JABchem

Past Papers Higher Chemistry

2003

Marking Scheme

Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	76+	%
B	62+	%
C	49+	%
D	?	%
No award	?	%

2003 Higher Chemistry Marking Scheme

MC Qu	Answer	% Pupils Correct	Reasoning
1	C	81	☒A Argon is monatomic and does not conduct in any state. ☒B Potassium has metallic bonding and conducts when solid and liquid ☑C Potassium fluoride is ionic. Conducts as a liquid but not as a solid ☒D tetrachloromethane is covalent and does not conduct in any state.
2	D	64	☒A $HCl(g) \rightarrow H^+(aq) + Cl^-(aq)$ ☒B $SO_2(g) + H_2O(l) \rightleftharpoons 2H^+(aq) + SO_3^{2-}(aq)$ ☒C $NH_3(g) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$ ☑D CH_4 is non-polar covalent and does not dissolve in a polar solvent like water.
3	B	52	☒A Adding ions will speed up corrosion (ions complete the circuit better) ☑B glucose is covalent so does not help complete the circuit like an ionic compound would ☒C iron nail will sacrificially corrode faster to protect copper wire attached ☒D CO_2 dissolves in water to form carbonic acid. H^+ reacts with iron (and more ions complete the circuit better)
4	C	31	N_2 molecule 1: $^{14}N\equiv{}^{14}N$ N_2 molecule 2: $^{14}N\equiv{}^{15}N$ N_2 molecule 3: $^{15}N\equiv{}^{15}N$
5	D	57	Formula of sodium sulphate = Na_2SO_4 → 0.2mol of sulphate ions ∴ 0.4mol Na^+ ions Formula of sodium chloride = NaCl → 0.6mol chloride ∴ 0.6mol Na^+ ions Total no. of mol Na^+ ions = 0.4mol + 0.6mol = 1.0mol
6	B	41	☒A Acid in excess → increased concentration of acid would produce same volume of gas more quickly ☑B Increasing mass of $CuCO_3$ → more gas produced → More loss of mass → Line shifts from P to Q ☒C Decreasing particle size → stepper initial line but same mass loss at end of reaction ☒D Adding a catalyst would not change the mass loss from the flask (just the initial steepness)
7	C	69	1mol butanal = 72g (in question) 3.6g butanal ⇔ -134kJ (-ve sign as heat is released) 1mol = 72g butanal ⇔ $-134kJ \times {}^{72}/_{3.6} = -2680kJ\ mol^{-1}$
8	B	58	☒A ΔEneg. = 3.0 – 1.0 = 2.0 ☑B ΔEneg. = 3.0 – 0.8 = 2.2 (Most ionic character has biggest electronegativity difference) ☒C ΔEneg. = 3.0 – 1.5 = 1.5 ☒D ΔEneg. = 3.0 – 1.0 = 2.0
9	C	66	☒A reactant molecule is diatomic and is not a gas ☒B reactant molecule is diatomic and bond must be broken first ☑C 1^{st} ionisation energy: Gaseous free atoms with 1 electron removed per atom ☒D Positive ions are formed by 1^{st} ionisation energy
10	D	59	☒A Boron is covalent network (mpt = 2075°C) ☒B Carbon (diamond) is covalent network (sublimes at = 3825°C) ☒C Silicon is covalent network (mpt = 1414°C) ☑D sulphur comes in S_8 discrete molecules (mpt=115°C)
11	D	55	☒A $BaCl_2$ is ionic ∴ not soluble in non-polar CCl_4 ☒B CsCl is ionic ∴ not soluble in non-polar CCl_4 ☒C $CaCl_2$ is ionic ∴not soluble in non-polar CCl_4 ☑D PCl_3 is covalent ∴ most likely to be soluble in non-polar CCl_4
12	A	63	☑A CH_3COOH has –OH bonds to form hydrogen bonds between molecules ☒B $CH_3CH_2OCOCH_3$ has no –OH bonds (or N-H or H-F bonds) to form hydrogen bonds ☒C C_6H_{14} has no N, O or F attached to H to from hydrogen bonds ☒D C_6H_{12} has no N, O or F attached to H to from hydrogen bonds

13	B	41	☒A Not metallic as bpt is-33°C and metals do not dissolve in water ☑B polar covalent compounds dissolve in water (NH_3 has bpt of -33°C and forms an alkaline solution) ☒C Bpt too low to be ionic bonding (ionic compounds have higher mpt and bpt) ☒D non-polar covalent compounds do not dissolve in polar solvents like water
14	D	58	Ionic formula of calcium phosphate = $(Ca^{2+})_3(PO_4^{3-})_2$ 1mol calcium phosphate = 5 mol of ions (3mol of Ca^{2+} ions and 2 mols of PO_4^{3-} ions)
15	C	57	☒A 1mol C atoms =12g → 2mol of C present → 2L (2xAvogadro's Constant) ☒B 1mol O_2 molecules =32g → $\frac{1}{2}$mol of O_2 present → $\frac{1}{2}$L ($\frac{1}{2}$xAvogadro's constant) ☑C 1mol H_2 molecules = 2g → 1mol of H_2 present → 1L (1xAvogadro's constant) ☒D 1litre of 1mol l^{-1} = 1mol of NaCl solution → 2mol ions present → 2L
16	C	72	$C_4H_{10}(g) + 6\frac{1}{2}O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$ 1mol 6.5mol 4mol 5mol 1vol 6.5vol 4vol – (liquids have negligible volume compared to gases) 1litre 6.5 litres
17	A	80	☑A reforming turns straight chains into branched and ring/aromatic hydrocarbons ☒B propane has 3 carbons, cracking makes molecules smaller (aromatics have minimum 6 carbons) ☒C Steam reforming of coal produces synthesis gas (carbon monoxide + hydrogen) ☒D catalytic cracking of heavy oil fractions can produce petrol and unsaturated compounds for plastics
18	C	65	☒A RAM=44 → 3C + 8H = 36+8=44 → C_3H_8 ∴ propane (alkane) ☒B RAM=72 → 5C + 12H = 60+12=72 → C_5H_{12} ∴ pentane (alkane) ☑C RAM=84 → 6C + 12H = 72+12=84 → C_6H_{12} ∴ hexene (alkene) ☒D RAM=100 → 7C + 16H = 84+16=100 → C_7H_{16} ∴ heptane (alkane)
19	A	38	☑A 1,1,2-trichloroethene has no isomer (always rearranged back to same C_2HCl_3 molecule) ☒B 1,1-dichloroethane CH_3CHCl_2 and 1,2-dichloroethane CH_2ClCH_2Cl are isomers ☒C Propene C_3H_6 and cyclopropane C_3H_6 are isomers ☒D propan-1-ol $CH_3CH_2CH_2OH$ and propan-2-ol $CH_3CH(OH)CH_3$ are isomers
20	B	85	☒A Primary alcohol: 1 carbon directly attached to the carbon with the –OH group ☑B Tertiary alcohol: 3 carbons directly attached to the carbon with the –OH group ☒C Secondary alcohol: 2 carbons directly attached to the carbon with the –OH group ☒D Secondary alcohol: 2 carbons directly attached to the carbon with the –OH group
21	A	74	4-methylpentan-2-ol is secondary alcohol → oxidises to ketone 4-methylpentanone 4-methylpentan-2-ol → $CH_3CH(CH_3)CH_2CH(OH)CH_3$ → $C_6H_{14}O$ → 102g mol^{-1} 4-methylpentanone → $CH_3CH(CH_3)CH_2COCH_3$ → $C_6H_{12}O$ → 100g mol^{-1}
22	C	63	propanol → propene + water $CH_3CH_2CH_2OH$ → $CH_3CH{=}CH_2$ + H_2O (dehydration reaction)
23	D	87	☒A oxides of carbon: CO (poisonous) and CO_2 (greenhouse gas) have no effect on the ozone layer ☒B hydrocarbons do not react with ozone e.g. remnants of benzene are carcinogenic ☒C SO_2 is an acid rain gas ☑D Chlorofluorocarbons (CFCs) breakdown ozone (O_3)
24	D	83	Polyester fibres are linear, cured polyester resins are cross-linked
25	A	50	Amine groups ($-NH_2$) are most similar to ammonia NH_3
26	D	69	☒A Fats & oils have no cross links between chains ☒B hydrolysis of fats & oils produces glycerol and 3 fatty acids ☒C carbon chain lengths do not chain in hardening of oils into fats ☑D Hardening of oils to fats involves hydrogenation (addition of H_2 across C=C bonds)
27	C	52	In fats & oils, fatty acids usually react with –OH groups in glycerol Sucrose has 8x –OH groups which fatty acids can react with.

28	A	91	Denaturing proteins always involves in changing the shape of the protein
29	B	70	☒A Has to be purified from crude oil, etc ☑B Natural gas is mainly methane ☒C Has to be made by molten electrolysis of Al_2O_3 ☒D Made in a blast furnace by reacting Fe_2O_3 with carbon
30	A	79	Equation ❷: $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\Delta H = q$ Equation ❸: $S + O_2 \rightarrow SO_2$ $\Delta H = r$ Equation ❹x-1: $H_2O + SO_2 \rightarrow H_2S + 1\frac{1}{2}O_2$ $\Delta H = -s$ Equation ❶=❷+❸+❹': $S + H_2 \rightarrow H_2S$ $\Delta H = p = q + r - s$
31	D	83	☒A rate of forward reaction and rate of reverse reaction increase equally ☒B rate of forward reaction and rate of reverse reaction increase equally ☒C Equilibrium position in unchanged but is reached more quickly ☑D Equilibrium position in unchanged
32	B	68	ICl_3 solid is a product ∴ for more products to be formed more forward reaction is required. Forward reaction is exothermic so <u>decreasing temperature</u> will favour the forward reaction Forward reaction lowers pressure so <u>increasing pressure</u> will favour forward reaction
33	A	75	Ethanoic acid is a weak acid (only partially dissociates) 0.1mol l^{-1} is classified as a dilute solution.
34	D	94	$[OH^-] = 1 \times 10^{-2}$ mol l^{-1} $[H^+] \times [OH^-] = 10^{-14}$ ∴ $[H^+] = 10^{-14} \div [OH^-] = 10^{-14} \div 10^{-2} = 1 \times 10^{-12}$mol l^{-1}
35	B	60	☒A ethanoic acid: pH<7 → dilution will raise pH to 7 ☑B sodium chloride: pH still 7 and dilution will decrease conductivity as there is less ions ☒C sodium hydroxide: pH>7 → dilution will lower pH to 7 ☒D nitric acid: pH<7 → dilution will raise pH to 7
36	D	53	Equation ❶x5: $10I^- \rightarrow 5I_2 + 10e^-$ Equation ❷x2: $2MnO_4^- + 16H^+ + 10e^- \rightarrow 2Mn^{2+} + 8H_2O$ Add ❶' + ❷': $2MnO_4^- + 16H^+ + 10I^- \rightarrow 2Mn^{2+} + 8H_2O + 5I_2$ 2mol 10mol 1mol 5mol
37	C	27	Oxidising agent: Oxidises something else but is reduced (hydrogen gains e^-) it self ☒A Addition Reaction: no transfer of electrons ☒B no transfer of electrons ☑C $H_2 + 2Na \rightarrow 2Na^+H^-$: Na is oxidised and H_2 gains electrons (reduction) to become $2H^-$ ions ☒D H_2 is acting as reducing agent: $Cu^{2+} + 2e^- \rightarrow Cu$ (reduction)∴H_2 must be oxidised
38	C	58	☒A Half-life must be the same for the same isotope of lead ☒B Half-life must be the same for the same isotope of lead ☑C Same lead isotope means same half life & different intensity due to concentration ☒D Intensity of radiation will be different as there is less radioactive lead in the solution
39	A	69	β-emission: neutron splits into proton (stays in nucleus) and electron (ejected from nucleus) β-emission: atomic number increases +1 and Mass number stays same
40	B	78	☒A Nuclear fisson: large atoms split into smaller atoms ☑B Nuclear fusion: small atoms join together top become a bigger atom ☒C Proton capture: Proton absorbed into nucleus ☒D Neutron capture: neutron absorbed into the nucleus of atom.

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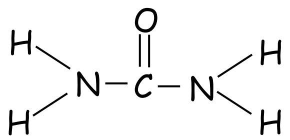
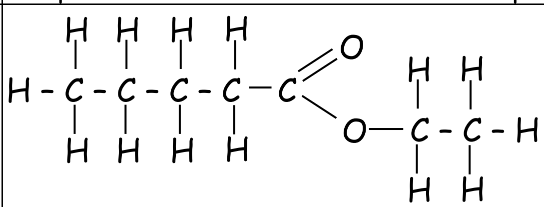
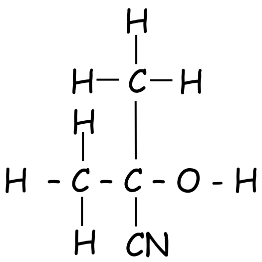
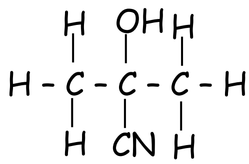
<table>
<tr><th>Long Qu</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>1a</td><td>2,3,3-trimethylpentane</td><td>a) identify longest carbon chain (no functional group to decide numbering system → pentane
b) identify side-groups → 3x methyl groups → trimethyl
c) give side-groups lowest numbering system → 2,3,3-trimethylpentane lower than 3,3,4-trimethylpentane</td></tr>
<tr><td>1b</td><td>Cycloalkanes or aromatics/benzenes</td><td>Ring structures like cycloalkanes and benzene-based aromatic compounds help to keep molecules apart due to irregular shape preventing premature auto-ignition</td></tr>
<tr><td>2a</td><td>Very strong</td><td>Kevlar is used in bullet-proof vests due to its strength, coming from hydrogen bonds at regular intervals between on the linear fibres of kevlar.</td></tr>
<tr><td>2b</td><td>Amide link</td><td>The amide link on plastics is the same group of bonds as the peptide link in proteins.</td></tr>
<tr><td>3a</td><td>Graph showing points at:</td><td><table><tr><td>Time (days)</td><td>0</td><td>140</td><td>280</td><td>420</td><td>560</td></tr><tr><td>Mass of ^{210}Po (g)</td><td>200</td><td>100</td><td>50</td><td>25</td><td>12.5</td></tr></table></td></tr>
<tr><td>3b</td><td>$^{210}_{84}Po \rightarrow ^{206}_{82}Pb + ^{4}_{2}He$</td><td>$\alpha$-emission: atomic number decreases by 2 and mass number decreases by 4</td></tr>
<tr><td>3c</td><td>3.01×10^{23}</td><td>1 mol ^{210}Po = 210g = 6.02×10^{23} atoms
105g = $6.02 \times 10^{23} \times {}^{105}/_{210} = 3.01 \times 10^{23}$ atoms</td></tr>
<tr><td>4a</td><td>Reaction produces molten iron which can be used to fill in cracks in line</td><td>Reaction mixture is ~3000°C and iron melts at 1538°C.
Molten iron will pour into mould to repair crack in railway line.</td></tr>
<tr><td>4b</td><td>$-851 kJ\ mol^{-1}$</td><td>Equation ❶: $2Al + 1\frac{1}{2}O_2 \rightarrow Al_2O_3$ $\Delta H = -1676 kJ\ mol^{-1}$
Equation ❷ x-1: $Fe_2O_3 \rightarrow 2Fe + 1\frac{1}{2}O_2$ $\Delta H = \underline{+825} kJ\ mol^{-1}$
Add ❶ +❷': $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$ $\Delta H = \underline{-851} kJ\ mol^{-1}$</td></tr>
<tr><td>5a</td><td>Synthesis gas</td><td>Synthesis gas is a mixture of carbon monoxide and hydrogen gas.
Synthesis gas is made be steam reforming coal or natural gas</td></tr>
<tr><td>5b</td><td>oxidation</td><td><table><tr><td rowspan="3">Oxidation of alcohols</td><td>Primary alcohol → aldehyde → carboxylic acid</td></tr><tr><td>Secondary alcohol → ketone —×→ [No oxidation]</td></tr><tr><td>Tertiary alcohol —×→ [No oxidation]</td></tr></table></td></tr>
<tr><td>5c(i)</td><td></td><td>$-NH_2$ on ether end of CO.
Carbon makes 4 bonds and 2 bonds go to the 2 $-NH_2$ groups
∴Carbon must make double bond with O (C=O carbonyl group)</td></tr>
<tr><td>5c(ii)</td><td>thermosetting</td><td>Thermosetting plastics do not soften/melt on heating
Thermoplastic materials soften/melt on heating</td></tr>
<tr><td>6a(i)</td><td>Reactant vapours are flammable</td><td>Alcohols and carboxylic acids are flammable ∴ no naked flames should be used</td></tr>
<tr><td>6a(ii)</td><td>Condenser</td><td>The wet paper towel gives a cold surface for any vapours to condense on and prevent/reduce loss of flammable vapour from the test tube</td></tr>
<tr><td>6b</td><td>Diagram showing:</td><td></td></tr>
<tr><td>6c</td><td>7.12g</td><td>1 mol CH_3CH_2OH = (2x12) + (6x1) + (1x16) = 24+6+16 = 46g
CH_3CH_2OH + C_4H_9COOH → $CH_3CH_2OCOCH_2CH_2CH_2CH_3$ + H_2O
1mol, 1mol → 1mol, 1mol
46g → 130g
3.6g → 130g $\times {}^{3.6}/_{46}$ = 10.17g (theoretical)
$\% \text{ Yield} = \frac{\text{Actual}}{\text{Theoretical}} \times 100$ ∴ $\text{Actual} = \text{theoretical} \times \frac{\% \text{ Yield}}{100} = 10.17g \times \frac{70}{100} = 7.12g$</td></tr>
</table>

<table>
<tr><td>7a</td><td>Magnesium in excess</td><td>No. of mol HCl = volume x concentration = 0.05 x 4 = 0.2mol
no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{4.0}{24.3}$ = 0.165mol
$Mg + 2HCl \rightarrow MgCl_2 + H_2$
1mol 2mol
0.165mol 0.330mol (NB only 0.2mol HCl available ∴ HCl is limiting reactant)
0.1mol 0.2mol (NB 0.1 mol of Mg needed + 0.165mol available ∴ Mg in excess)</td></tr>
<tr><td>7b</td><td>System where gas bubbles through water before going to syringe</td><td></td></tr>
<tr><td>7c</td><td><table><tr><td>Rate of reaction</td><td>slower</td></tr><tr><td>Volume of gas produced</td><td>same</td></tr></table></td><td>Ethanoic acid is a weak acid with less H^+ ions present at any one time due to partial dissociation of CH_3COOH molecules ∴ <u>slower reaction rate</u> of Mg + CH_3COOH. As the same volume and concentration of CH_3COOH was used, the equilibrium moves to replace the reacted H^+ ions ∴ same total no of H^+ moles are reacted giving the <u>same volume of gas</u></td></tr>
<tr><td>8a(i)</td><td>Answer to include:</td><td>Aldehydes have at least 1 hydrogen on the end of the carbonyl C=O group, ketones have carbon groups on both ends of C=O.</td></tr>
<tr><td>8a(ii)</td><td>blue → brick red
(or blue → orange)</td><td><table><tr><th>Oxidising agent</th><th>Start Colour</th><th>End Colour</th></tr><tr><td>Acidified Dichromate</td><td>Orange</td><td>Green</td></tr><tr><td>Benedict's/Fehling's</td><td>Blue</td><td>Brick Red (orange)</td></tr><tr><td>Hot copper (II) oxide</td><td>Black</td><td>Brown</td></tr><tr><td>Tollen's Reagent</td><td>(Colourless)</td><td>Silver mirror produced</td></tr></table></td></tr>
<tr><td>8a(iii)</td><td>$C_3H_6O + H_2O$
↓
$C_2H_5COOH + 2H^+ + 2e^-$</td><td>1. Balance atoms (other than H and O) $C_3H_6O \rightarrow C_2H_5COOH$
2. Balance O by adding H_2O to other side $C_3H_6O + H_2O \rightarrow C_2H_5COOH$
3. Balance H by adding H^+ to other side $C_3H_6O + H_2O \rightarrow C_2H_5COOH + 2H^+$
4. Balance charge by adding e^- to most positive side $C_3H_6O + H_2O \rightarrow C_2H_5COOH + 2H^+ + 2e^-$</td></tr>
<tr><td>8a(iv)</td><td>Propanoic acid</td><td>-COOH group is the carboxyl group found in carboxylic acids
∴ 3 carbon carboxylic acid is called propanoic acid</td></tr>
<tr><td>8b(i)</td><td>addition</td><td>Addition reaction: small compound adds across a double bond.</td></tr>
<tr><td>8b(ii)</td><td>One from:</td><td> also drawn as </td></tr>
<tr><td>9a</td><td>Total volume of liquid not same in each experiment</td><td><table><tr><td>Volume of Iodide</td><td>25cm³</td><td>20 cm³</td><td>15 cm³</td><td>10 cm³</td><td>5 cm³</td></tr><tr><td>Volume of Water</td><td>0 cm³</td><td>5 cm³</td><td>10 cm³</td><td>15 cm³</td><td>20 cm³</td></tr></table></td></tr>
<tr><td>9b</td><td>Answer to include:</td><td>1. Start timer at same time as addition of hydrogen peroxide to reduce error
2. Use a $10cm^3$ measuring cylinder instead of $100cm^3$ measuring cylinder to reduce error</td></tr>
<tr><td>10a</td><td>Rate of forward reaction equals rate of reverse reaction</td><td>Equilibrium is when the rate of the forward reaction equals the rate of the reverse reaction. The concentrations of reactants and products are constant (<u>not</u> equal!)</td></tr>
<tr><td>10b</td><td>Iodine moves from top layer to lower layer</td><td>Iodine is three times more soluble in chloroform than in water. Iodine is added to the top layer (water) and to maintain the equilibrium Iodine leaves the water layer and moves into the chloroform layer (bottom)</td></tr>
<tr><td>10c</td><td>$30g\ l^{-1}$</td><td>$\frac{[I_2]_{chloroform}}{[I_2]_{water}} = \frac{3}{1}$ ∴ $[I_2]_{chloroform} = 3x\ [I_2]_{water}$
∴ 3 times more iodine dissolved in chloroform layer than water layer
If 0.4g of Iodine added: $(0.3g\ I_2/10cm^3)_{chloroform} = (0.1g\ I_2/10cm^3)_{water}$
∴0.3g I_2 in $10cm^3$ chloroform
30g I_2 in $1000cm^3$ chloroform</td></tr>
</table>

<table>
<tr><td>11a</td><td>Curve Peaks at 75kJ mol^{-1}
Curve Falls to -26kJ mol^{-1}</td><td>Exothermic reaction: Products must have lower potential energy than reactants</td></tr>
<tr><td>11b(i)</td><td>Heterogeneous</td><td>Heterogeneous catalysts: catalyst and reactant(s) in different states
Homogeneous catalysts: catalyst and reactant(s) in same state</td></tr>
<tr><td>11b(ii)</td><td>Curve peaks between
0 to 75kJ mol^{-1}</td><td>Catalysts lower the activation energy required for a reaction.</td></tr>
<tr><td>11c(i)</td><td>1.2cm^3 s^{-1}</td><td>$\text{Rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}} = \frac{36-24}{20-10} = 1.2\ cm^3\ s^{-1}$</td></tr>
<tr><td>11c(ii)</td><td>0.113g</td><td>Final volume of oxygen produced = 40cm^3 = 0.04litres
$\text{no. of mol } O_2 = \frac{\text{Volume}}{\text{Molar Volume}} = \frac{0.04\text{litres}}{24\text{ litres mol}^{-1}} = 0.00167\text{mol}$
$2H_2O_2 \rightarrow 2H_2O + O_2$
2mol 2mol 1mol
0.00333mol 0.00167mol
gfm H_2O_2 = (2x1) + (2x16) = 2+32 = 34g
mass H_2O_2 = no. of mol x gfm = 0.00333 x 34 = 0.113g</td></tr>
<tr><td>12</td><td>Answer must include:</td><td>Propane is a non-polar covalent compound. Only Van der Waals attractions between propane molecules. Propane is a gas at room temperature because propane molecules are far enough apart to be a gas due to the weak attractions between the molecules.
Ethanol is a polar covalent compound with hydrogen bonding between the molecules due to the presence of the –O-H bonds. Due top the hydrogen bonding, ethanol molecules are much closer together, close enough for ethanol to be a liquid at room temperature.</td></tr>
<tr><td>13a</td><td>10^{-8}</td><td><table>
<tr><td>pH</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td></tr>
<tr><td>[H^+]</td><td>10^0</td><td>10^{-1}</td><td>10^{-2}</td><td>10^{-3}</td><td>10^{-4}</td><td>10^{-5}</td><td>10^{-6}</td><td>10^{-7}</td><td>10^{-8}</td><td>10^{-9}</td><td>10^{-10}</td><td>10^{-11}</td><td>10^{-12}</td><td>10^{-13}</td><td>10^{-14}</td></tr>
<tr><td>[OH^-]</td><td>10^{-14}</td><td>10^{-13}</td><td>10^{-12}</td><td>10^{-11}</td><td>10^{-10}</td><td>10^{-9}</td><td>10^{-8}</td><td>10^{-7}</td><td>10^{-6}</td><td>10^{-5}</td><td>10^{-4}</td><td>10^{-3}</td><td>10^{-2}</td><td>10^{-1}</td><td>10^0</td></tr>
</table></td></tr>
<tr><td>13b</td><td>Strong alkali
Weak acid</td><td>Potassium cyanide salt is made from potassium hydroxide (strong alkali) and hydrogen cyanide (weak acid). Salts made from strong alkali and weak acid are alkaline.</td></tr>
<tr><td>13c</td><td>HCN</td><td>Acids always contain H^+ ions. Other ion in acid is cyanide CN^- ion.</td></tr>
<tr><td>14a</td><td>carbon dioxide
ammonia
sodium chloride solution</td><td>Follow the in arrows into the Solvay Tower in the diagram.</td></tr>
<tr><td>14b</td><td>Equation 1: ΔH = +ve
Equation 2: ΔH = -ve</td><td>$CaCO_3 \rightarrow CaO + CO_2$: Endothermic reaction as carbonates decompose when heated
$C + O_2 \rightarrow CO_2$: Combustion of carbon is always exothermic</td></tr>
<tr><td>14c</td><td>$Ca(OH)_2 + 2NH_4Cl$
↓
$CaCl_2 + 2H_2O + 2NH_3$</td><td>$Ca(OH)_2 + 2NH_4Cl \longrightarrow CaCl_2 + 2H_2O + 2NH_3$</td></tr>
<tr><td>14d</td><td>Sodium carbonate is soluble but magnesium carbonate is insoluble</td><td>Magnesium ions are removed by precipitation of magnesium carbonate.
Soluble sodium carbonate goes into the reaction to provide the carbonate ions to precipitate out the magnesium ions</td></tr>
<tr><td>14e</td><td>Inexpensive raw materials &
Recycling of unused reactants</td><td>Limestone, coke, air and seawater are all inexpensive raw materials in this reaction
Other reactants are recycled to save money</td></tr>
<tr><td>15a</td><td>Hydrolysis</td><td>Hydrolysis: Proteins → amino acids
Condensation: Amino acids → proteins</td></tr>
<tr><td>15b(i)</td><td>NH_2
|
H – C – H
|
COO^-</td><td>In alkaline pH, H^+ ions are removed from -COOH to form $-COO^-$ ion

In acidic pH, H^+ ions are added to $-NH_2$ group to form $-NH_3^+$ ion</td></tr>
<tr><td>15b(ii)</td><td>A – least furthest to Right
B – furthest to Right
C – To right between A + B</td><td>A – Only one +ve charge ($-NH_3^+$) and is heaviest
B – Two +ve charges ($-NH_3^+$) and is lightest
C – Only one +ve charge ($-NH_3^+$) but is lighter than A</td></tr>
</table>

16a	23.9 litres	Q=It = 0.5A x (14x60)seconds = 420C $2H^+$ + $2e^-$ → H_2 2mol 2mol 1mol 2x96500C 1mol 193000C 1mol 420C 1mol x $^{420}/_{193000}$ = 0.00218mol 0.00218mol H_2 = 0.052litres H_2 Molar volume = 1 mol H_2 = 0.052litres x $^{1}/_{0.00218}$ = 23.9litres
16b	Use variable resistor Or Use platinum electrodes	PPA Technique Question.