JABchem

Past Papers Higher Chemistry

2013

Marking Scheme

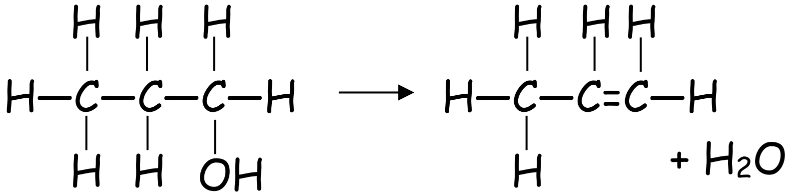
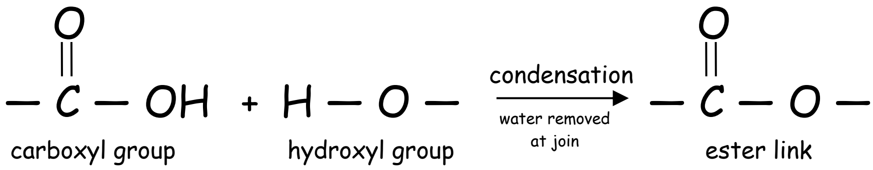
Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	73+	30.7%
B	60+	23.7%
C	47+	22.5%
D	43+	9.2%
No award	<43	13.8%

Section:	Multiple Choice	Extended Answer
Average Mark:	26.1 /40	35.1 /60

2013 Higher Chemistry Marking Scheme

MC Qu	Answer	% Pupils Correct	Reasoning
1	A	84	☑A Calcium is a metal and chlorine is a non-metal ∴ ionic ∴ conductor when molten ☒B Nitrogen and chlorine are both non-metals ∴ covalent ∴ non-conductor ☒C Phosphorus and chlorine are both non-metals ∴ covalent ∴ non-conductor ☒D silicon and chlorine are both non-metals ∴ covalent ∴ non-conductor
2	C	60	☒A Electron Arrangements: Ca^{2+} = 2,8,8 and O^{2-} = 2,8 ☒B Electron Arrangements: Ca^{2+} = 2,8,8 and Br^{-} = 2,8,18,8 ☑C Electron Arrangements: Na^{+} = 2,8 and O^{2-} = 2,8 ☒D Electron Arrangements: Li^{+} = 2 and F^{-} = 2,8
3	B	35	☒A Iron is lower down ECS than zinc ∴ no displacement reaction takes place ☑B Tin is higher up ECS than silver ∴ displacement reaction takes place ☒C Copper is lower down ECS than hydrogen ∴ no displacement reaction takes place ☒D Lead is lower down ECS than magnesium ∴ no displacement reaction takes place
4	B	62	Silver nitrate + sodium chloride ⟶ sodium nitrate (filtrate) + silver chloride (precipitate) NB: There is excess silver nitrate ∴ filtrate is solution of sodium nitrate <u>and</u> silver nitrate ☒A Barium chloride + silver nitrate ⟶ barium nitrate + silver chloride (precipitate) ☑B Potassium nitrate + silver nitrate ⟶ (no precipitate) ☒C Calcium iodide + silver nitrate ⟶ calcium nitrate + silver iodide (precipitate) ☒D Sodium bromide + silver nitrate ⟶ sodium bromide + silver chloride (precipitate)
5	D	62	☒A Temperature would increase as reaction proceeds as reaction is exothermic ☒B Volume of gas released would increase as reaction proceeds ☒C pH of solution would increase as acid is neutralised and pH rises towards pH=7 ☑D mass of beaker + contents would decrease as gas escapes the reaction vessel
6	A	69	☑A both factors would increase the rate of reaction ☒B an increase in activation energy would decrease the rate of reaction ☒C an increase in particle size would decrease the rate of reaction ☒D a decrease in surface area of reactants would decrease the rate of reaction
7	D	37	NB: All the alkali has reacted but only half of the acid has reacted ☒A Greater volume of acid would result in the temperature rise being smaller ☒B More acid but additional alkali needed to increase the temperature rise ☒C Same temperature rise as same number of moles of OH^{-} ions are present ☑D Doubling of moles of OH^{-} ions ∴ remaining acid reacts and temp rise increases
8	C	66	☒A Poisoning of a catalyst reduces the surface activity as sites are blocked up ☒B Impurities must be removed from catalyst to maintain the catalyst's activity ☑C Catalytic convertor is solid and reactants molecules are gases (heterogenous) ☒D Heterogenous catalysts adsorb reactant molecules during reaction
9	B	43	For a reaction to take place at room temperature: • reaction is likely to have a small activation energy • reaction is likely to be exothermic
10	A	81	1mol CH_3OH = (1x12) + (4x1) + (1x16) = 12+4+16 = 32g 1mol CH_3OH = -727 kJ = 32g = -72.7 kJ = 32g x $^{-72.7}/_{-727}$ = 3.2g
11	B	74	☒A Electronegativity of lithium = 1.0 ☑B Electronegativity of chlorine = 3.0 ∴ greatest attraction for bonding electrons ☒C Electronegativity of sodium = 0.9 ∴ smallest attraction for bonding electrons ☒D Electronegativity of bromine = 2.8

12	C	59	☒A potassium atom (2,8,8,1) is larger than potassium ion (2,8,8) ☒B Chloride ion (2,8,8) is not smaller than a chlorine atom (2,8,7) ☑C Sodium atom (2,8,1) is larger than a sodium ion (2,8) ☒D Oxygen atom (2,6) is not larger than an oxide ion (2,8)
13	D	69	☒A Elements can not have ionic bonds (ionic bonding only found in compounds) ☒B Covalent bonds are strong bonds ☒C Melting does not involve the removal of outer electrons (melting=physical change) ☑D Weak inter-molecular bonds are easily overcome in elements with low melting pt
14	C	50	☒A Metal elements contain metallic bonding ☒B All elements contain Van der Waals' bonding between atoms ☑C Atoms in elements must have same electronegativity so bonds cannot be polar ☒D All molecular elements contain non-polar covalent bonding e.g. H_2, N_2, O_2, P_4
15	D	63	☒A boron has a melting point of 2075°C ∴ covalent network structure ☒B carbon (diamond) sublimes at 3825°C ∴ covalent network structure ☒C silicon has a melting point of 1414°C ∴ covalent network structure ☑D sulphur has a melting point of 115°C ∴ molecular covalent structure
16	D	36	Compounds containing -OH hydroxyl groups have hydrogen bonding between molecules ∴ hydrogen bonding brings molecules closer together. Compound D has two –OH hydroxyl groups and is more viscous due to the additional hydrogen bonding compared to the other compounds which only have one –OH group per molecule.
17	A	50	4mol of Br^- ions in $MgBr_2$ ∴ 2mol of $MgBr_2$ formula units ∴ 2 mol of Mg^{2+} ions 3 mol of Mg^{2+} ions in total = 2 mol Mg^{2+} ions in $MgBr_2$ + 1 mol Mg^{2+} ions in $MgSO_4$ 1 mol of Mg^{2+} ions in $MgSO_4$ ∴1 mol $MgSO_4$ formula units ∴ 1 mol SO_4^{2-} ions
18	A	70	$2C_2H_{2(g)} + 5O_{2(g)} \longrightarrow 4CO_{2(g)} + 2H_2O_{(l)}$ 2mol 5mol 4mol 2mol 2vol 5vol 4vol negligible volume $100cm^3$ $200cm^3$ -
19	C	71	☒A Dehydration: Water is removed and C=C double bond formed on molecule ☒B Reforming: Straight hydrocarbons rearrange into branched or ring structures ☑C Cracking: Larger saturated molecules split in small molecules (some unsaturated) ☒D Addition Polymerisation: Unsaturated molecules join to form polymer
20	B	57	☒A this molecules has same structure (2-methylpent-2-ene) ∴ not an isomer ☑B this molecules has different structure (3-methylpent-2-ene) ∴ an isomer ☒C this molecules has same structure (2-methylpent-2-ene) ∴ not an isomer ☒D this molecules has same structure (2-methylpent-2-ene) ∴ not an isomer
21	D	82	☒A hexanal has a formula of $C_6H_{12}O$ ☒B hexan-2-ol has a formula of $C_6H_{14}O$, usually written as $C_6H_{13}OH$ ☒C hexan-2-one has a formula of $C_6H_{12}O$ ☑D hexanoic acid has a formula of $C_6H_{12}O_2$, usually written as $C_5H_{11}COOH$
22	B	73	$\underbrace{CH_3CH_2CH_2COO}\underbrace{CH_2CH_3}$ carboxylic acid side (2nd name in ester) — alcohol side (1st name in ester) 4 carbon carboxylic acid = -**butanoate** — 2 carbon alcohol = **ethyl** - Ester name = **ethyl butanoate**
23	D	48	☒A both molecules contain a C=C double bond and undergo addition polymerisation ☒B both molecules contain a C=C double bond and undergo addition reactions ☒C phenylethene C_8H_8 contains 6 less hydrogens than cyclohexylethene C_8H_{14} ☑D both molecules contain one C=C double bond and reacts with same moles of bromine

<table>
<tr><td>24</td><td>B</td><td>79</td><td>
</td></tr>
<tr><td>25</td><td>C</td><td>68</td><td>☒A compound 2 (butan-2-ol) is a secondary alcohol and oxidises to form an ketone
☒B compound 2 (butan-2-ol) is a secondary alcohol and oxidises to form an ketone
☑C Both alcohols are primary alcohols and oxidise to aldehydes then carboxylic acids
☒D compound 3 (2-methylpropan-2-ol) is a tertiary alcohol and does not oxidises</td></tr>
<tr><td>26</td><td>A</td><td>70</td><td>
</td></tr>
<tr><td>27</td><td>D</td><td>65</td><td>Polyamides are formed by the condensation polymerisation of diamines (with two amine groups) and diacids (with two carboxyl groups)
Polyesters are formed by the condensation polymerisation of diols (with two hydroxyl groups) and diacids (with two carboxyl groups)</td></tr>
<tr><td>28</td><td>B</td><td>71</td><td>☒A Hardening of vegetable oils involves the addition of hydrogen across C=C bonds
☑B Cured polyester resins involves the cross linking to give the necessary strength
☒C Production of aromatic compounds from naphtha is called reforming
☒D Cross-linked materials are not thermoplastic</td></tr>
<tr><td>29</td><td>A</td><td>83</td><td>☑A oils are liquids and have a higher proportion of unsaturated molecules
☒B fats contain high proportion of saturated molecules, oils are more unsaturated
☒C oils are liquids at room temperature
☒D oils are liquids at room temperature and are more unsaturated</td></tr>
<tr><td>30</td><td>A</td><td>36</td><td>☑A Dipeptide shown has middle and right amino acid joined in correct order
☒B Amino Acid with R group = $-CH_3$ should be left side of dipeptide formed
☒C Amino Acids shown in dipeptide are not next to each other in tripeptride X
☒D Amino Acid with R group = $-CH(CH_3)_2$ should be right side of dipeptide formed</td></tr>
<tr><td>31</td><td>C</td><td>83</td><td>☒A labour costs are fixed costs due to pay deals to control the increase in pay
☒B land rental costs are fixed in long term rental agreements
☑C raw material costs are variable as the cost of raw materials fluctuates
☒D cost of plant construction are fixed in a contract</td></tr>
<tr><td>32</td><td>A</td><td>83</td><td>❶ $HCOOH + \frac{1}{2}O_2 \rightarrow CO_2 + H_2O$ $\Delta H = b$
❷ $C + O_2 \rightarrow CO_2$ $\Delta H = c$
❸ $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\Delta H = d$

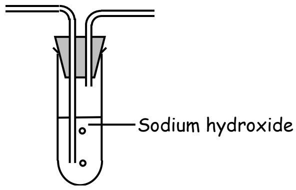
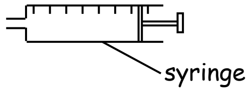
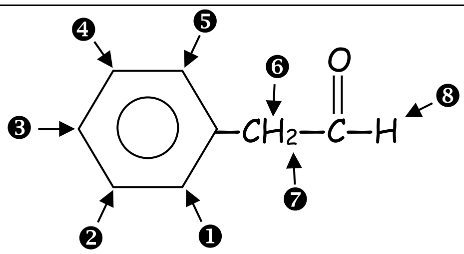
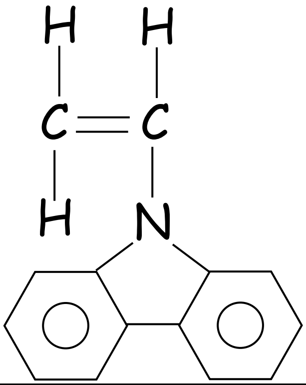
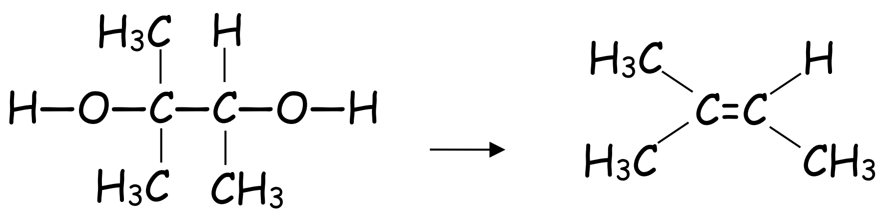
❶x-1 $CO_2 + H_2O \rightarrow HCOOH + \frac{1}{2}O_2$ $\Delta H = -b$
❷ $C + O_2 \rightarrow CO_2$ $\Delta H = c$
❸ $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\Delta H = d$

Add ❶'+❷+❸ $C + H_2 + O_2 \rightarrow HCOOH$ $\Delta H = c+d-b = a$</td></tr>
<tr><td>33</td><td>A</td><td>82</td><td><table><tr><td>Factor</td><td>Rate of Forward Reactions</td><td>Rate of Back Reaction</td></tr><tr><td>Change after two hours</td><td>Reaction already at equilibrium so remains unchanged two hours later</td><td>Reaction already at equilibrium so remains unchanged two hours later</td></tr></table></td></tr>
<tr><td>34</td><td>C</td><td>68</td><td>☒A increase in pressure would favour the forward reaction to reduce gas volume
☒B same no. of moles of gas on either side of arrow ∴ pressure has no effect
☑C increase in pressure would favour the reverse reaction to reduce gas volume
☒D same no. of moles of gas on either side of arrow ∴ pressure has no effect</td></tr>
</table>

35	D	65	☒A pH of sodium hydroxide is higher than ammonia solution due to full dissociation. ☒B sodium hydroxide has a higher gfm. This means a higher mass of solute present. ☒C sodium hydroxide has higher conductivity due to full dissociation. ☑D same number of moles of hydrochloric acid neutralised.
36	C	81	$[H^+] = \frac{10^{-14}}{[OH^-]} = \frac{10^{-14}}{10^{-1}} = 10^{-13}$ mol l^{-1} ∴ pH = 13
37	D	62	☒A 1mol l^{-1} HCl has pH=0 as it is a strong acid ☒B NaCl solution has pH=7 as it was made from strong acid and strong alkali ☒C Na_2CO_3 solution has pH>7 as it is made from strong alkali and weak acid ☑D CH_3COOH is a weak acid and has pH between pH=1 and pH=7
38	B	63	☒A 0.5mol silver is formed from passage of 48250C through silver (I) nitrate ☑B 1mol silver is formed from passage of 96500C through silver (I) nitrate ☒C 1mol copper is formed from passage of 193000C through copper (II) sulphate ☒D 2mol copper is formed from passage of 386000C through copper (II) sulphate
39	B	74	☒A This graphs shows the relationship between chemical reaction rate and temp ☑B Rate of radioactive decay does not change when temperature is varied ☒C This graph represents the activity of an enzyme against temperature ☒D This graph shows an increase in rate when temperature is increased
40	C	76	☒A This equation shows neutron capture ☒B This equation shoes nuclear fusion ☑C This equation shows nuclear fission ☒D This equation shows alpha particle capture followed by neutron emission

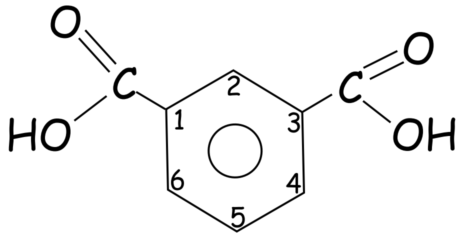
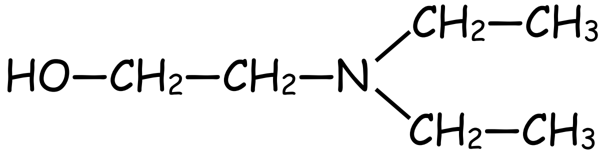
2013 Higher Chemistry Marking Scheme

Long Qu	Answer	Reasoning
1a	Reforming	Reforming rearranges straight chain hydrocarbons into branched chain hydrocarbons or cyclo-ring & aromatic hydrocarbons. The number of carbons in the molecule remains the same.
1b	2,2,4-trimethylpentane	1. Identify the longest chain: 5 carbons -pentane 2. Identify the sidechains: 3 x $-CH_3$ -trimethylpentane 3. Lowest numbering system selected $-CH_3$ on C_2, C_2 & C_4 2,2,4-trimethylpentane
1b	2,2,4-trimethylpentane	2,2,4-trimethylpentane Side Groups on C_2, C_2 and C_4 — Three methyl - CH_3 side groups — Five Carbons on Main Chain — Single bonds in main chain
1c	Branches	Reforming increases the branches on molecules which keeps the molecules in petrol further apart to prevent auto-ignition of petrol before the spark.
1d	Toxic	Methanol is a very toxic compound which can cause blindness and death.
2a	purple → colourless	This reaction is self-indicating as purple permanganate ions react with oxalic acid and turn into colourless manganese ions.
2b(i)	58°C	$\text{rate} = \frac{1}{\text{time}} = \frac{1}{25s} = 0.04\ s^{-1}$ From graph: if rate = $0.04s^{-1}$ then temperature = 58°C
2b(ii)	Colour change is too slow	At temperatures below 30°C, the colour change is too gradual to calculate a consistent end point.
2c	Collisions have more energy	There are two factors which decide whether a collision is successful and products are formed: a) angle of collision b) energy of collision
3a	$3Al + 3NH_4ClO_4$ ↓ $Al_2O_3 + AlCl_3 + 3NO + 6H_2O$	$Al + NH_4ClO_4 \rightarrow Al_2O_3 + AlCl_3 + NO + H_2O$ 3xAl atoms in $Al_2O_3/AlCl_3$ after arrow – balance with 3xAl before arrow $3Al + NH_4ClO_4 \rightarrow Al_2O_3 + AlCl_3 + NO + H_2O$ 3xCl in $AlCl_3$ after arrow – balance with $3xNH_4ClO_4$ before arrow $3Al + 3NH_4ClO_4 \rightarrow Al_2O_3 + AlCl_3 + NO + H_2O$ 3xN in $3NH_4ClO_4$ before arrow ∴ balance with 3xNO after arrow $3Al + NH_4ClO_4 \rightarrow Al_2O_3 + AlCl_3 + 3NO + H_2O$ 12xO in $3NH_4ClO_4$ before arrow but 6xO already accounted for in Al_2O_3 and 3NO ∴ balance with $6xH_2O$ after arrow $3Al + 3NH_4ClO_4 \rightarrow Al_2O_3 + AlCl_3 + 3NO + 6H_2O$
3b	0.255	1 mol Al_2O_3 = 102g = $6.02x10^{23}$ formula units But 2 Aluminium ions per formula unit 1 mol Al_2O_3 = 102g = $12.04x10^{23}$ Al^{3+} ions $\frac{3.01x10^{21}}{12.04x10^{23}}$ x102g $3.01x10^{21}$ Al^{3+} ions = 0.255g
4a(i)	$K_{(g)} \rightarrow K^+_{(g)} + e^-$	1st Ionisation Energy: The energy required to remove one mole of electrons from one mole of atoms in the gaseous state.
4a(ii)	Outer electron is further from nucleus	Potassium atoms are bigger than chlorine atoms so the outer electron is further from the nucleus of potassium than an outer electron in a chlorine atom and the nucleus of the atom has less of a hold on electrons further from the nucleus.
4b	8	Fatty acids contain carboxyl -COOH groups which react with hydroxyl –OH groups to form an ester group. Sucrose contains 8 hydroxyl -OH groups.
5a	N≡C–C≡N	Carbon is in group 4, has a valency of 4 and makes 4 bonds Nitrogen is in group 5, has a valency of 3 and makes 3 bonds

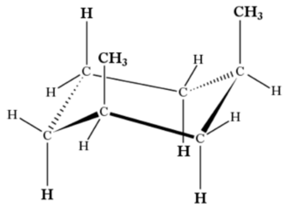
5b	Answer to include:	Working method to remove unreacted carbon dioxide  e.g. bubbling gases through sodium hydroxide solution Working method to collect gas  e.g. syringe to collect gas or collection of gas over water
6a	Answer to include:	Trichloromethane is a polar molecule and there are permanent dipole to permanent dipole attractions with the polar water molecules making it soluble. Tetrachloromethane is a non-polar molecule due to the shape, of the molecule and is insoluble in polar water.
6b	absorbs harmful u.v. radation from sun	Ozone absorbs harmful ultraviolet radiation from the sun. U.V. radiation can cause skin cancer. Ozone is broken down by CFCs (chlorofluorocarbons)
7a	One from:	Tollen's Reagent / Benedict's Solution, Fehling's Solution / Acidified Dichromate solution / hot copper (II) oxide
7b(i)	8	
7b(ii)	oxidation	Phenylethanal is an aldehyde and is converted into phenylethanoic acid (a carboxylic acid) by oxidation
8a		Take a two carbon segment of the main chain and place a C=C double bond between the two carbons.
8b	photocopiers and laser printers	Polyvinylcarbazole is a photoconductive polymer and which can be used in in photocopiers and laser printers.
9a	more –OH groups more hydrogen bonding between molecules	Hydrogen bonding brings molecules closer together. Ethane-1,2-diol has two –OH groups per molecule which is much more effective at bringing molecules closer together.
9b	2-methylbut-2-ene	Draw 2-methylbutane-2,3-diol in same format as example diol in question Work out the structure of the original alkene used to give 2-methylbutane-2,3-diol  2-methylbutane-2,3-diol → 2-methylbut-2-ene

<table>
<tr><td>9c</td><td>benzene-1,3-dicarboxylic acid</td><td>Carboxyl groups are separated by two carbons on the benzene ring

- C_1 has first carboxyl group
- C_3 has 2nd carboxyl group to give lowest numbering system


</td></tr>
<tr><td>10a(i)</td><td>Amine</td><td>Amine functional groups have the $-NH_2$ group in their structure</td></tr>
<tr><td>10a(ii)</td><td>Diagram showing:</td><td>
</td></tr>
<tr><td>10b</td><td>25min</td><td>Anaesthetic X resembles procaine on the left side
∴7min duration must be starting point in calculation of duration of X
Anaesthetic X has N-containing ring structure:
Mepivacaine has the same N-containing ring structure and has a duration 18 min longer than lidocaine which lacks the n-containing ring (and looks like procaine too)
∴Anaesthetic X should have a duration 18 minutes longer than procaine
= 7 + 18 min = 25 min</td></tr>
<tr><td>11a</td><td>Condensation or esterification</td><td>Condensation reactions involve two smaller molecules joining together and a small molecule (usually water) removed as the join together.
In this reaction al –OH group in salicylic acid and the CH_3-CO-O- group from ethanoic anhydride join together to make aspirin with CH_3COOH removed at the joining point.</td></tr>
<tr><td>11b</td><td>40.0</td><td>gfm salicylic acid $C_7H_6O_3$ = (7x12)+(6x1)+(3x16) = 84+6+48 = 138g
gfm aspirin $C_9H_8O_3$ = (9x12)+(8x1)+(4x16) = 108+8+64 = 180g
$C_7H_6O_3 + C_4H_6O_3 \longrightarrow C_9H_8O_4 + C_2H_4O_2$
1mol → 1mol
138g → 180g
5.02g → 180g x $^{5.02}/_{138}$
=6.58g (100% theoretical)
$\% \text{ yield} = \frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{2.62}{6.58} \times 100 = 40.0\%$</td></tr>
<tr><td>11c</td><td>H^+ ions in water and salicylate ions join up to form molecules</td><td>Sodium salt of aspirin is made from a strong alkali (sodium hydroxide) and a weak acid (salicylic acid). When dissolved in water, the salicylate ions pair up with H^+ ions in water to form molecules of salicylic acid. The OH^- ions remain and make the pH alkaline.</td></tr>
<tr><td>12a</td><td>0
+1</td><td>$^{40}_{19}K \rightarrow {}^{40}_{18}Ar + {}^{0}_{+1}e$</td></tr>
<tr><td>12b</td><td>2.52×10^9</td><td>If 75% of ^{40}K has decayed then 25% of ^{40}K must remain
<table>
<tr><th>Percentage</th><th>Time</th></tr>
<tr><td>100%</td><td>0</td></tr>
<tr><td>50%</td><td>1.26×10^9 years</td></tr>
<tr><td>25%</td><td>2.52×10^9 years</td></tr>
</table></td></tr>
<tr><td>13a(i)</td><td>only partially dissociated</td><td>weak acids only partially dissociate to release H^+ ions into solution</td></tr>
<tr><td>13a(ii)</td><td>move to right</td><td>NH_3 dissolves in water to form an alkali. Alkali will neutralise H^+ ions which removes a product from the equilibrium. Equilibrium will shift to right to replace missing product.</td></tr>
</table>

13b	0.289g	no. of mol = $\frac{\text{Volume}}{\text{Molar Volume}}$ = $\frac{0.079\text{litres}}{24 \text{ litres mol}^{-1}}$ = 0.00329mol $FeS + 2HCl \longrightarrow FeCl_2 + H_2S$ 1mol 1mol 0.00329mol 0.00329mol 1mol FeS = (1x55.8) + (1x32.1) = 55.8+32.1 = 87.9g **m**ass = **n**o. of mol x **gfm** = 0.00329mol x 87.9 g mol^{-1} = 0.289g
14a(i)	synthesis gas	synthesis gas is a mixture of carbon monoxide and hydrogen, made by the steam reforming of methane or coal and can me used to make methanol.
14a(ii)	206	❶ $CO + \frac{1}{2}O_2 \rightarrow CO_2$ ΔH= -283 kJ mol^{-1} ❷ $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ ΔH= -242 kJ mol^{-1} ❸ $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ ΔH= -803 kJ mol^{-1} ❶x-1 $CO_2 \rightarrow CO + \frac{1}{2}O_2$ ΔH= +283 kJ ❷x-3 $3H_2O \rightarrow 3H_2 + 1\frac{1}{2}O_2$ ΔH= +726 kJ ❸ $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ ΔH= -803 kJ Add ❶'+❷'+❸ $CH_4 + H_2O \rightarrow CO + 3H_2$ ΔH= +206 kJ mol^{-1}
14b	decrease increase	Forward reaction is exothermic ∴ decrease in temperature favours forward reaction Forward reaction reduces gas pressure (from 3mol to 1mol) ∴ increase in pressure favours forward reaction
15a	-37.62	Total volume = 25cm^3 KOH + 25cm^3 = 50cm^3 ∴ mass = 0.05kg $\Delta H = c \times m \times \Delta T$ = 4.18 x 0.05 x 4.5 = 0.9405 kJ **n**o. of mol H$^+$ = **v**olume x **c**oncentration = 0.025litres x 1mol l^{-1} = 0.025mol $H^+ + OH^- \longrightarrow H_2O$ 1mol 1mol 0.025mol 0.025mol 0.025mol H_2O ⟷ 0.9405kJ 1mol H_2O 0.9405kJ x $^1/_{0.025}$ = -37.62kJ mol^{-1}
15b	Use plastic cup or use a lid on beaker	The glass beaker will lose heat quicker than an insulted polystyrene cup. A lid with a hole in the top for the thermometer will also prevent some heat loss and improve the accuracy of the temperature readings.
15c	Initial temp of acid Initial temp of alkali Final temp of mixture	The average temperature of the aid and the alkali must be taken using the initial temperatures of the acid and the alkali. The temperature will rise during the reaction and the final temperature is the highest temperature reached on the thermometer.
16a	$I_2 + 2e^- \rightarrow 2I^-$	Oxidising agent oxidises another species and the oxidising agent is reduced itself. Reduction is gain of electrons and electrons appear on LEFT of arrow. $I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$ Split up species into two half reactions $I_2 \rightarrow 2I^-$ $2S_2O_3^{2-} \rightarrow S_4O_6^{2-}$ Balance each equation by adding electrons $I_2 + 2e^- \rightarrow 2I^-$ $2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2e^-$
16b(i)	1st titration is rough and excluded from average	The rough titration is used to work out the rough volume by adding around 1cm^3 at a time until the colour change is achieved. The experiment is then repeated by adding the majority of the rough titre volume in one go and them adding small volumes from this point until the colour change is achieved accurately. The experiment is repeated until concordancy is achieved (two or more volumes within 0.2cm^3 of each other)

16b(ii)	0.0045375	no. of mol $S_2O_3^{2-}$ = volume x concentration = 0.01815litres x 0.01mol l^{-1} = 0.0001815mol $I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$ 1mol 2mol 0.00009075mol 0.0001815mol concentration = $\frac{\text{no. of mol}}{\text{volume}} = \frac{0.00009075\text{mol}}{0.02\text{litres}}$ = 0.0045375mol l^{-1}
17a	3.86	Q = I x t = 0.5 x (2x60x60) = 3600C $Pb + SO_4^{2-} \longrightarrow Pb^{2+}SO_4^{2-} + 2e^-$ 1mol 2mol 207.2g 193000C 207.2g x 3600/193000 3600C =3.86g
17b	$PbO_2 + SO_4^{2-} + 4H^+ + 2e^-$ ↓ $PbSO_4 + 2H_2O$	Step 1: Write down main species in reaction $PbO_2 + SO_4^{2-} \rightarrow PbSO_4$ Step 2: Balance all atoms other than O or H $PbO_2 + SO_4^{2-} \rightarrow PbSO_4$ Step 3: Balance O atoms by adding H_2O to the other side $PbO_2 + SO_4^{2-} \rightarrow PbSO_4 + 2H_2O$ Step 4: Balance H atoms by adding H^+ to the other side $PbO_2 + SO_4^{2-} + 4H^+ \rightarrow PbSO_4 + 2H_2O$ Step 5: Balance charge by adding electrons to the most positive side $PbO_2 + SO_4^{2-} + 4H^+ + 2e^- \rightarrow PbSO_4 + 2H_2O$
18a	Diagram showing:	Any ring structure with two CH_3 groups both pointing up or both pointing down 
18b(i)	Larger the group the larger the steric strain	The larger the atom (H<F<Br) the larger the steric strain The larger the group the larger the steric strain e.g. CH_3 < $(CH_3)_3C$
18b(ii)	7.8	Steric Strain = 2 x steric strain between H and CH_3 = 2 x 3.8 = 7.6