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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; *All three for 2 marks* *two for 1 mark*	**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)	*Any **two** from:* 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)	*Any **three** from:* 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 *Forming an oxide* (all) elements or (all) impurities become oxides; M2 *Gaseous oxides* carbon dioxide or sulfur (di)oxide escape / are removed as gases; M3 *Acidic oxides* silicon(IV) oxide or phosphorus(III / V) oxide react / are neutralised by calcium oxide / lime; M4 *Equation mark* 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 *Word equation mark* 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; $Zn + CuCl_2 \rightarrow ZnCl_2 + Cu$ **OR** $Zn + Cu^{2+} \rightarrow Cu + Zn^{2+}$;	 **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 × ½ **A** ECF for M2 × 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 $C_{10}H_{22}O$ 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** $C_{10}H_{21}OH$ for two marks **A** (10 × 12) + (22 × 1) + 16 = 158 for one (working) mark
4(b)	they have the same molecular formula ($C_4H_{10}O$); 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 $CH_3CH_2CH=CH_2$ Double bond must be shown **R** structure of but-2-ene for M2
4(c)(ii)	butyl ethanoate;	1	**A** butanyl **R** ethenoate and ethanoic
4(c)(iii)	butanoic acid; structural formula of butanoic acid;	2	**A** butyric acid Minimum acceptable structure is $CH_3CH_2CH_2CO_2H$ **A** $CH_3CH_2CH_2COOH$ with C–HO connectivity in acid group
5(a)	M1 add chlori**n**e to (potassium) iodi**d**e solution; M2 red / brown / yellow / orange (solution) is formed; M3 $Cl_2 + 2KI \rightarrow 2KCl + I_2$ $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$;	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 IFl_5 or I_5Fl

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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 '⇌' 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 dark**er** 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)	$2CH_3CH_2NH_2 + H_2SO_4 \rightarrow (CH_3CH_2NH_3)_2SO_4$ 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

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