

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

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Page 2	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

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

Page 3	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

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

Page 4	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

Question	Answer	Marks	Guidance
3(a)	<p>M1 both correct charges of ions (calcium 2+ and nitrogen 3–);</p> <p>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);</p> <p>M3 Two electrons on the inner shell on any nitride ions/nitrogen atom: allow 2x or 2o once;</p>	<p>3</p>	<p>Charges can be shown anywhere I missing symbols for nitrogen R wrong symbol of nitrogen anywhere</p> <p>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</p> <p>General guidance: I electron configuration / symbol of calcium ion I formulae / stoichiometry Covalent can score only M3</p>
3(b)(i)	<p>regular / repeated / pattern / framework / periodic / ordered / alternating / organised;</p> <p>(of)particles / atoms / molecules / ions / cations / anions;</p>	<p>2</p>	<p>I layers</p> <p>A ionic / molecular / atomic I arrangement / bonding / properties</p>
3(b)(ii)	<p>M1 (so that ionic) charges balance or cancel / charge = 0 / no charge / number of positive = number of negative charges / charge is neutral or neutralised;</p> <p>M2 $3(-) \times 2 = 2(+) \times 3$;</p>	<p>2</p>	<p>A 6(+) = 6(-)</p> <p>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</p>

Page 5	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

Question	Answer	Marks	Guidance
3(c)	<p>it (refers to Ca)/Calcium/Ca (atom) loses/gives/donates electrons/e/e^- ;</p> <p>(these are) gained by nitrogen/N/N_2 ;</p> <p>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);</p>	3	<p>A half-equation with electrons on right-hand side R calcium ion/Ca^{2+}</p> <p>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</p> <p>Electrons/e/e^- move from calcium to nitrogen get marks 1 and 2</p> <p>A calcium/Ca/it is a reductant or calcium/Ca/it reduces</p>
4(a)	<p>large surface area/large area of contact/large surface;</p> <p>more (successful) collisions (between catalyst and gases or between reacting gases) OR more active sites OR faster reaction/increase rate/increase speed;</p>	2	<p>I activation energy Second mark must be comparative</p>
4(b)	<p>decrease temperature/temperature below $450^\circ C$/quoted temperature below $450^\circ C$;</p> <p>increase pressure/pressure above 200 atm/quoted pressure above 200 atm;</p>	2	<p>I comments about concentration I low temperature and high pressure. Both answers must be comparative I explanations</p>

Page 6	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

Question	Answer	Marks	Guidance
4(c)	decreased <u>temperature</u> would reduce rate/reaction slower/ 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 longer 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/HCl/hydrogen chloride solution; nickel carbonate + hydrochloric acid → nickel chloride + water + carbon dioxide;	3	hydrochloric acid/HCl can only score if written in the reagent space i.e. R hydrochloric acid/HCl in equation if reagent space is blank I hydrogen chloride (therefore 'hydrogen chloride + HCl' would get mark 2 BOD) I nickel carbonate A fully correct balanced chemical equation i.e. $\text{NiCO}_3 + 2\text{HCl} \rightarrow \text{NiCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$ 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; $\text{Pb}^{2+} + 2\text{Br}^- \rightarrow \text{PbBr}_2$;	3	A correct formula of soluble bromide I lead nitrate I state symbols A multiples

Page 7	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

Question	Answer	Marks	Guidance
5(c)	method B; sulfuric acid / hydrogen sulfate / H_2SO_4 ; $2\text{LiOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Li}_2\text{SO}_4 + 2\text{H}_2\text{O}$ 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 / $(\text{NH}_4)_2\text{SO}_4$ / calcium nitrate / $\text{Ca}(\text{NO}_3)_2$ / urea / $\text{CO}(\text{NH}_2)_2$;	2	A 2 marks for 'ammonia is a fertiliser' A ammonia is used to make sodium nitrate H aber 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) / NPK ;	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)	$2\text{NaNO}_3 \rightarrow 2\text{NaNO}_2 + \text{O}_2$ species; balancing;	2	A multiples I state symbols / word equation

Page 8	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

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 <i>it</i> 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

Page 9	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

Question	Answer	Marks	Guidance
6(c)(ii)	<p>Avogadro('s) number / constant / 6.02×10^{23}; COND particles;</p> <p>OR (the number of particles which is equal to the number of atoms in) 12 g of carbon 12; COND atoms;</p> <p>OR the mass in grams which contains Avogadro('s) Number; COND particles;</p> <p>OR (the amount of substance which has a mass equal to) its <u>relative</u> formula mass / RFM / <u>relative</u> atomic mass / Ar / <u>relative</u> molecular mass / Mr / molar mass; COND in grams;</p> <p>OR (the amount of substance which has a volume equal to) 24 dm^3; COND of a gas at RTP;</p>	2	<p>A any values from 6 to 6.023×10^{23}</p> <p>A atoms / ions / molecules / electrons</p> <p>A one mark for reference to C12</p> <p>A equivalent statement for any element or compound e.g. 32 grams of oxygen(1) COND <u>molecules</u> / O_2 (1) e.g. 16 grams of oxygen (1) COND <u>atoms</u> / O(1)</p> <p>A different volumes under different conditions e.g. 22.4 dm^3 at STP or volumes in different units e.g. $24\,000 \text{ cm}^3$ at RTP</p>
6(c)(iii)	<p>M1 (number of moles of CuO formed =) 0.03;</p> <p>M2 (number of moles of $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ in 7.26 g =) 0.03;</p> <p>M3 (mass of 1 mole of $\text{Cu}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ $7.26 \div 0.03$ =) 242 (g); (mass of 1 mole of $\text{Cu}(\text{NO}_3)_2$ is 188 g)</p> <p>M4 the value of x = 3;</p>	4	<p>ecf same as M1</p> <p>ecf $7.26 \div \text{M2}$</p> <p>ecf M3 – $188 \div 18$</p>

Page 10	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

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 ₂ O; 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

Page 11	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

Question	Answer	Marks	Guidance
7(b)(iii)	<p><u>all</u> 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;</p> <p>yeast (cells) dies OR enzymes denatured OR ethanol is toxic to yeast/ethanol kills yeast;</p>	2	<p>I glucose or reactants reacted/stopped reacting</p> <p>R enzyme dies/yeast denatures R yeast used up</p>
7(c)	<p>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;</p>	2	<p>I medicine (unqualified)/chemical feedstock</p>

Page 12	Mark Scheme	Syllabus	Paper
	Cambridge IGCSE – May/June 2015	0620	32

Question	Answer	Marks	Guidance
7(d)	cracking / crack; (hexane to obtain) ethene / C ₂ H ₄ ; $C_6H_{14} \rightarrow C_2H_4 + C_4H_{10}$; hydration (of ethene) / hydrate / hydrated or add(ition of) water / add(ition of) steam / addition; $C_2H_4 + H_2O \rightarrow C_2H_5OH$;	5	I fractional distillation / distillation wherever mentioned I catalytic / thermal + other conditions Ethene / C ₂ H ₄ can be given in either equation whether the equation is otherwise correct or not 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. $C_6H_{14} \rightarrow 2C_2H_4 + 2C + 3H_2$ A additional I conditions / react with water I C ₂ H ₆ O / state symbols A multiples