CAMBRIDGE INTERNATIONAL EXAMINATIONS

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

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
- **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

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

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

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

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

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

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

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

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

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

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