1)

A

2)

B

3)

A

4)

A

5)

D

6)

C

7)

C

8)

D

9)

D

10)

C

11)

(a)	B

uestion umber	Correct Answer
(b)	A

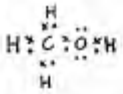
uestion umber	Correct Answer
(c)	C

12)

(b)(i)	Because the ions are free to move (when a potential difference is applied)	Electrons / particles are free to move	1

estion mber	Acceptable Answers	Reject	Mark
(b)(ii)	The cations / barium and calcium (ions) are different sizes Ignore any discussion of reasons (could select either the calcium ion because it has more water molecules associated with it OR the barium ion because it has more shells of electrons and so larger)	Atoms are different sizes	1
(b)(iii)	Mass of calcium ions in 1 kg = 0.100 x 40 (= 4.0) (g) **(1)** If mass quoted must be correct to score first mark Hence 4.0 g per 1000 g of solution So ppm = (4.0/1000) x 1000000 = 4000 (ppm) **(1)** OR Mass of calcium ions in 1 kg = 0.100 x 40.1 (= 4.01) (g) **(1)** Hence 4.01 g per 1000 g of solution So ppm = (4.01/1000) x 1000000 = 4010 (ppm) **(1)** Correct answer alone = 2 marks Allow TE for second mark from incorrect mass		2

13)

(a)	 (1) for around carbon and its hydrogens (1) for around oxygen and its hydrogen Allow all dots or all crosses Ignore circles around atoms		2

estion mber	Acceptable Answers	Reject	Mark
(b)(i)	$C(s)$ / (graphite) + $2H_2(g)$ + $2O_2(g)$ Correct species (1) Allow oxygen above arrows rather than in box Balancing and state symbols (1) Second mark dependent on correct species except as below with either hydrogen or oxygen or both as atoms e.g $C(s)$ / (graphite) + $4H(g)$ + $4O(g)$ Scores second mark		2

estion mber	Acceptable Answers	Reject	Mark
(b)(ii)	Enthalpy / energy / heat(energy) change when one mole of a substance (1) Is formed from its elements (in their most stable / standard states) (1) Under standard conditions of 298K/ 25 °C / any stated temperature AND 1 atm pressure /	heat required / heat given out / heat taken in	3

(b)(iii)	$\Delta H^{\ominus}_c = -\Delta H_1^{\ominus} + \Delta H_2^{\ominus}$ (1) = (2 x −285.8 + −393.5) − (−239.1) = −726 (1) Ignore units Correct answer alone = 2 marks +726 = 1 -440.2 = 1 if omit multiply by 2		2

estion mber	Acceptable Answers	Reject	Mark
(c)(i)	20.7 x 200 x 4.18 = 17305(.2) (J) ignore sf except 1 sf i.e. 20000 OR 20.7 x 200 x 0.00418 = 17.305(2) kJ ignore sf except 1 sf i.e. 20 ignore signs ignore mol^{-1}		1

estion mber	Acceptable Answers	Reject	Mark
(c) (ii)	0.848/32 = 0.0265 (mol) ignore sf except 1 sf i.e. 0.03		1

(c)(iii)	17305.2/0.0265 = −653000 (J mol^{-1}) (3sf) OR −653 (kJ mol^{-1}) (3sf) Ignore missing units but penalise incorrect units Allow TE from (c)(i) & (ii)		1

estion mber	Acceptable Answers	Reject	Mar
(c)(iv)	Any two from As heat/energy absorbed by apparatus / heat/energy 'lost' to surroundings (1) methanol not completely burnt / incomplete combustion (1) methanol 'lost' by evaporation (1) cannot ensure all products are at standard conditions at end of reaction / water is produced as a gas / reaction not carried out in the standard conditions (1)	just heat/energy loss just incomplete reaction	2

14)

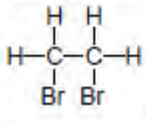
(a)(i)	Crude oil / petroleum / coal	Oil on its own / Natural gas / fossil fuels / any named fraction of crude oil	1

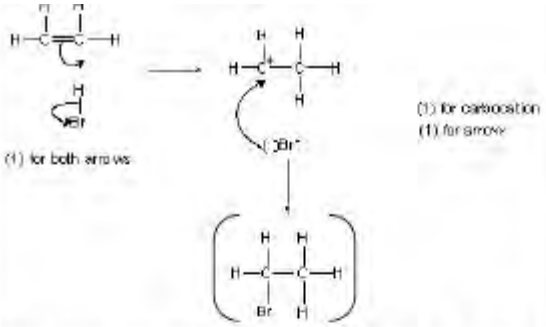
estion mber	Acceptable Answers	Reject	Mar
(a)(ii)	use of high temperatures / heat (in the absence of air) / thermal decomposition / catalysts (1) Either to break large molecules / to form smaller molecules / to break bonds in large molecules / to break carbon-carbon bonds (1) OR producing alkenes / producing carbon-carbon double bonds (1)		2

(a)(iii)	Risks **(2)** Amendments **(2)** Mark all 4 points independently If escaping gases linked to 2 amendments but no risk mentioned then allow 1 for risk	Dangerous collect in syringe	4

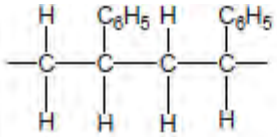
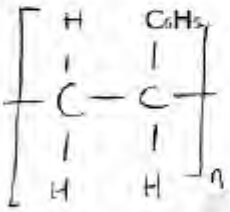
Risk	Amendment
exposure to harmful / toxic fumes	Set up in fume cupboard
Escape of flammable / harmful / toxic reactants or products from ill fitting bung	Correct fitting of bung
Escape of flammable / harmful /toxic reactants or products from poorly positioned delivery tube	Placement of delivery tube below mouth of test tube / use a longer delivery tube
suck back	Attach Bunsen valve / remove delivery tube from water before stopping heating etc

uestion umber	Acceptable Answers	Reject	Mark
(b)(i)	Reagent - Hydrogen/H_2 **(1)** Catalyst - Nickel/Ni/palladium/Pd/platinum/Pt **(1)** Mark independently		2

uestion umber	Acceptable Answers	Reject	Mark
(b)(ii)	1,2 - dibromoethane **(1)** ignore punctuation  **(1)** Mark independently Allow CH_2BrCH_2Br	1,2 - bromoethane dibromoethane Skeletal formula $C_2H_4Br_2$	2
(b)(iii)	From purple / pink → colourless	clear	1

(c)(i)	 arrow from bromide ion can start from any part of the bromide ion and can go towards the C or the + sign on the intermediate bromide ion must show negative charge allow 2 max for addition of Br_2 and any other electrophilic additions half headed arrows used throughout penalise only once	δ- on bromide ion for third mark	3

Question Number	Acceptable Answers	Reject	Mark
(c)(ii)	Bromine / bromide / hydrogen could add to either carbon (in the double bond) / bromide / bromine could add to either primary or secondary carbocation / (propene is unsymmetrical) so could form 1-bromopropane and / or 2-bromopropane. Allow correct structural or displayed formulae.	bromine could add to any of the three carbons	1

(d)	 position of hydrogen atoms and phenyl groups **(1)** Allow phenyl groups on 2nd and 3rd carbon OR 1st and 4th OR 1st and 3rd carbon carbon single bonds and continuation bonds **(1)** second mark not awarded for incorrect monomer  **(1)** max with or without square brackets and n or numbers Do not penalise H from phenyl groups attaching to carbon chains Ignore extra square brackets, numbers and 'n' provided 2 monomer units shown		2
(e)(i)	Any two (raw material for) paper cup requires cutting down trees **(1)** polystyrene cup uses less energy (280 kWh rather than 980 kWh) to produce so less CO_2 released / less fossil fuels **(1)** polystyrene cup releases less sulfur based compounds into air so less chance of forming acid rain / less chance of damaging buildings / acidifying lakes (produces 3.5 kg rather than 11 kg) **(1)** polystyrene cup releases no chlorine compounds which damages ozone layer / poisonous (produce 0 kg rather than 0.4 kg) **(1)** 2 pieces of data chosen with no explanation allow 1 mark Ignore comments regarding water		2

(e)(ii)	2 additional factors e.g ease of recyclability whether cup is easy to reuse space taken up in landfill type and amount of gases formed if incinerated useful heat obtained if incinerated biodegradeability / how long they take to decompose management of gases produced during decomposition durability / how long the cup lasts method of disposal Ignore comments regarding atom economy Ignore comments regarding acid rain / ozone layer / greenhouse gases unless linked to gases produced during disposal		2

15)

(a)	$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$ ALLOW $MgCO_3(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + CO_2(g) + H_2O(l)$ All formulae and balancing (1) State symbols - mark independently; can be given even if eg $MgCl_2$ formula incorrect or for $H_2CO_3(aq)$(1) $CO_3^{2-}(s) + 2H^+(aq) \rightarrow CO_2(g) + H_2O(l)$ (1 mark max) ALLOW 1 missing/incorrect state symbol		2

Question Number	Acceptable Answers	Reject	Mar
(b)	Any two from Bubbles (of gas)/ fizzing/ effervescence (1) Solid disappears/ disintegrates /gets smaller /dissolves OR $MgCO_3$ disappears (if given as solid in (i)) (1) IGNORE clear solution forms Mixture gets warmer/cooler OR temperature change occurs/ heat change occurs(1)	 Carbon dioxide /gas given off Precipitate forms (no TE for $MgCl_2(s)$) Just "exothermic"	2

Question Number	Acceptable Answers	Reject	Mar
(c) (i)	Moles acid = ((25 x 2/ 1000)) = 0.05/0.050 / $5x10^{-2}$ Ignore units and sf		1

(c) (ii)	Mass Mg CO_3 = ((0.05 x 84.3÷2)) = 2.1075/ 2.108 /2.11/2.1 (g) ALLOW TE from (c)(i) and (a) ALLOW Moles acid x 84.3 ÷2 for TE(from (i) (1) (4.2(15)) if factor of 2 missing for TE from (a)) Ignore sf except 1 sf Ignore units	2 / 2.12(g)	1
(c) (iii)	To ensure all acid reacts/ all acid is used up / to ensure product is neutral/ it (HCl) is neutralised	All reactants used up To ensure reaction is complete (without reference to HCl) To ensure yield is high To ensure magnesium carbonate is in excess	1

estion mber	Acceptable Answers	Reject	Mark
(c) (iv)	Filter ALLOW centrifuge/ decant/ pour off / (use) filter paper Ignore comments about heating solution first to concentrate it	Sieve Collect $MgCl_2$ in filter paper Use filter paper to dry crystals Evaporate	1
(c) (v)	100% yield = (203.3 x 0.025) /5.08(25)g) (1) yield = $\frac{(3.75 \times 100)}{5.08}$ = **74 %** (1) OR Mol magnesium chloride = $\frac{(3.75}{203.3)}$ = 0.018445/0.01845/0.0184/0.018 (1) yield = $\frac{(100 \times 0.01845)}{0.025}$ = **74 %** (1) Second mark can be given as TE if expected yield or number of moles is wrong. ALLOW 73.82/73.78/73.8 /73.6 /other answers rounding to 74 % from earlier approximations /72 (from 0.018 moles) Allow TE from (a) and or (c)(i) and or (c)(ii) If the ratio HCl to $MgCl_2$ is 1:1 ans 37 % (2) If moles of HCl in (c)(i) are wrong (2) If (a) and (c)(i) are correct 37 % scores (1) If moles $MgCO_3$ = 0.05 allow TE giving 37/ 36.9% Ignore sf except 1 sf	70	2

(c) (vi)	Some stays in solution / losses on transferring from one container to another/ loss on filtering /crystals left behind/some left on filter paper etc Any one ALLOW correct answers with other comments which are not incorrect eg "there may be some spillage and also ....."	Incomplete reaction/side reaction Lost as waste products Lost to environment Lost in manipulation? Hydrolysis Weighing errors Just "spillage"	1

uestion mber	Acceptable Answers	Reject	Mar
(d)(i)	Not 100% ionic /almost completely ionic OR (partial) covalent character/ almost no covalency OR Discrepancy in BH values indicates polarisation (of ions) (1) *Mark can be given if answer here refers to bond strength and the answer above is included in (ii)*	Magnesium chloride is covalent Magnesium chloride is partially ionic Just "polarity of ions"	1

uestion mber	Acceptable Answers	Reject	Mar
(d)(ii)	QWC I^- larger (than Cl^-) (1) so (ion) easier to polarise /distort (1) ALLOW for 2nd mark increases covalent character / more covalent than $MgCl_2$ / converse for $MgCl_2$ / description of polarisation instead of the term If clearly ions, allow reference to iodine instead of iodide ("iodine has a larger ion") Read in conjunction with (i). Direct comparison not needed if (i) covers bonding in chloride.	Size of atoms rather than ions I_2 is larger than Cl_2 I_2 molecules are polarised Mg^{2+} is polarised Iodine more electronegative than chlorine	2

mber			
(e) (i)	$\frac{(100 \times 20)}{10^6} = 2 \times 10^{-3}$(g) ALLOW 0.002(g) 1/500 (g) 2×10^{-6} kg IGNORE % as unit	$2 \times 10^{-3} = 0.0002$	1

mber			
(e) (ii)	(More) soluble (in water)/ (more) soluble in blood stream/ can be given as solution/ won't produce gas in stomach / won't react with stomach acid/ doesn't produce CO_2 Converse answers for $MgCO_3$ Or other valid answers ALLOW can be given in liquid form	$MgCl_2$ is a liquid $MgCO_3$ is too reactive	1