JABchem

Past Papers Higher Chemistry

2001

Marking Scheme

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<table>
<tr><th>MC Qu</th><th>Answer</th><th>% Pupils Correct</th><th>Reasoning</th></tr>
<tr><td>1</td><td>A</td><td>65</td><td>☑A Fluorine atoms have electron arrangement of 2,7 ∴F^- ion is 2,8 (negative ion)
☒B Sodium atoms have electron arrangement of 2,8,1 (neutral atom)
☒C Aluminium atoms have electron arrangement of 2,8,3 ∴Al^{3+} ion is 2,8 (positive ion)
☒D Neon atoms have electron arrangement of 2,8 (neutral atom)</td></tr>
<tr><td>2</td><td>B</td><td>73</td><td>☒A H-Br molecule dissolves in water to form acidic H^+ ions (hydrobromic acid)
☑B NH_3 dissolves in water to form alkaline NH_4OH ammonium hydroxide solution
☒C CO_2 dissolves in water to form carbonic acid (H_2CO_3)
☒D CH_4 is a non-polar hydrocarbon ∴ does not dissolve in a polar solvent like water</td></tr>
<tr><td>3</td><td>D</td><td>50</td><td>NaOH no. of mol = volume x concentration = 0.02_{litres} x 0.3mol l^{-1} = 0.006mol
$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$
1mol 2mol
0.003mol 0.006mol
$$\text{volume} = \frac{\text{no. of mol}}{\text{concentration}} = \frac{0.003\text{mol}}{0.3\text{mol l}^{-1}} = 0.01_{litres} = 10cm^3$$</td></tr>
<tr><td>4</td><td>A</td><td>37</td><td>2mol of Br^- ions ∴ 2mol of NaBr f.u. ∴ 2mol Na^+ ions
total of 5mol Na^+ ions but 2mol Na^+ ions from NaBr ∴ 3mol of Na^+ ions from Na_2SO_4 f.u.
3mol Na^+ ions ∴ 1.5 mol Na_2SO_4 f.u.</td></tr>
<tr><td>5</td><td>D</td><td>58</td><td>☒A Temperature *increases* as exothermic reaction releases heat
☒B Volume of gas *increases* as the reaction proceeds: $CaCO_3+2HCl \rightarrow CaCl_2+H_2O+CO_2$
☒C pH *increases* as acid is used up during the reaction
☑D Mass of beaker + contents decreases as gas escapes from the beaker</td></tr>
<tr><td>6</td><td>B</td><td>66</td><td>ΔH = 160 – 190 = -30kJ mol^{-1} (same for uncatalysed and catalysed reactions)
Activation Energy for catalysed forward reaction = 35kJ mol^{-1}
Activation Energy for catalysed reverse reaction = 35 – (-30) = 65kJ mol^{-1}</td></tr>
<tr><td>7</td><td>C</td><td>70</td><td>The definition of the enthalpy of neutralisation is the energy released from the formation of one mole of water. The neutralisation of one mole of acid (H^+) cannot be used as 2mol of H^+ ions reaction to form 1 mole of water for neutralisations with metal oxides and carbonates.</td></tr>
<tr><td>8</td><td>C</td><td>90</td><td><table>
<tr><th>Periodic Table</th><th>Trend</th><th>Example</th></tr>
<tr><td>Across a Period</td><td>Increases</td><td><table><tr><td>Element</td><td>Li</td><td>Be</td><td>B</td><td>C</td><td>N</td><td>O</td><td>F</td><td>Ne</td></tr><tr><td>Electronegativity</td><td>1.0</td><td>1.5</td><td>2.0</td><td>2.5</td><td>3.0</td><td>3.5</td><td>4.0</td><td>-</td></tr></table></td></tr>
<tr><td>Down a Group</td><td>Decreases</td><td><table><tr><td>Element</td><td>F</td><td>Cl</td><td>Br</td><td>I</td></tr><tr><td>Electronegativity</td><td>4.0</td><td>3.0</td><td>2.8</td><td>2.6</td></tr></table></td></tr>
</table></td></tr>
<tr><td>9</td><td>D</td><td>43</td><td>☒A Fullerene is a hydrocarbon ∴ fullerene has covalent bonding
☒B Fullerene is a hydrocarbon ∴ fullerene has covalent bonding
☒C Fullerene is molecular as it has C_{60} structure and is not a covalent network
☑D Fullerene has covalent C_{60} molecules</td></tr>
<tr><td>10</td><td>B</td><td>80</td><td>☒A Covalent bonding is intramolecular (inside molecules)
☑B Hydrogen bonding is found between molecules containing H-O, H-N or H-F
☒C Ionic bonding has lattice of oppositely charged ions and no molecules
☒D Metallic bonding is between metals atoms but has no molecules</td></tr>
<tr><td>11</td><td>B</td><td>46</td><td>☒A element must be a non-metal so is a non-conductor of electricity
☑B elements are non-metals which form covalent bonds between atoms
☒C some non-metal elements are gases at room temp and have low melting points
☒D some non-metal elements are covalent molecular and not covalent network</td></tr>
</table>

12	C	66	☒A **gfm** O_2 = 32g ∴ **no**. of mol = $^{mass}/_{gfm}$ = $^{0.32}/_{32}$ = 0.01mol ☒B **gfm** CO_2 = 44g ∴ **no**. of mol = $^{mass}/_{gfm}$ = $^{0.44}/_{44}$ = 0.01mol ☑C **gfm** H_2 = 2g ∴ **no**. of mol = $^{mass}/_{gfm}$ = $^{0.2}/_{2}$ = 0.10mol ☒D **gfm** Ar = 40g ∴ **no**. of mol = $^{mass}/_{gfm}$ = $^{0.80}/_{40}$ = 0.02mol
13	D	75	☒A 3mol gas → 3mol gas ∴ 3vol gas → 3vol gas ∴ no change in pressure of gas ☒B 2mol gas → 4mol gas ∴ 2vol gas → 4vol gas ∴ increase in pressure of gas ☒C 2mol gas → 2mol gas ∴ 2vol gas → 2vol gas ∴ no change in pressure of gas ☑D 3mol gas → 2mol gas ∴ 3vol gas → 2vol gas ∴ decrease in pressure of gas
14	B	35	☒A 1mol O_2 = 32g ∴ 16g = 0.5mol O_2 molecules ☑B 1mol H_2 = 2g ∴ 1g = 0.5mol H_2 molecules = 1mol of H atoms = 1mol of electrons ☒C 1mol C = 12g ∴ 24g = 2mol C atoms ☒D 1mol Na^+Cl^- f.u. = **v**olume x **c**oncentration = 1 x 1 = 1mol Na^+Cl^- f.u. ∴ 2mol of ions
15	C	89	Methane is the main constituent of biogas made by fermentation of biological materials in anaerobic conditions.
16	A	36	☑A Reforming: Straight chains rearranged into branched chains or ring structures ☒B Hydrogenation: Hydrogen added across C=C double in addition reaction ☒C Dehydration: Water removed from structure leaving C=C double bond behind ☒D Cracking: Breaking hydrocarbons into smaller hydrocarbons some with C=C bonds
17	D	58	☒A Methanol CH_3OH has only one structure and no isomers ☒B Propane $CH_3CH_2CH_3$ has only one structure and no isomers ☒C Trichloroethene $CHCl_3$ has only one structure and no isomers ☑D $C_2H_4Cl_2$ has 2 structures: 1,1-dichloroethane and 1,2-dichloroethane
18	C	80	☒A Chlorines add onto adjacent carbons not same carbon ☒B Chlorines add onto adjacent carbons not same carbon ☑C 1mol of chlorine required to turn 1mol C≡C triple bonds into C=C double bonds ☒D 2mol of chlorine required to turn 1mol C≡C triple bonds into C-C single bonds
19	D	84	☒A Secondary alcohol: 2 carbons directly attached to carbon with the –OH bond ☒B Secondary alcohol: 2 carbons directly attached to carbon with the –OH bond ☒C Tertiary alcohol: 3 carbons directly attached to carbon with the –OH bond ☑D Primary alcohol: 1 carbon directly attached to carbon with the –OH bond
20	D	68	☒A carboxylic acid side (side with C=O bond) has 3 carbons ∴ propanoic acid ☒B carboxylic acid side (side with C=O bond) has 3 carbons ∴ propanoic acid ☒C alcohol side has O attached to C_2 of 3 carbons ∴ propan-2-ol not propan-1-ol ☑D ester is made from propan-2-ol and propanoic acid
21	C	59	☒A propan-2-ol dehydrates to form only propene ☒B pentan-3-ol dehydrates to form only pent-2-ene ☑C hexan-3-ol dehydrates to form hex-2-ene and hex-3-ene ☒D heptan-4-ol dehydrates to form only hept-3-ene
22	C	56	☒A Ozone absorbs not reflects harmful ultraviolet radiation ☒B CFCs break down ozone ☑C Ozone absorbs harmful ultraviolet radiation ☒D CFCs break down ozone
23	C	38	☒A single esters are used in flavourings, perfumes and solvents ☒B proteins are made from condensation of amino acids into a polymer ☑C polyester can be used to make fibres (straight) and resins (cross-linked) ☒D Polyester fibres are not cross-linked and are straight linear chains

24	B	70	☒A 2 carbon atoms between the amine group $-NH_2$ and the carboxyl group -COOH ☑B 1 carbon atom between the amine group $-NH_2$ and the carboxyl group -COOH ☒C 2 carbon atoms between the amine group $-NH_2$ and the carboxyl group -COOH ☒D 2 carbon atoms between the amine group $-NH_2$ and the carboxyl group -COOH
25	A	56	☑A Benzene is found and purified from crude oil ☒B Water is found naturally on Earth and is a raw material ☒C Iron oxide (iron ore) is found naturally on Earth and is a raw material ☒D Sodium chloride (salt) is found naturally on Earth and is a raw material
26	B	46	☒A Sulphuric acid is needed in huge quantities and is made by a continuous process ☑B Medicines are needed in smaller quantities and made by a batch process ☒C Iron for steel is needed in huge quantities and is made by a continuous process ☒D Ammonia is needed for fertilisers and is made by a continuous process
27	D	52	☒A Hydrogen H_2 is not a reactant or product ∴ equilibrium is not altered ☒B H^+ ions are a product ∴ equilibrium shifts to left (reactant side) ☒C Cl^- ions are product ∴ equilibrium shifts to left (reactant side) ☑D OH^- ions remove H^+ ions ∴ equilibrium shifts to right to replace H^+ ions
28	C	88	$[OH^-] = \frac{10^{-14}}{[H^+]} = \frac{10^{-14}}{10^{-4}} = 10^{-10}$ mol l^{-1}
29	A	73	(see table below)

Acid	Type	Dissociation	pH	Conductivity	Rate of Reaction with Magnesium	Volume of sodium hydroxide reacted
Hydrochloric	strong	Full	Lower	Higher	Faster	Same
Ethanoic	weak	Partial	higher	lower	Slower	

30	C	37	Half life is the same as the nucleus splitting is the same with the same half-life. The intensity of the radiation is different as 1g of radium metal contains more radium nuclei than 1g of radium oxide

Q31→35 are Grid Questions which are a style no longer used in Higher Chemistry.
However the content of the questions can still come up in future exams.
(If the question suggests there is more than 1 answer then there are usually 2 answers)

31a	E	☑E Hydrogen bonding is found between molecules containing the following bonds: H-O or H-N or H-F
31b	A+B (both for 1 mark)	(see table below)

Answer	A	B	C	D	E	F
Substance	hydrogen	phosphorus	sodium	lithium hydroxide	hydrogen fluoride	hydrogen iodide
Bonding Type	Pure covalent	Pure covalent	Metallic	Ionic	Hydrogen	Polar covalent

32a	D	Rate of enzyme activity increases with temperature, peaks at optimum temperature (usually around 37°C) and falls above this temperature
32b	F	Rate of radioactive decay is unchanged by changes in temperature
33a	B	Cracking breaks alkanes into smaller molecules with C=C double bonds formed
33b	D	Hydration is a type of addition reaction where water is added across a C=C double bond
34	B,D (1 mark each)	☒A catalysts do not alter the enthalpy change for a reaction ☑B catalysts reduce the time taken for equilibrium to be established ☒C catalysts do not alter the position of equilibrium ☑D catalysts reduce the activation energy for both forward and reverse reactions ☒E rate of forward reaction is increased by same amount as reverse reaction
35	B,D (1 mark each)	☒A sodium sulphite is soluble so cannot be made by a precipitation reaction ☑B sulphurous acid + sodium carbonate → sodium sulphite + water + carbon dioxide ☒C sodium sulphite is alkaline (weak acid in salt) but sodium sulphate is neutral ☒D sulphites ions are reducing agents and oxidised themselves: $SO_3^{2-}+H_2O \rightarrow SO_4^{2-}+2H^++2e^-$ ☒E sodium ions are spectator ions and are chemically unchanged

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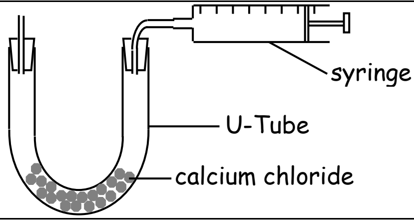
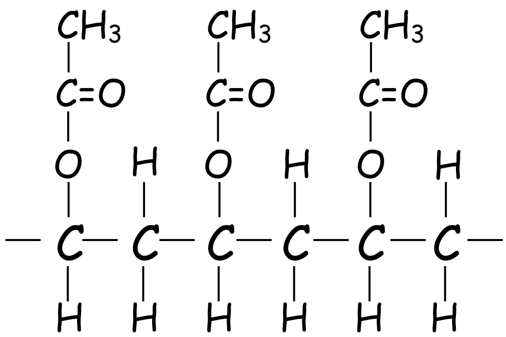
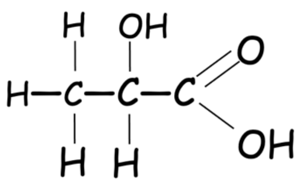
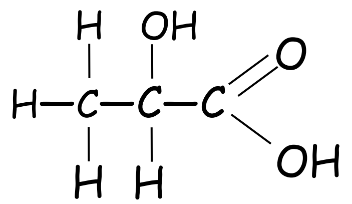
<table>
<tr><th>Long Qu</th><th>Answer</th><th>Reasoning</th></tr>
<tr><td>1a</td><td>Neutron or $^{1}_{0}n$</td><td>The atomic and mass numbers must balance on both sides of the equation:
$^{99}_{43}Tc + ^{1}_{0}n \rightarrow ^{100}_{43}Tc$</td></tr>
<tr><td>1b</td><td>$^{100}_{43}Tc \rightarrow ^{101}_{44}Ru + ^{0}_{-1}e$</td><td><table>
<tr><th>Radiation</th><th>Effect on Atomic Number</th><th>Effect on Mass Number</th></tr>
<tr><td>Alpha</td><td>Decrease by 2</td><td>Decrease by 4</td></tr>
<tr><td>Beta</td><td>Increase by 1</td><td>No change</td></tr>
<tr><td>Gamma</td><td>No change</td><td>No change</td></tr>
</table></td></tr>
<tr><td>1c</td><td>$\frac{1}{8}$</td><td><table>
<tr><th>Time (s)</th><th>No of half-lives</th><th>Fraction Left</th></tr>
<tr><td>0</td><td>0</td><td>1</td></tr>
<tr><td>16</td><td>1</td><td>$\frac{1}{2}$</td></tr>
<tr><td>32</td><td>2</td><td>$\frac{1}{4}$</td></tr>
<tr><td>48</td><td>3</td><td>$\frac{1}{8}$</td></tr>
</table></td></tr>
<tr><td>2a</td><td>Synthesis gas</td><td>Synthesis gas is a mixture of carbon monoxide gas and hydrogen gas, made by steam reforming of methane: $CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3H_{2(g)}$</td></tr>
<tr><td>2b</td><td>Answers to include:</td><td><table>
<tr><td>1mark</td><td>Reducing temperature leads to system at equilibrium increasing the temperature which favours the forward exothermic reaction making more products</td></tr>
<tr><td>1mark</td><td>Cooling mixture below 100°C leads to steam condensing into water. This removes the steam from the equilibrium mixture and the equilibrium shifts to the right to replace the steam which makes more products.</td></tr>
</table></td></tr>
<tr><td>3a</td><td>Oxalic acid</td><td>PPA Question: Oxalic acid has the formula $(COOH)_2$</td></tr>
<tr><td>3b</td><td>The time taken for purple colour to become colourless</td><td>PPA Technique Question:
$5(COOH)_2 + 6H^+ + 2MnO_4^- \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$
purple colourless</td></tr>
<tr><td>3c</td><td>$^1/_s$ or s^{-1}</td><td>Rate is proportional to $^1/_{time}$ ∴ rate has units s^{-1}</td></tr>
<tr><td>4a</td><td>Diagram showing:
1mark: valid drying system with calcium chloride

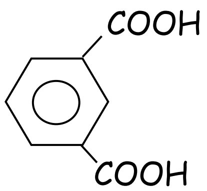
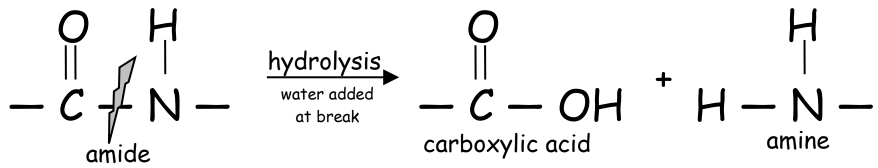
1mark: dry gas collection system (syringe)</td><td>
</td></tr>
<tr><td>4b</td><td>6.02×10^{21} molecules</td><td>1mol = 44g = 6.02×10^{23}molecules = 24 litres
$^{0.24}/_{24} \times 6.02 \times 10^{23}$molecules = 0.24litres
= 6.02×10^{21}molecules</td></tr>
<tr><td>5a</td><td>Diagram showing:</td><td></td></tr>
<tr><td>5b</td><td>Vinyl acetate has polar covalent bonds
Polar molecules are closer together</td><td><table>
<tr><td>1mark</td><td>Hexane is a hydrocarbon and C-H bonds are non-polar. Vinyl acetate contains C-O bonds which are polar due to the electronegativity difference of 1.0</td></tr>
<tr><td>1mark</td><td>Polar bonds in vinyl acetate give increase intermolecular attractions bringing the vinyl acetate molecules are closer together which raises the boiling point</td></tr>
</table></td></tr>
</table>

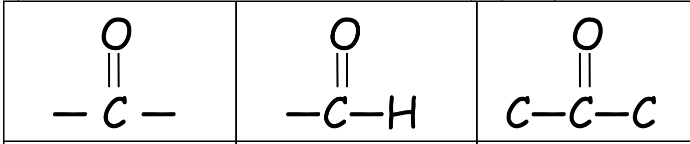
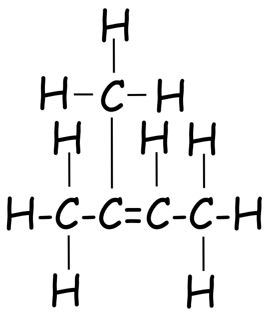
6a	Arrow recycling sodium hydroxide solution	Arrow added to diagram to show sodium hydroxide solution formed in Stage 2 goes back into the process in stage 1
6b	Acidic oxide	Acidic oxides react with alkalis e.g. SO_2, NO_2 and CO_2 Basic oxides react with acids e.g. Na_2O
6c	Dehydration	Water is removed from aluminium hydroxide to form aluminium oxide: $2Al(OH)_3 \rightarrow Al_2O_3 + 3H_2O$
6d	60435g	Q=I x t = 180 000 x (1x60x60) = 648 000 000C $Al^{3+}(l) + 3e^- \longrightarrow Al(l)$ 3mol → 1mol 3x96500C → 27g 648 000 000C → 27g x $^{648\,000\,000}/_{289500}$ = 60435g
6e	Carbon will react with oxygen and wear away	Carbon will react with oxygen at high temperatures needed for molten electrolysis. Once worn away, electrolysis will stop.
7a	Enthalpy change for any particular reaction is the same regardless of chemical route	Hess's Law states that the enthalpy change for any particular chemical is the same reaction regardless of chemical route.
7b	Volume of water Temperature at start Temperature at end	Volume of water is required to calculate the mass of water (m) being heated up (1litre of water = 1kg water and 1cm^3 water = 1g) Temperatures at start and end are required to calculate the change in temperature (ΔT) Both m and ΔT are required to calculate $\Delta H=cm\Delta T$
7c	hydrochloric acid	hydrochloric acid + potassium hydroxide → potassium chloride + water
8a(i)		**2-hydroxypropanoic acid** hydroxyl -OH group on C_2 / 3 carbons attached by single bonds / carboxyl -COOH group on C_1 
8a(ii)	x=2	$Ca_{10}(PO_4)_6(OH)_2 + 8H^+ \longrightarrow 10Ca^{2+} + 2H_2O + 6HPO_4^{2-}$
8a(iii)	10^{-5}	(see pH table below)

pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
$[H^+]$	10^0	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}	10^{-13}	10^{-14}
$[OH^-]$	10^{-14}	10^{-13}	10^{-12}	10^{-11}	10^{-10}	10^{-9}	10^{-8}	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}	10^{-2}	10^{-1}	10^0

8b(i)	Fibrous are straight and globular are specially shaped	Fibrous proteins are linear structural proteins e.g. collagen Globular proteins are specially-shaped proteins found in enzymes, etc.
8b(ii)	carbon, hydrogen, oxygen & nitrogen	(see table below)

Type	Use in Body	Carbon	Hydrogen	Oxygen	Nitrogen
Carbohydrate	provides energy	✓	✓	✓	x
Fat	provides energy	✓	✓	✓	x
Protein	Tissue repair and growth	✓	✓	✓	✓

9a(i)		The amide link splits with water added at the split: 
9a(ii)	1,4-diaminobenzene	1,3-diaminobenzene is drawn at the start of the question. In this structure, the amine groups ($-NH_2$) are on carbons 1 and 4 instead.
9b	Photoconductivity	Polyvinylcarbazole is used in laser printers and photocopiers as it has the special property of photoconductivity

<table>
<tr><td>10a(i)</td><td>Carbonyl group</td><td>Both aldehydes and ketones contain the carbonyl group:

Carbonyl group | Aldehyde group | Ketone group</td></tr>
<tr><td>10a(ii)</td><td>Silver mirror formed on bottom of test tube</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>10b</td><td>$-236 kJ\ mol^{-1}$</td><td>
❶ $C + O_2 \longrightarrow CO_2$ $\Delta H = -394\ kJ$
❷ $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$ $\Delta H = -286\ kJ$
❸ $C_3H_6O + 4O_2 \longrightarrow 3CO_2 + 3H_2O$ $\Delta H = -1804\ kJ$
❶x3 $3C + 3O_2 \longrightarrow 3CO_2$ $\Delta H = -1182\ kJ$
❷x3 $3H_2 + 1\frac{1}{2}O_2 \longrightarrow 3H_2O$ $\Delta H = -858\ kJ$
❸x-1 $3CO_2 + 3H_2O \longrightarrow C_3H_6O + 4O_2$ $\Delta H = +1804\ kJ$
add $3C + 3H_2 + \frac{1}{2}O_2 \longrightarrow C_3H_6O$ $\Delta H = -236\ kJ$</td></tr>
<tr><td>11a(ii)</td><td></td><td>2-methylbut-2-ene
methyl $-CH_3$ group on C_2 | 4 carbons on main chain | C=C double bond between C_2 and C_3</td></tr>
<tr><td>11a(ii)</td><td>Catalyst</td><td>The large surface area on mordenite allows it to act as a heterogeneous catalyst. The mordenite speeds up the reforming reaction but is chemically unchanged itself.</td></tr>
<tr><td>11a(iii)</td><td>Branch chain helps prevent autoignition</td><td>Too many straight chains in petrol leads to auto-ignition before the spark from the spark plug (pinking). Branched chain hydrocarbons and ring hydrocarbons keep the molecules far enough apart to prevent auto-ignition before the spark.</td></tr>
<tr><td>11b</td><td>Covalent network</td><td>Silicon and oxygen are both non-metals so SiO_2 contains covalent bonds.
SiO_2 melts at 1713°C ∴ SiO_2 contains covalent network bonding.</td></tr>
<tr><td>12a</td><td>Chlorine has larger nucleus which pulls in outer shell nearer</td><td>Sodium and chlorine are in the same period same electron shell is being filled as you go across the period. Chlorine has a nucleus with 17 protons and the larger positive charge pulls in the outer shell closer to the nucleus making the atomic size of chlorine smaller than sodium.</td></tr>
<tr><td>12b</td><td>P^{3-} has an additional electron shell to Si^{4+}</td><td>P has electron arrangement of 2,8,5 ∴ P^{3-} ion has electron arrangement 2,8,8
Si has electron arrangement of 2,8,4 ∴ Si^{4+} ion has electron arrangement 2,8
Si^{4+} has 2 occupied electron shells and P^{3-} has 3 occupied electron shells</td></tr>
<tr><td>13a</td><td>Ammonium chloride solution is acidic</td><td>Ammonium chloride is acidic because the salt is made with a strong acid (hydrochloric acid) and a weak alkali (ammonium hydroxide). Hydroxide OH^- ions found in water pair up with ammonium ions from the salt and form molecules: $NH_4^+ + OH^- \rightarrow NH_3 + H_2O$.
Water splits to replace OH^- ions ($H_2O \rightarrow H^+ + OH^-$) but these OH^- ions are also removed but the additional H^+ ions build up and make the solution acidic.</td></tr>
<tr><td>13b</td><td>$15.21\ kJ\ mol^{-1}$</td><td>1mol NH_4Cl = (1x14) + (4x1) + (1x35.5) = 14 + 4 + 35.5 = 53.5g
E_h = c x m x ΔT
= $4.18 kJ\ kg^{-1}\ {}^oC^{-1}$ x 0.2kg x 3.4^oC
= 2.8424 kJ
10g NH_4Cl = 2.8424kJ
1mol = 53.5g NH_4Cl = 2.8424kJ x $^{53.5}/_{10}$
= $15.21\ kJ\ mol^{-1}$
Endothermic reaction = $+15.21\ kJ\ mol^{-1}$</td></tr>
</table>

14a	$Pd^{2+} + 2e^- \rightarrow Pd$	$PdCl_2$ contains Pd^{2+} ions and Cl^- ions. The Chloride Cl^- ions are spectator ions but the Palladium Pd^{2+} ions react and become Palladium metal $Pd^{2+} + 2e^- \longrightarrow Pd$ (Reduction reaction as electrons are gained)
14b	$2CO + O_2 \longrightarrow CO_2$	❶ $CO + H_2O \rightarrow CO_2 + 2H^+ + 2e^-$ ❷ $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ ❶x2 $2CO + 2H_2O \rightarrow 2CO_2 + 4H^+ + 4e^-$ ❷ $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ add $2CO + O_2 \rightarrow 2CO_2$
15a	Increase in the %oxygen in molecule	Oxidation is indicated by: loss of electrons increase in oxygen : hydrogen ratio decrease in hydrogen : oxygen ratio
15b(i)	First (rough) titration is too inaccurate to use	The initial (rough) titration is used to get an approximate of the volume and is usually added in volume of ~1cm^3. This will probably overshoot the actual endpoint of the reaction. Subsequent titrations will add the majority of the rough titration and then volumes will be added by the drop until the colour change in found in the conical flask.
15b(ii)	0.0172	**n**o. of mol Cu^{2+} = **v**olume x **c**oncentration = 0.0172 x 0.500 = 0.0086mol $C_6H_{12}O_6 + 2Cu^{2+} + 2H_2O \longrightarrow Cu_2O + 4H^+ + C_6H_{12}O_7$ 1mol 2mol 0.0043mol 0.0086mol $\text{concentration} = \frac{\text{no. of mol}}{\text{volume}} = \frac{0.0043\text{mol}}{0.025\text{litres}} = 0.172 \text{ mol l}^{-1}$
15c	Sucrose does not react with Benedict's solution	(see table below)

Carbohydrate	glucose	fructose	maltose	sucrose	starch
Formula	$C_6H_{12}O_6$	$C_6H_{12}O_6$	$C_{12}H_{22}O_{11}$	$C_{12}H_{22}O_{11}$	$(C_6H_{10}O_5)_n$
Reaction with Benedict's Sol	Blue ↓ Brick Red	Blue ↓ Brick Red	Blue ↓ Brick Red	No reaction	No reaction
Reaction with Iodine Solution	No reaction	No reaction	No reaction	No reaction	Turns Blue/Black

16a	1.36	gfm methane CH_4 = (1x12) + (4x1) = 12 + 4 = 16g From Graph: Time for 60cm^3 of gas released for mass 16g = 44s $\text{Rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}} = \frac{60-0}{44-0} = \frac{60}{44} = 1.36 \text{ cm}^3\text{ s}^{-1}$
16b	Ethyne C_2H_2	From graph: mass which takes 56 seconds to release 60cm^3 of gas = 26 Ethyne C_2H_2 = (2x12) + (2x1) = 24 + 2 = 26
16c	Use larger volume of gas collected to increase size of time measurement	By using a larger volume of gas collected, the time measurement will be larger. The percentage error decrease as the actual error will be smaller relative to the size of the measurement.
17a	glycerol or propane-1,2,3,-triol	Fats/oils/triglycerides contain a glycerol molecule joined to 3 fatty acids. In this reaction, the ester bonds between the glycerol and fatty acids is broken and the fatty acids form an ester bond with the methanol present.
17b	C=C double bond (or C≡C triple bond)	Hexadecane is a 16 carbon alkane with formula $C_{16}H_{34}$ and follows the general formula of C_nH_{2n+2}. The $C_{21}H_{39}$ part of the biodiesel molecule is unsaturated and contains two C=C double bonds (or less likely a C≡C triple bond) to save the four hydrogens which would be needed for the group to be saturated with a formula of $C_{19}H_{43}$.
17c	Hydrogenation or Hardening	Oils have hydrogen added across the C=C double bonds (hydrogenation). The straightening of the carbon chains makes the molecules fit together closer and raises the melting point make a fat. This is called hardening