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Cambridge International General Certificate of Secondary Education

MARK SCHEME for the October/November 2015 series

0620 CHEMISTRY

0620/33 Paper 3 (Extended Theory), maximum raw mark 80

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Abbreviations used in the Mark Scheme

- ; separates marking points
- / separates alternatives within a marking point
- () the word or phrase in brackets is not required but sets the context
- **A** accept (a less than ideal answer which should be marked correct)
- **I** ignore (mark as if this material were not present)
- **R** reject
- ecf credit a correct statement that follows a previous wrong response
- ora or reverse argument
- owtte or words to that effect (accept other ways of expressing the same idea)

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Question	Answer	Marks
1(a)	cobalt chloride (paper) / anhydrous cobalt chloride / $CoCl_2$; from blue; to pink; **or** copper sulfate / anhydrous copper sulfate / $CuSO_4$; from white; to blue;	**3**
1(b)	boils at 100 °C / boiling point 100 °C / freezes at 0 °C / freezing point 0 °C / melts at 0 °C / melting point 0 °C;	**1**
1(c)	any two from: • filtration / sedimentation / sieving / screening / (pass through) gravel (beds) / flocculation / decantation / clarification / coagulation / flotation / settling tank / add aluminium sulfate; • (add) carbon; • chlorination / (add) chlorine / add Cl_2; • fluoridation / add fluoride; • ozone dosing; • desalination; • aeration; • distillation;	**2**
1(d)	any two from: making steel; making paper; textiles; generating electricity / energy / power / turbines; HEP; water mills; steam power (e.g. steam engines); geothermal power; agriculture; livestock; irrigation; hydration of alkenes / manufacture of ethanol / alcohols; manufacture of sulfuric acid / Contact process; manufacture of hydrogen; solvent / dissolving; coolant / cooling; cleaning / washing; (supply of) drinking (water); central heating; production of slaked lime; cooking;	**2**

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Question	Answer	Marks
2(a)	sulfur dioxide / SO_2;	1
2(b)	hydrogen / H_2;	1
2(c)	ethene / C_2H_4;	1
2(d)	argon / Ar;	1
2(e)	carbon monoxide / CO;	1
2(f)	methane / CH_4;	1

Question	Answer	Marks
3(a)(i)	vibrate (about fixed position) / vibration;	1
3(a)(ii)	electrostatic force of) attraction; (between) positive ions and negative ions / oppositely charged ions / unlike charged ions / cations and anions;	1 1
3(a)(iii)	regular / repeated / pattern / framework / ordered / alternating / organised (arrangement of); positive and negative ions / oppositely charged ions / cations and anions / unlike charged ions;	1 1
3(b)(i)	correct direction (going towards negative electrode);	1
3(b)(ii)	$Li^+ + e^- \rightarrow Li$ / $Li^+ \rightarrow Li - e^-$;	1
3(b)(iii)	$2Br^- \rightarrow Br_2 + 2e^-$ / $2Br^- - 2e^- \rightarrow Br_2$ formulae; balancing;	2
3(b)(iv)	Br^- / bromide (ion); electron lost / donated electrons / increased oxidation state / increased oxidation number / oxidation numbers changed from –1 to 0 / increased valency;	1 1

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Question	Answer	Marks
3(c)	**M1** (gas) hydrogen (given off at cathode) / H_2; **M2** hydroxide <u>ions</u> / lithium hydroxide / OH^- / LiOH are alkali(ne); **M3** $2LiBr + 2H_2O \rightarrow 2LiOH + H_2 + Br_2$; **or** $2H^+ + 2e^- \rightarrow H_2$ / $2H^+ \rightarrow H_2 - 2e^-$; **or** $2Br^- \rightarrow Br_2 + 2e^-$ / $2Br^- - 2e^- \rightarrow Br_2$; **or** $2H^+ + 2Br^- \rightarrow H_2 + Br_2$;	**3**

Question	Answer	Marks
4(a)(i)	any three from: • (same) general (molecular) formula; • (consecutive members) differ by CH_2; • same functional group; • common (allow similar) methods of preparation; • same / similar chemical properties / (chemical) reactions;	**3**
4(a)(ii)	C_nH_{2n} alkene; C_nH_{2n+2} alkane;	**1** **1**
4(a)(iii)	alkanes <u>all</u> or <u>only</u> (C–C) single bonds / no double bonds / no multiple bonds; alkenes (at least one) C=C / double bond / multiple bond;	**1** **1**
4(b)(i)	heat / high temperature / temperature between 450 °C and 800 °C; catalyst / named catalyst, e.g. zeolites or alumina or aluminium oxide or aluminosilicates or silica or oxides of chromium; **or** high pressure / pressure in range of 2–70 atm; **or** steam; absence of air / oxygen;	**2**
4(b)(ii)	any correct equation producing an alkane and an alkene adding up to seven carbon atoms in the products;	**1**

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Question	Answer	Marks
4(b)(iii)	any correct equation producing two alkenes and hydrogen, e.g. → C_2H_4 + C_5H_{10} + H_2 / C_3H_6 + C_4H_8 + H_2;	1
4(b)(iv)	**alkenes:** more useful than alkanes / used to make polymers or plastics / used to make chemicals / petrochemicals; **or** **alkanes:** (balance the demand for different) fuels / increase petrol (fraction) or hydrogen / produce lighter fractions from heavier fractions or suitable example, e.g. naphtha to gasoline / more useful smaller molecules or more demand for smaller molecules or more demand for smaller fractions / used as fuel / used to make ammonia / used in Haber process / used in hydrogenation of vegetable oils / used to make HC*l*;	1 1
4(c)(i)	150 (cm^3);	1
4(c)(ii)	100 (cm^3);	1
4(c)(iii)	This question was discounted.	1

Question	Answer	Marks
5(a)(i)	proton donor / H^+ donor / hydrogen ion donor;	1
5(a)(ii)	strong acid completely or fully ionises / completely or fully dissociates / completely or fully splits into ions; weak acid partially or incompletely ionises or dissociates or splits into ions / does not ionise fully;	1 1
5(b)(i)	barium sulphite / barium sulfate(IV) / $BaSO_3$;	1
5(b)(ii)	barium sulfate / $BaSO_4$;	1
5(b)(iii)	Br_2 + $2e^-$ → $2Br^-$ / Br_2 → $2Br^-$ – $2e^-$;	1
5(b)(iv)	sulfuric acid;	1
5(c)(i)	(→) magnesium sulfate + water;	1
5(c)(ii)	(→) zinc sulfate + hydrogen;	1
5(c)(iii)	(→) copper(II) sulfate / copper sulfate + carbon dioxide + water;	1
5(d)(i)	$2NH_3$ + H_2SO_4 → $(NH_4)_2SO_4$ / NH_3 + H_2SO_4 → $(NH_4)HSO_4$;	1

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Question	Answer	Marks
5(d)(ii)	$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$ Na_2SO_4; rest of equation correct; **or** $H^+ + OH^- \rightarrow H_2O$ H_2O as the only product on the right hand side; rest of equation correct; **or** $NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$ $NaHSO_4$; rest of equation correct; **or** $OH^- + H_2SO_4 \rightarrow HSO_4^- + H_2O$ HSO_4^-; rest of equation correct;	**2**
5(d)(iii)	$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2$; $FeSO_4$; rest of equation correct; **or** $Fe + 2H^+ \rightarrow Fe^{2+} + H_2$; Fe^{2+}; rest of equation correct; **or** $2Fe + 3H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3H_2$; $Fe_2(SO_4)_3$; rest of equation correct; **or** $2Fe + 6H^+ \rightarrow 2Fe^{3+} + 3H_2$; Fe^{3+}; rest of equation correct;	**2**

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Question	Answer	Marks
6(a)	Na / sodium **and** Li / lithium;	1
6(b)	Cu / copper **and** Rh / rhodium;	1
6(c)	$Fe_2(SO_4)_3$;	1
6(d)	Mg^{2+};	1
6(e)	copper sulfate (solution); add manganese / Mn to solution; copper displaced or forms / blue colour changes; **or** (a solution of) an iron salt or a zinc salt; add copper and manganese to each; only manganese reacts / displaces; **or** (a solution of a) manganese salt and a copper salt; add, e.g. iron / zinc; copper (displaced) and manganese not; **or** to a (dilute) acid / any named acid / water / steam; add Mn and Cu / both metals to the liquid; rate faster or shorter time or more bubbles or more hydrogen or more gas with Mn or with the more reactive metal / reaction only with Mn or with the more reactive metal; **or** copper oxide; add manganese and heat; evidence of reaction; **or** burn manganese and copper / both elements; in air / oxygen; Mn or more reactive metal burns brighter / only Mn or more reactive metal burns / evidence that manganese reacts faster; **or** add carbon; to both metal oxides and heat; evidence that reaction occurs with copper oxide more readily / least reactive metal oxide;	3

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Question	Answer	Marks
	or both metal nitrates or carbonates; heat; evidence that manganese compound is most stable / most reactive compound is most stable; **or** (electrochemical) cell / use of voltmeter / electrolyte; copper and manganese (as electrodes); manganese is the negative terminal;	
6(f)	*physical properties* any three from: hard; strong; high density; malleable; ductile; sonorous; shiny; high melting point / high boiling point; (good) conductor (of heat/electricity); forms coloured compounds / coloured ions / coloured salts; *chemical properties* any two: catalytic behaviour; more than one or different or variable oxidation state or oxidation number or valency / variable charges / many differently charged ions; forms complex (ions); forms coloured compounds / coloured ions / coloured salts; amphoteric oxide / amphoteric / basic oxide / alkaline oxides / acidic oxide; (other metallic reactions) with acids / water / steam; reducing agent / electron donor / reacts with non-metal to form ionic compound / forms positive ions;	**5**

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Question	Answer	Marks
7(a)	*moles of KOH used* (= 0.025 × 2.53 =) 0.06325 / 0.063; *number of moles of H_2SO_4 needed to neutralise the KOH* = 0.031625 / 0.032; *concentration of dilute sulfuric acid* = 1.121/1.1 (mol / dm^3);	3
7(b)(i)	repeat experiment using same volume / amount of (same) H_2SO_4; and same volume / amount of (same) KOH; **or** (add activated) charcoal / carbon; filter out the charcoal; **or** mix volumes / amounts of H_2SO_4 and KOH in the ratio 1:2; of the same concentration;	2
7(b)(ii)	make solution of potassium sulfate as above; add same volume / amount of acid again; **or** same volume / amount of KOH; add double the volume / amount of H_2SO_4; 25 cm^3 KOH + 56.4 cm^3 H_2SO_4 = [2] **or** same volume / amount of H_2SO_4; add half the volume / amount of KOH; 12.5 cm^3 KOH + 28.2 cm^3 H_2SO_4 = [2] **or** mix equal volumes / amounts of H_2SO_4 and KOH ; of the same concentration; mix solutions containing equal numbers moles of KOH and H_2SO_4 = [2]	2

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Question	Answer	Marks
7(c)	*test:* reactive metal / name or formula of suitable metal, e.g. Mg / Fe / Zn; *result:* bubbles or gas or hydrogen or H_2 evolved / dissolves; *test:* insoluble carbonate or name / formula of suitable insoluble carbonate, e.g. $CaCO_3$; *result:* bubbles or gas or carbon dioxide or CO_2 evolved / dissolves provided that carbonate is insoluble; *test:* alkali or name / formula of suitable alkali, e.g. NaOH / KOH; *result:* temperature change; *test:* alkali or name / formula of suitable alkali, e.g. NaOH / KOH and indicator; *result:* colour change; *test:* insoluble base or name / formula of suitable insoluble base; *result:* dissolves; *test:* indicator, e.g. blue litmus; *result:* colour change (colour need not be specified); *test:* measure pH / pH paper / UI paper / pH meter; *result:* pH 0–3 or indicator red / orange or pH lower than pH of K_2SO_4;	**2**

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