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

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(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

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	

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

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

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

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

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

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

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

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

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