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Cambridge International General Certificate of Secondary Education

MARK SCHEME for the May/June 2015 series

0620 CHEMISTRY

0620/32 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
- **OR** gives alternative marking point
- **R** reject
- **I** ignore mark as if this material was not present
- **A** accept (a less than ideal answer which should be marked correct)
- **COND** indicates mark is conditional on previous marking point
- owtte or words to that effect (accept other ways of expressing the same idea)
- max indicates the maximum number of marks that can be awarded
- ecf credit a correct statement that follows a previous wrong response
- ( ) the word / phrase in brackets is not required, but sets the context
- ora or reverse argument

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Question	Answer	Marks	Guidance
1	$^{39}_{19}K$; 26p 26e 30n All three for 1 mark; $^{7}_{3}Li^{+}$ numbers and symbol; charge +; 31p 28e 39n All three for 2 marks, any two for 1 mark; $^{79}_{34}Se^{2-}$ numbers and symbol; charge 2^-;	8	

Question	Answer	Marks	Guidance
2(a)	E; high melting point / mp / mpt **OR** high boiling point / bp / bpt; poor / non conductor (when liquid and / or solid);	3	**I** mpt/bpt above room temp
2(b)	B; (good) conductor when <u>solid</u> (and liquid);	2	**A** (good) conductor in any state / both states **I** high melting point/boiling point **R** low melting point/boiling point
2(c)	A; melting point / –7 (°C) is below room temperature / 25 (°C) / RTP ora; boiling point / 59 (°C) is above room temperature / 25 (°C) / RTP ora;	3	**I** low melting point / boiling point / conductivity 25 (°C) / room temperature / RTP is in between –7 (°C) and 59 (°C) **OR** 25 (°C) / room temperature / RTP is between mpt and bpt would both score the 2 evidence marks
2(d)	C; high melting point / mp / mpt **OR** high boiling point / bp / bpt; **BOTH** poor / non conductor when solid **and** good conductor when liquid **OR** molten / only conduct when liquid;	3	**A** melting point **and** boiling point both above room temp / 25 °C / RTP **I** conducts when aqueous or in solution **I** conducts in liquid due to free electrons

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Question	Answer	Marks	Guidance
3(a)	M1 both correct charges of ions (calcium 2+ and nitrogen 3–); M2 8 electrons around nitrogen (can be 3 dots and 5 crosses **or** 5 crosses and 3 dots **or** all dots **or** all crosses, but reject any other combinations of dots and crosses); M3 Two electrons on the inner shell on any nitride ions/nitrogen atom: allow 2x or 2o once;	**3**	Charges can be shown anywhere **I** missing symbols for nitrogen **R** wrong symbol of nitrogen **anywhere** **A** if electron configuration of nitride is given as 2,8 or N is given as 2,5 **I** any missing inner shells as long as one is present *General guidance:* **I** electron configuration / symbol of calcium ion **I** formulae / stoichiometry Covalent can score **only** M3
3(b)(i)	regular / repeated / pattern / framework / periodic / ordered / alternating / organised; (of)particles / atoms / molecules / ions / cations / anions;	**2**	**I** layers **A** ionic / molecular / atomic **I** arrangement / bonding / properties
3(b)(ii)	M1 (so that ionic) charges balance or cancel / charge = 0 / no charge / number of positive = number of negative charges / charge is neutral or neutralised; M2 3(–) × 2 = 2(+) × 3 ;	**2**	**A** 6(+) = 6(–) **I** statements about electron transfer / valency / ox state unless valency is referring to ionic charges e.g. valencies 3+ and 2– can get credit if used properly Ratio of ions is 3:2 therefore ratio of charges is 2:3 scores 2

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Question	Answer	Marks	Guidance
3(c)	it (refers to Ca) / Calcium / Ca (atom) loses / gives / donates electrons / e / e^- ; (these are) gained by nitrogen / N / N_2 ; nitrogen / N / N_2 is reduced so calcium / Ca is the reducing agent (these two statements could be split i.e. not in same sentence) **OR** reducing agents are electron donors / give / lose electrons **OR** calcium / Ca is oxidised (by electron loss) therefore calcium is the reducing agent (these two statements could be split i.e. not in same sentence);	**3**	**A** half-equation with electrons on right-hand side **R** calcium ion / Ca^{2+} **A** half-equation with electrons on left-hand side **R** nitride ion / N^{3-} **I** numbers of electrons / charges on ions / oxidation state / valency if mentioned **R** reference to oxygen / hydrogen if there is a suggestion that oxygen / hydrogen are involved in the reaction **I** reference to oxygen / hydrogen if in general statement e.g. oxidation is gain of oxygen Electrons / e / e^- move from calcium to nitrogen get marks 1 and 2 **A** calcium / Ca / it is a reductant or calcium / Ca / it reduces
4(a)	large surface area / large area of contact / large surface; more (successful) collisions (between catalyst and gases or between reacting gases) **OR** more active sites **OR** faster reaction / increase rate / increase speed;	**2**	**I** activation energy Second mark must be comparative
4(b)	decrease temperature / temperature below 450 °C / quoted temperature below 450 °C; increase pressure / pressure above 200 atm / quoted pressure above 200 atm;	**2**	**I** comments about concentration **I** low temperature and high pressure. Both answers must be comparative **I** explanations

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Question	Answer	Marks	Guidance
4(c)	decreased <u>temperature</u> would reduce rate / reaction slow**<u>er</u>** / too slow; increased <u>pressure</u> expensive / uneconomic / safety risks / leaks / explosions / yield **or** rate good enough at lower pressure / strong pipes needed / thick pipes needed / sturdy pipes needed / requires a lot of energy;	**2**	**A** takes long**<u>er</u>** **I** slow (unqualified) **I** answers that do not refer to decreased temperature and increased pressure e.g. it is too expensive unless this is linked with pressure
5(a)	method A; hydrochloric acid / HC*l* / hydrogen chloride solution; nickel carbonate + hydrochloric acid → nickel chloride + water + carbon dioxide;	**3**	hydrochloric acid / HC*l* can only score if written in the reagent space i.e. **R** hydrochloric acid / HC*l* in equation if reagent space is blank **I** hydrogen chloride (therefore 'hydrogen chloride + HC*l*' would get mark 2 BOD) **I** nickel carbonate **A** fully correct balanced chemical equation i.e. $NiCO_3 + 2HCl \rightarrow NiCl_2 + CO_2 + H_2O$ for the third mark **R** combination of words and formulae in the same equation for the third mark **I** concentration of acid for marks 2 and 3
5(b)	method C; any (aqueous / dilute / solution of soluble) bromide including potassium bromide / KBr, hydrogen bromide / HBr i.e. all bromides except silver, lead and mercury; $Pb^{2+} + 2Br^- \rightarrow PbBr_2$;	**3**	**A correct** formula of soluble bromide **I** lead nitrate **I** state symbols **A** multiples

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Question	Answer	Marks	Guidance
5(c)	method B; sulfuric acid / hydrogen sulfate / H_2SO_4 ; $2LiOH + H_2SO_4 \rightarrow Li_2SO_4 + 2H_2O$ species; balancing;	 **4**	 **I** concentration of acid for mark 2 **I** indicators / lithium hydroxide **I** state symbols **A** multiples

Question	Answer	Marks	Guidance
6(a)(i)	(Haber process makes) ammonia / NH_3 ; (ammonia converted into) fertilisers / nitrates / ammonium salts or names or formulae of examples e.g. ammonium nitrate / NH_4NO_3 / ammonium sulfate / $(NH_4)_2SO_4$ / calcium nitrate / $Ca(NO_3)_2$ / urea / $CO(NH_2)_2$;	 **2**	 **A** 2 marks for 'ammonia is a fertiliser' **A** ammonia is used to make sodium nitrate Haber process used to make fertilisers gets second mark only
6(a)(ii)	it (refers to sodium nitrate) / sodium nitrate would dissolve (in rain) / soluble (in water) / wash away / leach / drain off;	**1**	**A** reacts with water **I** reference to fertiliser **R** sodium reacts / dissolves **A** because they are not dissolved by rainfall (implication is in desert)
6(a)(iii)	potassium (is required by plants as well as nitrogen) / NP**K**;	**1**	**R** comments about pH / better for soil / %N higher / reactivity of potassium **I** comments about what K does for plants e.g. combat disease
6(b)(i)	$2NaNO_3 \rightarrow 2NaNO_2 + O_2$ species; balancing;	 **2**	 **A** multiples **I** state symbols / word equation

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Question	Answer	Marks	Guidance
6(b)(ii)	(colour changes) from pink / purple; to colourless / decolourised;	2	**I** clear / discoloured / effervescence **I** brown fumes / brown gas **NOTE:** stays pink or purple gets first mark but turns purple or pink is 0
6(b)(iii)	the more reactive the metal the lower rate of decomposition / more difficult the decomposition / more stable the nitrate / more energy needed to decompose / decomposes at higher temperature ora;	1	**A** less (extent the) decomposition **A** reactive metals produce nitrates difficult to decompose ora i.e. comparatives not essential **A** the more reactive the metal the less it decomposes is acceptable because we can assume that *it* refers to the nitrate BOD **A** inverse relationship with further qualification **A** group 1 / reactive metals produce nitrite (and oxygen) **and** less reactive metals produce oxide (+ NO_2 + O_2) (both required for mark) **I** less products (unqualified) **R** less products / metals decompose
6(c)(i)	(changes from) blue solid / blue crystals; black solid formed; brown gas / brown vapour / (pungent) smell;	3	**R** precipitate **A** one mark out of the first two for changes from blue to black (without solid or crystals) **I** red / melt **I** water / steam / condensation given off **I** reference to glowing / burning splints / colourless gas / effervescence **I** names / formulae

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Question	Answer	Marks	Guidance
6(c)(ii)	Avogadro('s) number / constant / 6.02×10^{23}; **COND** particles; **OR** (the number of particles which is equal to the number of atoms in) 12 g of carbon 12; **COND** atoms; **OR** the mass **in grams** which contains Avogadro('s) Number; **COND** particles; **OR** (the amount of substance which has a mass equal to) its relative formula mass / RFM / relative atomic mass / Ar / relative molecular mass / Mr / molar mass; **COND** in grams; **OR** (the amount of substance which has a volume equal to) 24 dm^3; **COND** of a gas **at** RTP;	**2**	**A** any values from 6 to 6.023×10^{23} **A** atoms / ions / molecules / electrons **A** one mark for reference to C12 **A** equivalent statement for any element **or** compound e.g. 32 grams of oxygen(1) **COND** molecules / O_2 (1) e.g. 16 grams of oxygen (1) **COND** atoms / O(1) **A** different volumes under different conditions e.g. 22.4 dm^3 at STP or volumes in different units e.g. 24 000 cm^3 at RTP
6(c)(iii)	M1 (number of moles of CuO formed =) **0.03**; M2 (number of moles of $Cu(NO_3)_2.xH_2O$ in 7.26 g =) **0.03**; M3 (mass of 1 mole of $Cu(NO_3)_2.xH_2O$ 7.26 ÷ 0.03 =) **242** (g); (mass of 1 mole of $Cu(NO_3)_2$ is 188 g) M4 the value of x = **3**;	**4**	ecf same as M1 ecf 7.26 ÷ M2 ecf M3 – 188 ÷ 18

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Question	Answer	Marks	Guidance
7(a)(i)	living/organism or named example e.g. yeast / cells / plants / animals / part of animal or plant e.g. muscle / humans / micro-organisms; produces / releases or gain or obtain energy / exothermic / heat; from food / named foodstuff / carbohydrate / named carbohydrate / sugar / named sugar / glucose / nutrients;	3	**A** 'we / us' for 'humans' **I** products / breathing / oxygen / anaerobic / aerobic
7(a)(ii)	***Any 2 from 3:*** carbon dioxide / CO_2; water / H_2O; adenosine triphosphate / ATP;	1	**I** energy
7(a)(iii)	biological catalyst or protein catalyst;	1	**R** biocatalyst / living biological catalyst
7(a)(iv)	**answer must include both** measuring the time and measuring a relevant quantity; **OR** alternatively measuring the time taken for something to happen; alternatives to time are: units of time / apparatus to measure time / regular intervals / how long examples of relevant quantities are: (Increase in / decrease in) amount / mass / volume / bubbles of carbon dioxide / bubbles of gas **OR** (Increase in / decrease in) mass of apparatus;	1	Examples: **A** time taken for lime water to turn milky **A** time taken for bubbling to stop / gas stop being evolved **A** count bubbles per minute **A** measure temperature (change) with time **R** time taken for reaction to end **R** measure carbon dioxide / gas with time (no reference to amount)
7(b)(i)	temperature increase / heat increase / warmer / high temperature / exothermic / **more** yeast / yeast reproduces / yeast increases / yeast multiplies;	1	**R** yeast was added
7(b)(ii)	**more** yeast / yeast reproduces / increases / multiplies;	1	**R** yeast was added

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Question	Answer	Marks	Guidance
7(b)(iii)	all glucose or reactant(s) reacted **OR** no glucose or reactant(s) left **OR** glucose or reactant(s) used up / finished / runs out / reacted completely / fully reacted; yeast (cells) dies **OR** enzymes denatured **OR** ethanol is toxic to yeast / ethanol kills yeast;	**2**	**I** glucose or reactants reacted / stopped reacting **R** enzyme dies / yeast denatures **R** yeast used up
7(c)	***Any two from**:* fuel; **OR** petrol additive; **OR** solvent / tinctures; **OR** (making) perfumes; **OR** varnishes; **OR** preserving biological specimens / preserving food; **OR** essence / flavourings; **OR** antiseptic / kill bacteria (in medicine) / sterilizer; **OR** antitussive agent; **OR** (in) disinfectant / hand sanitizer; **OR** to make esters / esterification; **OR** to make ether(s); **OR** to make amines; **OR** to make carboxylic acid(s) / vinegar / ethanoic acid; **OR** thermometers; **OR** alcohol lamp / spirit burners; **OR** any other suitable use;	**2**	**I** medicine (unqualified) / chemical feedstock

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Question	Answer	Marks	Guidance
7(d)			**I** fractional distillation / distillation wherever mentioned
	cracking / crack;		**I** catalytic / thermal + other conditions
	(hexane to obtain) ethene / C_2H_4 ;		Ethene / C_2H_4 can be given in either equation whether the equation is otherwise correct or not
	$C_6H_{14} \rightarrow C_2H_4 + C_4H_{10}$;		**I** state symbols **A** multiples / other equations e.g. $C_6H_{14} \rightarrow 3C_2H_4 + H_2$ $C_6H_{14} \rightarrow 2C_2H_4 + C_2H_6$ $C_6H_{14} \rightarrow C_2H_4 + C_4H_8 + H_2$ **A** any correct equations in which carbon is produced e.g. $C_6H_{14} \rightarrow 2C_2H_4 + 2C + 3H_2$
	hydration (of ethene) / hydrate / hydrated **or** add(ition of) water / add(ition of) steam / addition;		**A** additional **I** conditions / react with water
	$C_2H_4 + H_2O \rightarrow C_2H_5OH$;	**5**	**I** C_2H_6O / state symbols **A** multiples

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