

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

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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 ₂ H 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 ⁻ → Li / Li ⁺ → Li – e ⁻ ;	1
3(b)(iii)	2Br ⁻ → Br ₂ + 2e ⁻ / 2Br ⁻ – 2e ⁻ → 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)/H₂; M2 hydroxide <u>ions</u>/lithium hydroxide/OH⁻/LiOH are alkali(ne); M3 2LiBr + 2H₂O → 2LiOH + H₂ + Br₂; or 2H⁺ + 2e⁻ → H₂/2H⁺ → H₂ - 2e⁻; or 2Br⁻ → Br₂ + 2e⁻/2Br⁻ - 2e⁻ → Br₂; or 2H⁺ + 2Br⁻ → H₂ + Br₂;	3

Question	Answer	Marks
4(a)(i)	any three from: • (same) general (molecular) formula; • (consecutive members) differ by CH₂; • 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. $\rightarrow \text{C}_2\text{H}_4 + \text{C}_5\text{H}_{10} + \text{H}_2 / \text{C}_3\text{H}_6 + \text{C}_4\text{H}_8 + \text{H}_2$;	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 HCl;	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)	$\text{Br}_2 + 2\text{e}^- \rightarrow 2\text{Br}^- / \text{Br}_2 \rightarrow 2\text{Br}^- - 2\text{e}^-$;	1
5(b)(iv)	sulfuric acid;	1
5(c)(i)	($\rightarrow$) magnesium sulfate + water;	1
5(c)(ii)	($\rightarrow$) zinc sulfate + hydrogen;	1
5(c)(iii)	($\rightarrow$) copper(II) sulfate / copper sulfate + carbon dioxide + water;	1
5(d)(i)	$2\text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4 / \text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)\text{HSO}_4$;	1

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Question	Answer	Marks
5(d)(ii)	$2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$ Na_2SO_4 ; rest of equation correct; or $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$ H_2O as the only product on the right hand side; rest of equation correct; or $\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{H}_2\text{O}$ NaHSO_4 ; rest of equation correct; or $\text{OH}^- + \text{H}_2\text{SO}_4 \rightarrow \text{HSO}_4^- + \text{H}_2\text{O}$ HSO_4^- ; rest of equation correct;	2
5(d)(iii)	$\text{Fe} + \text{H}_2\text{SO}_4 \rightarrow \text{FeSO}_4 + \text{H}_2$; FeSO_4 ; rest of equation correct; or $\text{Fe} + 2\text{H}^+ \rightarrow \text{Fe}^{2+} + \text{H}_2$; Fe^{2+} ; rest of equation correct; or $2\text{Fe} + 3\text{H}_2\text{SO}_4 \rightarrow \text{Fe}_2(\text{SO}_4)_3 + 3\text{H}_2$; $\text{Fe}_2(\text{SO}_4)_3$; rest of equation correct; or $2\text{Fe} + 6\text{H}^+ \rightarrow 2\text{Fe}^{3+} + 3\text{H}_2$; 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)	<i>physical properties</i> 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; <i>chemical properties</i> 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)	<i>moles of KOH used (= 0.025×2.53 =) $0.06325/0.063$; <i>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/dm³);</i> </i>	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 ; $25\text{ cm}^3\text{ KOH} + 56.4\text{ cm}^3\text{ H}_2\text{SO}_4 = [2]$ or same volume / amount of H_2SO_4 ; add half the volume / amount of KOH; $12.5\text{ cm}^3\text{ KOH} + 28.2\text{ cm}^3\text{ H}_2\text{SO}_4 = [2]$ 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)	<i>test:</i> reactive metal / name or formula of suitable metal, e.g. Mg / Fe / Zn; <i>result:</i> bubbles or gas or hydrogen or H₂ evolved / dissolves; <i>test:</i> insoluble carbonate or name / formula of suitable insoluble carbonate, e.g. CaCO₃; <i>result:</i> bubbles or gas or carbon dioxide or CO₂ evolved / dissolves provided that carbonate is insoluble; <i>test:</i> alkali or name / formula of suitable alkali, e.g. NaOH / KOH; <i>result:</i> temperature change; <i>test:</i> alkali or name / formula of suitable alkali, e.g. NaOH / KOH and indicator; <i>result:</i> colour change; <i>test:</i> insoluble base or name / formula of suitable insoluble base; <i>result:</i> dissolves; <i>test:</i> indicator, e.g. blue litmus; <i>result:</i> colour change (colour need not be specified); <i>test:</i> measure pH / pH paper / UI paper / pH meter; <i>result:</i> pH 0–3 or indicator red / orange or pH lower than pH of K₂SO₄;	2