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CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge International General Certificate of Secondary Education

MARK SCHEME for the May/June 2015 series

0620 CHEMISTRY

0620/31

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(a)	Any two fossil fuels from: crude oil / petroleum; natural gas / methane; petrol / gasoline; kerosene / paraffin; diesel (oil) / gas oil; fuel oil; refinery gas / LPG; propane; butane;	2	I ethane / oil / naphtha / coal / gas R coke / bitumen / lubricating oil / wood
1(b)	hydrogen, oxygen, nitrogen; <i>All three for 2 marks two for 1 mark</i>	2	A H, O, N I H ₂ , O ₂ , N ₂
1(c)(i)	M1 oxygen and nitrogen (from air) react; M2 oxides of nitrogen OR nitrogen oxide(s) are formed; M3 nitrogen oxides formed react with water (to form acid);	3	A nitrogen combust for M1 R M1 if oxygen or nitrogen originate from the fuel A named oxide of nitrogen e.g. nitrogen dioxide A correct formulae A NO _x

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Question	Answer	Marks	Guidance
1(c)(ii)	<i>Any two from:</i> M1 lowers pH or acidifies lakes / rivers or kills fish; M2 changes composition of soils or reduces fertility of soil or reduces crop yields deforestation or kills crops / trees / plants / leaves; M3 attacks (limestone) buildings or statues; M4 attacks metal (structures) / bridges;	3	R 'global warming / greenhouse effect' R 'increases pH of lakes so kills fish' for M1 A removes nutrients / leaches the soil A alternative words for 'attacks' e.g. damages / reacts with / corrode / erode for M3 and M4 I rusting but A 'enhances rusting' for M4 I toxicity to humans
1(d)	<i>Any three from:</i> M1 wood burns to produce (less) carbon dioxide; M2 trees (wood) take in carbon dioxide; M3 by photosynthesis; M4 wood is carbon neutral fuel;	3	

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Question	Answer	Marks	Guidance
2(a)	M1 <i>Forming an oxide</i> (all) elements or (all) impurities become oxides; M2 <i>Gaseous oxides</i> carbon dioxide or sulfur (di)oxide escape/are removed as gases; M3 <i>Acidic oxides</i> silicon(IV) oxide or phosphorus(III/V) oxide react/are neutralised by calcium oxide/lime; M4 <i>Equation mark</i> any one of the following equations $S + O_2 \rightarrow SO_2$; $C + O_2 \rightarrow CO_2$ or $2C + O_2 \rightarrow 2CO$; $Si + O_2 \rightarrow SiO_2$; $4P + 5O_2 \rightarrow 2P_2O_5$ or $P_4 + 5O_2 \rightarrow 2P_2O_5$; $4P + 3O_2 \rightarrow 2P_2O_3$ or $P_4 + 3O_2 \rightarrow 2P_2O_3$; M5 <i>Word equation mark</i> any one of the following word equations calcium oxide + silicon(IV) oxide → calcium silicate; calcium oxide + phosphorus(III/V) oxide → calcium phosphate;	5	(All) elements or (all) impurities react with oxygen A M1 for any one element becoming an oxide A formulae/carbon monoxide A oxides of sulfur/carbon I sulfur trioxide A silicon (di)oxide for silicon(IV) oxide A phosphorus (tri/pent)oxide for phosphorus(III/V) oxide A multiples I state symbols I unbalanced equations R other combustion equations with incorrect species A calcium oxide + silicon(IV) oxide → slag A correct symbol equation for M5 but R other equations with incorrect species used as M5

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Question	Answer	Marks	Guidance
2(b)(i)	Any one from: (making) car (bodies); machinery; chains; pylons; white goods; nails; screws; as a building material; sheds / roofs; reinforcing concrete;	1	A bridges A tools I cutlery
2(b)(ii)	Any one from: knives; drills; railway tracks; machine / cutting tools / hammers; razor blades; chisels;	1	I cutlery items I bridges
2(b)(iii)	M1 atoms or cations or (positive) ions or metal ions; M2 arranged in a lattice or in layers or in rows or in a regular structure; M3 rows or layers slide over one another;	3	I (sea of) electrons R protons or nuclei for M1 A M2 non-directional forces A ECF on particle named in M1 for M3 I 'atoms' slide over one another
2(b)(iv)	M1 carbon atoms or particles in structure different size (to cations); M2 so reduce moving or interrupt movement;	2	R ions and molecules for M1 A M2 for prevents sliding A M2 for 'stops' sliding
3(a)(i)	Zn to Zn ²⁺ ; because electron loss;	2	A because oxidation number has increased for M2

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Question	Answer	Marks	Guidance
3(a)(ii)	(2)H ⁺ or 'hydrogen ion(s)'; it accepts electrons or takes electrons (from zinc atoms);	2	R H ₂ or 'hydrogen' A because it is reduced or because it decreases in oxidation number A it causes zinc to lose electrons
3(b)(i)	zinc displaces copper or zinc more reactive than copper; Zn + CuCl ₂ → ZnCl ₂ + Cu OR Zn + Cu ²⁺ → Cu + Zn ²⁺ ;	2	A copper less reactive than zinc I zinc reacts with copper ions or with Cu ²⁺ or with copper chloride I zinc reacts with copper I Cu ²⁺ ions are reduced A multiples I state symbols
3(b)(ii)	steeper (line) or higher gradient; (means an) increased rate; but the same (final) volume;	3	A less time to complete the reaction / same amount of gas in less time / faster reaction / more gas in the same time period A same volume of hydrogen produced A 'amount' for volume A no extra gas is made
3(c)	M1 less steep (line) or lower gradient; M2 (because of) decreased rate; M3 ethanoic is a weak(er) acid; M4 only partially ionised or dissociated OR lower concentration of hydrogen ions;	4	A alternative phrases e.g. 'shallower' A more time to complete the reaction A same amount of gas in more time A slower rate or slower reaction ORA A not fully dissociated or ionised A ionises less (than HCl) I less hydrogen ions

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Question	Answer	Marks	Guidance
3(d)	M1 moles of HCl = 0.1 (mol); M2 moles of Zn = 0.05 (mol); mass of zinc = 3.25 g;	3	A ECF for M1 $\times \frac{1}{2}$ A ECF for M2 $\times 65$ Unit required for M3
4(a)(i)	Any three from: same general formula; contain the same functional group; consecutive members differ by CH_2 ; common methods of preparation; same or similar chemical properties; physical properties vary in a predictable manner / show trends / show a gradual change / an example of a physical variation e.g. mpt, bpt volatility viscosity;	3	I different physical properties / physical properties change / an unqualified or slight change R same or similar physical properties
4(a)(ii)	propanol / propan-1-ol / propan-2-ol;	1	
4(a)(iii)	if molecular formula is given as $\text{C}_{10}\text{H}_{22}\text{O}$ award 2 marks if not, look for evidence of some correct working for one mark $158 - 17 = 141$ OR $12n + 2n + 1 = 141$ OR $n = 10$	2	A $\text{C}_{10}\text{H}_{21}\text{OH}$ for two marks A $(10 \times 12) + (22 \times 1) + 16 = 158$ for one (working) mark
4(b)	they have the same molecular formula ($\text{C}_4\text{H}_{10}\text{O}$); different structures;	2	A same number of each type of atom I same number of atoms A different structural formula or different arrangement of atoms

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Question	Answer	Marks	Guidance
4(c)(i)	M1 butene or but-1-ene; M2 structural formula of but-1-ene;	2	M1 and M2 are independent A but-2-ene for M1 Minimum acceptable structure is $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ Double bond must be shown R structure of but-2-ene for M2
4(c)(ii)	butyl ethanoate;	1	A butanyl R ethanoate and ethanoic
4(c)(iii)	butanoic acid; structural formula of butanoic acid;	2	A butyric acid Minimum acceptable structure is $\text{CH}_3\text{CH}_2\text{CH}_2\text{CO}_2\text{H}$ A $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ with C–HO connectivity in acid group
5(a)	M1 add chlorine to (potassium) iodide solution; M2 red / brown / yellow / orange (solution) is formed; M3 $\text{Cl}_2 + 2\text{KI} \rightarrow 2\text{KCl} + \text{I}_2$ $\text{Cl}_2 + 2\text{I}^- \rightarrow 2\text{Cl}^- + \text{I}_2$;	3	Solution must be implied for M1 A any soluble iodide solution A black (ppt or solid) A multiples I state symbols but KI(aq) would allow the solution aspect of mark in M1
5(b)	M1 (0.013 moles of I and 0.065 moles of F atoms gives a) ratio 1:5; Formula = IF_5 ;	2	Award 2 marks for IF_5 A one mark for I_5F (as ratio is inverted) A one mark for IF_5 or I_5F

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Question	Answer	Marks	Guidance
5(c)(i)	example of a reversible reaction including attempts at removing / adding waters of crystallisation OR example of a reaction which under closed conditions would be reversible;	1	A written description of the reaction e.g. 'Haber process' unless equation is attempted in which case ignore written description A word equations / unbalanced equations A equations without equilibrium arrows I descriptions of physical changes
5(c)(ii)	Any two from: (a reaction) M1 which can take place in both directions OR which can be approached from both directions; M2 in which concentrations / macroscopic properties do not change (with time); M3 the two reaction rates are equal;	2	I reference to 'closed system' A 'a reaction which can go forwards and backwards' for M1 I 'a reaction with an equilibrium arrow' or with ' $\rightleftharpoons$ ' for M1 R concentrations (of reactants and products) are the same
5(d)	M1 equilibrium goes to LHS OR equilibrium goes to reactants side; M2 because the concentration of chlorine decreases;	2	A reaction goes to LHS but R 'equilibrium goes to LHS and to products side' A backward reaction is favoured I less yield or less products A 'reactant' for 'chlorine' but not reactants A to replace missing chlorine

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Question	Answer	Marks	Guidance
5(e)	M1 equilibrium goes to RHS OR equilibrium goes to products side; M2 exothermic reactions are favoured by low temperatures; M3 the forward reaction is exothermic;	3	A reaction goes to RHS but R 'equilibrium goes to RHS and to reactants side' A forward reaction is favoured I more yield or more products A for M1 and M2 'decreasing temperature makes the equilibrium go to RHS' A backward reaction is endothermic

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Question	Answer	Marks	Guidance
6(a)(i)	M1 proton acceptor; M2 does not accept (protons) readily OR less able to accept protons (than strong bases);	2	A alternative words to 'acceptor' e.g. 'receiver' I references to pH A 'hydrogen ion' or 'H ⁺ ' for proton I accepts fewer / less protons
6(a)(ii)	M1 same <u>concentration</u> of both bases; M2 measure their pH; M3 the higher pH is the stronger base;	3	A suitable method e.g. universal indicator or pH paper or pH meter I litmus or methyl orange or phenolphthalein I titration methods for M2 and M3 A suitable colours of both weak strong bases e.g. ethylamine is (greeny)blue, NaOH is darker blue / purple A alternative methods for M2 and M3 e.g. measure conductivity (M2) and higher conductivity is the stronger base (M3) e.g. add aluminium / Al (M2) and stronger base gives faster rate of effervescence / more fizzing / more bubbling (M3)
6(b)(i)	$2\text{CH}_3\text{CH}_2\text{NH}_2 + \text{H}_2\text{SO}_4 \rightarrow (\text{CH}_3\text{CH}_2\text{NH}_3)_2\text{SO}_4$ species; balancing; the salt is ethylammonium sulfate;	3	A multiples I state symbols A one mark for correct product A close spellings A diethylammonium sulfate

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Question	Answer	Marks	Guidance
6(b)(ii)	sodium hydroxide / calcium hydroxide / NaOH / Ca(OH) ₂ ;	1	A any Group 1 or Group 2 hydroxide or oxide
6(c)(i)	Any two from: (particles move in) random motion; (particles) collide; (particles) move from a region of high concentration to low concentration;	2	A alternative phrases for collide A down a concentration gradient
6(c)(ii)	C; M2 it has a lower (relative) molecular mass (than HBr); M3 ethylamine diffuses faster (than HBr);	3	A ethylamine is less dense A ethylamine is a lighter molecule but I 'ethylamine is lighter' I ethylamine is a smaller molecule A ethylamine molecules or particles move faster A ECF for M2 and M3 if A is given e.g. HBr diffuses faster for M3 because it is a lighter molecule for M2 A ECF for M2 if B is given e.g. they diffuse at same rate for M3 because molecules weigh the same for M2