CAMBRIDGE INTERNATIONAL EXAMINATIONS

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

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

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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)

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**

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

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**

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

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**

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

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**

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

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**