1)
		M4	bromine is not as reactive as chlorine / or converse bromine is a weaker oxidising agent than Cl_2 / or converse *(not Br_2 does not displace Cl_2 in statements do not allow bromide or chloride when the halogen is required)*	(1)
				(4)

(Total 25 Marks)

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