Past Papers Higher Chemistry

2012 Marking Scheme

Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	75+	31.4%
B	62+	25.2%
C	49+	22.4%
D	42+	9.3%
No award	<42	11.7%

Section:	Multiple Choice	Extended Answer
Average Mark:	27.3 /40	36.4 /60

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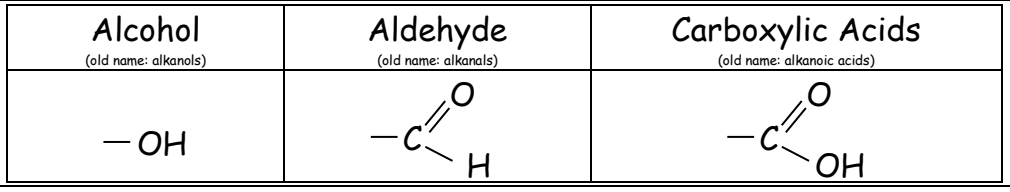
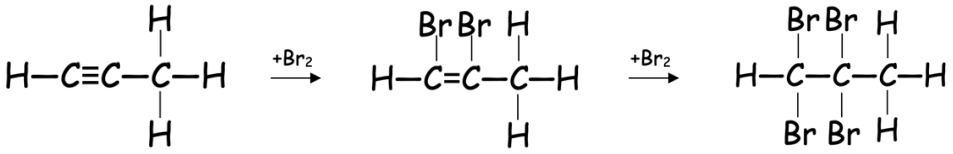
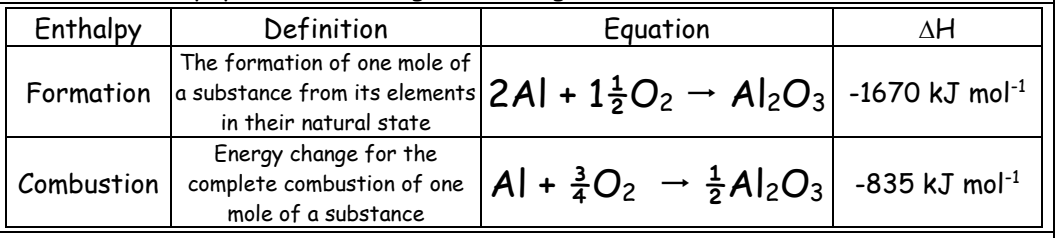
MC Qu	Answer	% Pupils Correct	Reasoning
1	D	76	Isotopes have <u>same</u> Atomic number / Number of protons but <u>different</u> Mass number / Number of neutrons
2	C	55	(i) W is the least reactive as it is the only metal which doesn't react with acid (ii) Z is most reactive as it is the only one not reduced when heated with carbon (iii) X is more reactive than Y as X displaces Y from a solution of Y nitrate
3	D	33	☒A Neon atoms are neutral and not positively charged ☒B Fluoride F^- ions are negatively charged ☒C Sodium atoms are neutral and not positively charged ☑D Aluminium Al^{3+} ions have electron arrangement 2,8 and are positively charged
4	C	58	☒A sodium carbonate is soluble ∴ no precipitate is formed ☒B potassium chloride is soluble ∴ no precipitate is formed ☑C magnesium carbonate is insoluble ∴ precipitate is formed ☒D potassium sulphate is soluble ∴ no precipitate is formed
5	B	62	0.8mol of H_2 remaining ∴ 0.2mol of H_2 has reacted $H_2 + I_2 \longrightarrow 2HI$ 1mol 2mol 0.2mol 0.4mol
6	D	79	☒A Activation Energy E_a is not altered by changes in temperature ☒B The Enthalpy Change ΔH is independent of the temperature it takes place at ☒C Activation Energy E_a is not altered by changes in temperature ☑D Increasing temperature means more collision with energy greater than E_a
7	C	65	$CaCO_3 + 2HNO_3 \longrightarrow Ca(NO_3)_2 + H_2O + CO_2$ 1mol 2mol 1mol 1mol 1mol 0.05mol 0.1mol ($0.1mol\ HNO_3$ required but only $0.08mol\ HNO_3$ available) 0.04mol (required) 0.08mol (available) 0.04mol 0.04mol 0.04mol
8	B	79	☒A distance x represents the activation energy for the forward reaction ☑B distance y represents the enthalpy change R→P for the forward reaction ☒C distance x+y represents the activation energy for the reverse reaction ☒D distance x-y does not represent anything on this graph
9	A	44	$5N_2O_4 + 4CH_3NHNH_2 \longrightarrow 4CO_2 + 12H_2O + 9N_2\ \Delta H=-5116kJ$ 5mol 4mol 2mol $4mol \times {}^2/_5$ $\Delta H=-5116kJ \times {}^2/_5$ $= 1.6mol$ (2mol available) $= -2046.4kJ$
10	C	62	☒A Electronegativity difference = 3.0 – 2.5 = 0.5 ☒B Electronegativity difference = 3.5 – 3.0 = 0.5 ☑C Electronegativity difference = 3.0 – 3.0 = 0 ☒D Electronegativity difference = 3.0 – 2.2 = 0.8
11	D	78	☒A Solid has high mpt and non-conductor as solid ∴ substance likely to be ionic ☒B Solid conducts as solid ∴ substance contains metallic bonding ☒C Solid conducts as solid ∴ substance contains metallic bonding ☑D Substances with lower mpt and non-conductor as a solid is likely to be non-polar covalent and have only London dispersion forces between molecules/atoms
12	B	68	☒A Hydrogen has a single covalent bond in the diatomic H_2 molecule ☑B Helium is monatomic Noble Gas element in Group 0 ☒C Nitrogen has a triple covalent bond in the diatomic N_2 molecule ☒D Sulphur has covalent bonds within the S_8 molecule

13	B	88	☒A All ionic substances must be compounds ☑B Monatomic elements cannot be found in compounds as they do not form bonds ☒C Covalent Networks can be elements (e.g. diamond) and compounds (e.g. SiO_2) ☒D Covalent molecules can be elements (e.g. H_2) or compounds (e.g. H_2O)
14	C	54	☒A Hexane C_6H_{14} is a non-polar hydrocarbon ∴ ionic substances do not dissolve in it ☒B Benzene C_6H_6 is a non-polar hydrocarbon ∴ ionic substances do not dissolve in it ☑C Methanol is polar (due to –OH bond) and polar ionic substances can dissolve in it ☒D Tetrachloromethane CCl_4 is non-polar due to it tetrahedral shape
15	D	75	1mol of any gas has the same volume (at the same conditions of temp and pressure) 1mol gas = 6.02×10^{23} molecules 0.1mol O_2 + 0.2mol CO_2 = 0.3mol gas = 6.02×10^{23} molecules x $^{0.3}/_{10}$ = 1.806×10^{23}molecules
16	B	74	☒A gfm H_2=2g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{2}/_{2}$ = 1 mol gfm N_2=28g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{14}/_{28}$ = 0.5 mol ☑B gfm CH_4=16g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{32}/_{16}$ = **2 mol** gfm CO_2=44g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{88}/_{44}$ = **2 mol** ☒C gfm CO=28g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{7}/_{28}$ = 0.25 mol gfm O_2=32g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{16}/_{32}$ = 0.5 mol ☒D gfm HCl=36.5g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{10}/_{36.5}$ = 0.27 mol gfm SO_2=64.1g ∴ no. of mol = $^{mass}/_{gfm}$ = $^{10}/_{64.1}$ = 0.16 mol
17	A	61	$2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$ 2mol 1mol 2mol 1mol ½mol 1mol 1vol ½vol 1vol 1litre ½litre 1litre
18	A	90	☑A Heptane is straight and lacks rings or branches needed for unleaded petrol ☒B Branch-chain hydrocarbons are added to unleaded petrol to prevent autoignition ☒C Cyclo-ring hydrocarbons are added to unleaded petrol to prevent auto-ignition ☒D Aromatic hydrocarbons are added to unleaded petrol to prevent auto-ignition
19	C	94	☒A Butane C_4H_{10} is not the main constituent of biogas ☒B Ethane C_2H_6 is not the main constituent of biogas ☑C Methane CH_4 is the main constituent of biogas ☒D Propane C_3H_8 is not the main constituent of biogas
20	A	60	☑A Reforming: straight molecules are converted into branched/ring structures ☒B Hydrogenation: the addition of hydrogen across a C=C double bond ☒C Dehydration: the removal of water leaving a C=C double bond behind ☒D Cracking: Larger hydrocarbons are broken into smaller hydrocarbons
21	A	56	☑A C_6H_{14} molecule shown is 2,3-dimethylbutane and has a different structure. ☒B Same molecule: $-CH_3$ methyl group sticking off C_2 of 5 carbon chain. ☒C Same molecule: $-CH_3$ methyl group sticking off C_2 of 5 carbon chain. ☒D Same molecule: $-CH_3$ methyl group sticking off C_2 of 5 carbon chain.
22	B	92	
23	B	74	☒A Ethyl ethanoate ∴ ethanol C_2H_5OH gfm=46g and ethanoic acid CH_3COOH gfm=60g ☑B Propyl ethanoate ∴ propanol C_3H_7OH gfm=60g and ethanoic acid CH_3COOH gfm=60g ☒C Methyl propanoate ∴ methanol CH_3OH gfm=32g and propanoic acid C_2H_5COOH gfm=74g ☒D Ethyl propanoate ∴ ethanol C_2H_5OH gfm=46g and propanoic acid C_2H_5COOH gfm=74g
24	A	78	☑A Benzene C_6H_6 and ethyne C_2H_2 have the same ratio of carbon to hydrogen ☒B Benzene is not oxidised by hot copper (II) oxide ☒C Benzene (bpt. 80°C) is less volatile than ethanal (bpt. 20°C) ☒D Benzene is resistant to addition reactions as it has no C=C double bonds

25	C	85	 propyne 1,2-dibromopropene 1,1,2,2-tetrabromopropane ☒A addition of 1st Br_2 molecule produces 1,2-dibromopropene (2 Br atoms attached) ☒B 1,1,2,2-tetrabromopropane produced not 1,1,1,2-dibromopropane ☑C 1,2-dibromopropene is the 1st addition product of propyne with bromine ☒D Br atoms are added to adjacent carbons as they add across triple/double bonds
26	D	87	☒A pentan-2-ol is a secondary alcohol and oxidises to a ketone ☒B pentan-3-ol is a secondary alcohol and oxidises to a ketone ☒C 2-methylbutan-2-ol is a tertiary alcohol and cannot be oxidised ☑D 2,2-dimethylpropan-1-ol: primary alcohol and can be oxidised to carboxylic acids
27	D	83	Synthesis Gas is made by the steam reforming of methane and is a mixture of carbon monoxide and hydrogen.
28	C	57	☒A Aluminium is a metal and has delocalised electrons which allow it to conduct ☒B poly(ethyne) is a polymer which has delocalised electrons to allow conduction ☑C poly(ethenol) is a soluble polymer which does not conduct electricity ☒D Graphite has delocalised electrons which allow it to conduct electricity
29	B	74	☒A mixture of peptides is missing a W-V fragment ☑B all possible fragments from peptide are in this answer ☒C mixture of peptides is missing a X-W fragment ☒D mixture of peptides is missing a Z-X fragment
30	A	56	
31	B	71	☒A Higher temperature will get you to equilibrium quicker ☑B Equilibrium explains why both reactants are still found in the mixture. ☒C methanol is left as products break down as fast as reactants are being used up ☒D there is an excess of ethanoic acid as there is only 0.1mol of methanol
32	D	83	☒A Catalysts do not affect the position of equilibrium ☒B Catalysts do not change the enthalpy change ☒C Catalysts do not affect the position of equilibrium ☑D Catalysts do not change the enthalpy change or the position of equilibrium
33	A	54	☑A OH^- ions will remove H^+, equilibrium moves to right ∴ more ClO^- produced ☒B adding H^+ ions moves equilibrium to the left ∴ concentration of ClO^- decreases ☒C adding Cl^- ions moves equilibrium to the left ∴ concentration of ClO^- decreases ☒D K^+ ion and SO_4^{2-} ions have no effect on the position of equilibrium
34	C	54	☒A x100 dilution of acid ∴ pH of acid increases and stays at pH=7 ☒B x100 dilution of alkali ∴ pH of alkali decreases and stays at pH=7 ☑C both acid and alkali are diluted and become pH=7 ☒D the diluted acid and alkali both have a pH=7
35	B	62	☒A Hydrochloric acid is a strong acid and fully ionises. ☑B Ethanoic acid is a weak acid and only partially ionises ∴ has fewest ions ☒C Sodium chloride is fully soluble and produces many ions ☒D Sodium hydroxide is a strong alkali and fully ionises
36	D	65	Sodium propanoate is a salt made from weak acid (propanoic acid) and a strong alkali ∴ pH of salt in solution is alkaline (pH>7)

Enthalpy	Definition	Equation	ΔH
Formation	The formation of one mole of a substance from its elements in their natural state	$2Al + 1\frac{1}{2}O_2 \rightarrow Al_2O_3$	-1670 kJ mol^{-1}
Combustion	Energy change for the complete combustion of one mole of a substance	$Al + \frac{3}{4}O_2 \rightarrow \frac{1}{2}Al_2O_3$	-835 kJ mol^{-1}

37	D	43	Write down main species involved IO_3^- → I_2 Balance all atoms other than O and H $2IO_3^-$ → I_2 Add H_2O to other side to balance O atoms $2IO_3^-$ → $I_2 + 6H_2O$ Add H^+ to other side to balance H atoms $2IO_3^- + 12H^+$ → $I_2 + 6H_2O$ Add electrons to most positive side to balance charge $2IO_3^- + 12H^+ + 10e^-$ → $I_2 + 6H_2O$
38	A	80	$Ag^+ + e^- \longrightarrow Ag$ (1mol, 96500C; 1mol, 1mol) $Au^{3+} + 3e^- \longrightarrow Ag$ (3mol, 289500C; 96500C; 1mol, 1mol, 0.33mol) $Ni^{2+} + 2e^- \longrightarrow Ni$ (2mol, 193000C; 96500C; 1mol, 1mol, 0.5mol) $Cu^{2+} + 2e^- \longrightarrow Cu$ (2mol, 193000C; 96500C; 1mol, 1mol, 0.5mol)
39	B	75	☒A Fission is the splitting of a larger nucleus to form smaller nuclei ☑B Fusion is the joining up of smaller nuclei into a larger nucleus ☒C Proton Capture is when a proton is added to a nucleus ☒D Neutron Capture is when a neutron is added to a nucleus
40	C	53	There are three different N_2 molecules formed from 2 isotopes of nitrogen: $^{14}N \equiv {}^{14}N$ $^{14}N \equiv {}^{15}N$ $^{15}N \equiv {}^{15}N$

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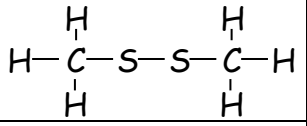
Long Qu	Answer	Reasoning
1a	Boron or carbon	Covalent Networks are found in non-metal elements with high melting points: Type: metal | metal | non-metal | non-metal | non-metal | non-metal | non-metal | non-metal Element: Li | Be | B | C | N | O | F | Ne m.pt. (°C): 181 | 1287 | 2075 | 3825 | -210 | -219 | -220 | -249
1b	Number of protons increases	Other acceptable answers: increased atomic number or greater/positive charge (pull) or greater pull on (outer) electrons
2a	To allow escape of gas from flask	Other acceptable answers: To prevent loss of any solution/spray/acid from flask or spurting or To stop any solids/liquids getting in/out
2b(i)	0.018	$\text{Rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}} = \frac{0.18}{10} = 0.018\ g\ s^{-1}$
2b(ii)	0.393 (acceptable: 0.37 to 0.4)	**m**ass of CO_2 given off = 165.00g – 164.86g = 0.14g. **gfm** CO_2 = (1x12)+(2x16) = 44g $\text{no. of mol} = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{0.14g}{44g\ mol^{-1}} = 0.00318mol$ $CuCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$ 1mol 0.00318mol — 1mol 0.00318mol **gfm** $CuCO_3$ = (1x63.5)+(1x12)+(3x16) = 123.5g **mass** = **no.** of mol x **gfm** = 0.00318mol x 123.5g mol^{-1} = 0.393g
3a	0.125	$\Delta H = cm\Delta T$ = 4.18 x 0.5 x 82 = -171.38kJ -1367kJ is released by burning 1 mol ethanol -171.38kJ released by 1 mol x $^{-171.38}/_{-1367}$ = 0.125mol
3b	2 from:	heat lost to surroundings | incomplete combustion | loss (of ethanol) through evaporation | ethanol impure
4a	Equation showing:	$^{89}_{38}Sr \rightarrow {}^{89}_{39}Y + {}^{0}_{-1}e$
4b(i)	no effect/no change	Half-life is not effected by physical state (solid/liquid/gas/solution), chemical state (atom/molecule/ion) or by changes of temperature
4b(ii)	5.56g	**gfm** $^{89}SrCl_2$ = (1x89)+(2x35.5) = 89+71 = 160g 160g of $^{89}SrCl_2$ contains 89g of ^{89}Sr 10g 89g x $^{10}/_{160}$ = 5.56g
4c	$\frac{1}{4}$	Time (days) | Fraction remaining 0 | 1 14 | $\frac{1}{2}$ 28 | $\frac{1}{4}$
5a	$2.76x10^{21}$	From graph: At voltage=20mV, volume = $110cm^3$ 1 mol ethanol = 46g = 24 litres = $6.02x10^{23}$ molecules 0.110litres = $6.02x10^{23}$molecules x $^{0.110}/_{24}$ = $2.76x10^{21}$molecules
5b	$CH_3CH_2OH + O_2 \rightarrow CH_3COOH + H_2O$	❶ $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ ❷ $CH_3CH_2OH + H_2O \rightarrow CH_3COOH + 4H^+ + 4e^-$ ❶+❷ $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ $CH_3CH_2OH + H_2O \rightarrow CH_3COOH + 4H^+ + 4e^-$ overall $CH_3CH_2OH + O_2 \rightarrow CH_3COOH + H_2O$

5c — Catalyst in different state to reactants

Catalyst	Description
Homogeneous	Catalyst in *same* state as reactants
Heterogeneous	Catalyst in *different* state as reactants

6a



Methyl $-CH_3$ groups must each be attached to a sulphur and this leaves a bond left for the sulphur to be attached to each other.

6b(i) — 1.47×10^{-3}

no. of mol Cl_2 = **v**olume x **c**oncentration = $0.0294_{litres} \times 0.01_{mol\ l^{-1}} = 2.94 \times 10^{-4}$ mol

$$4Cl_2 + H_2S + 4H_2O \longrightarrow SO_4^{2-} + 10H^+ + 8Cl^-$$

4mol 1mol

2.94×10^{-4}mol 7.35×10^{-5}mol

$50cm^3$ water sample contains 7.35×10^{-5}mol of Cl_2

$1000cm^3$ water sample 7.35×10^{-5} mol x $^{1000}/_{50}$

$= 1.47 \times 10^{-3}$ mol l^{-1}

6b(ii) — 2 marks for:

<u>First Mark</u>:

- Permanent dipole-permanent dipole attractions or polar-polar attractions/forces ($\frac{1}{2}$mark)
- weak intermolecular bonds/forces ($\frac{1}{2}$mark)

<u>Second Mark</u>:

If permanent dipole-permanent dipole attractions mentioned for 1st Mark:

- Mention of difference in electronegativities or indication of polar bonds or indication of permanent dipole (1mark)

If London dispersion forces mentioned for 1st Mark:

- instantaneous dipoles or temporary dipoles or uneven distribution of electrons or electron wobbles (1mark)

7a — w=9 z=6 y=2 z=2

Element	C	H	N	O
Number	9	6	2	2
Reasoning	6 carbons in benzene ring 1 carbon in $-CH_3$ group 2 carbons in N=C=O groups	3 hydrogens on benzene ring plus three in $-CH_3$ group	2 nitrogens off benzene ring	2 oxygens in molecule

7b — monomers have added across the (N=C) double bond

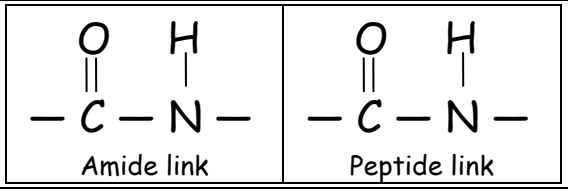
Other acceptable answers:
no elimination of a small molecule (such as water) or
only one product molecule formed or joined across the (N=C) double bond

7c — Dotted line between N and H between chains.

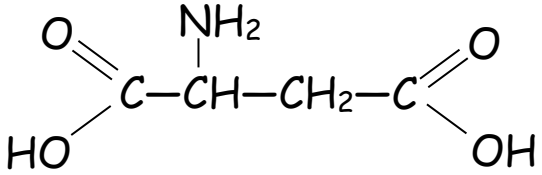
Hydrogen bonding takes place between:

N-H bonds	O-H bonds	H-F bonds

8a — Amide link or Peptide link



8b — diagram showing:



8c — essential

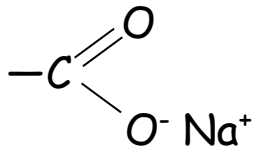
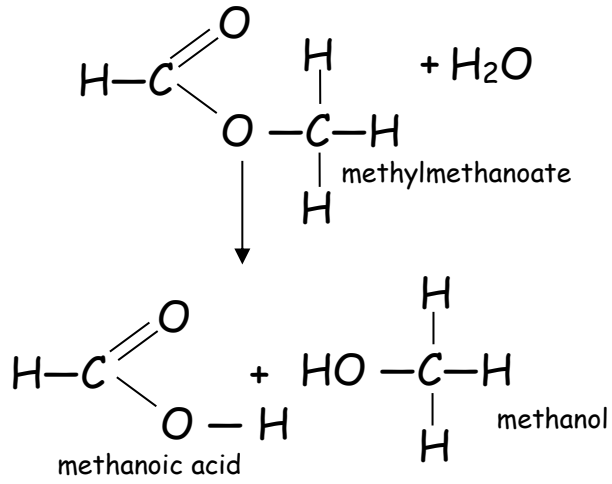
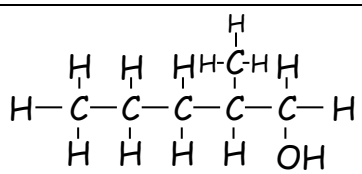
Amino acids which cannot be made by the body are described as essential amino acids and must be consumed through our diet.

8d — one answer from:

Use a condenser	wet paper towel	cold finger test tube

9a — Answer to include:

($\frac{1}{2}$ mark) Use Bromine solution
($\frac{1}{2}$ mark) Oleic acid decolourises or stearic acid does not decolourise

9b	Octadec-9,12,15-trienoic acid	**Octadec-9,12,15-trienoic acid** 18 Carbon Main Chain; Position of C=C double bonds; Three C=C double boinds; Carboxyl -COOH group on C_1
9c		Sodium hydroxide NaOH will neutralise carboxylic acids to form salts. The ionic portion of the molecule is ionic and water soluble. The hydrocarbon part of the molecule is non-polar and will be soluble in fat.
10a	air	Raw Materials include: air | water | methane (natural gas) | sodium chloride (salt) | calcium carbonate (chalk)
10b	methylmethanoate	 methylmethanoate methanoic acid methanol
10c	70%	1mol $HCOOH$ = (2x1)+(1x12)+(2x16) = 2+12+32 = 46g 1mol $HCONH_2$ = (3x1)+(1x12)+(1x16)+(1x14) = 3+12+16+14 = 45g $HCOOH + NH_3 \rightleftharpoons HCONH_2 + H_2O$ 1mol 46g 1.38g ; 1mol 45g ; 45g x $^{1.38}/_{46}$ = 1.35g (Theoretical) % Yield = $\frac{\text{Actual}}{\text{Theoretical}} \times 100 = \frac{0.935}{1.35} \times 100 = 70\%$
11a(i)	3-methylbutan-2-ol	**3-methylbutan-2-ol** Methyl -CH_3 side groups on C_3; Four carbons on main chain; Single bonds on main chain; -OH hydroxyl group on C_2
11a(ii)	Diagram of 2-methylpentan-1-ol	
11b(i)	$4BF_3 + 3NaBH_4$ ↓ $2B_2H_6 + 3NaBF_4$	$4BF_3 + 3NaBH_4 \longrightarrow 2B_2H_6 + 3NaBF_4$

11b(ii) — -2168

❶	$2B + 3H_2 \rightarrow B_2H_6$	$\Delta H = +36$ kJ mol^{-1}
❷	$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$	$\Delta H = -236$ kJ mol^{-1}
❸	$2B + 1\frac{1}{2}O_2 \rightarrow B_2O_3$	$\Delta H = -1274$ kJ mol^{-1}
❶x-1	$B_2H_6 \rightarrow 2B + 3H_2$	$\Delta H = -36$ kJ mol^{-1}
❷x3	$3H_2 + 1\frac{1}{2}O_2 \rightarrow 3H_2O$	$\Delta H = -858$ kJ mol^{-1}
❸	$2B + 1\frac{1}{2}O_2 \rightarrow B_2O_3$	$\Delta H = -1274$ kJ mol^{-1}
Add ❶'+❷'+❸	$B_2H_6 + 3O_2 \rightarrow B_2O_3 + 3H_2O$	$\Delta H = -2168$ kJ mol^{-1}

11c — 143 444 kJ

1mol B_5H_9 = (5x10.8)+(9x1) = 54+9 = 63g
1mol 63g = -9037kJ
1000g = -9037 kJ x $^{1000}/_{63}$
= 143 444 kJ

12a — One answer from:

To allow the potato discs/catalase to reach the pH of the buffer.	To allow buffer to soak/diffuse into the potato disc.	To allow the enzyme/potato to reach the same pH as the surrounding solution.	To allow the enzyme/potato to acclimatise.

12b — hydrogen peroxide

The enzyme (catalase) catalyses the breakdown of hydrogen peroxide:

$$H_2O_2 \longrightarrow H_2O + \tfrac{1}{2}O_2$$

12c — One answer from:

the enzyme is denatured	enzymes work best at an optimum pH	the enzyme changes its shape
enzyme is destroyed	too acidic for enzyme to function	enzyme has stopped working

13a — 1.89g

Q=It = 5 x (32x60) = 9600C

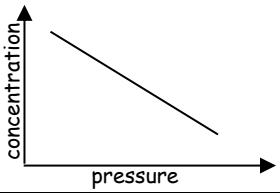
$$2F^- \longrightarrow F_2 + 2e^-$$

1mol 2mol
38g 193000C
$^{9600}/_{193000}$ x 38g 9600C
=1.89g

13b(i) — exothermic or heat given out

From Graph: Decrease in Temperature gives higher concentration of C_2F_4
∴ Decrease in temperature favours forward reaction which forms C_2F_4
A decrease in temperature always favours the exothermic reaction
∴ Forward Reaction (Formation of C_2F_4) is exothermic

13b(ii)



- Increasing pressure favours the pressure-reducing reaction
- Reverse reaction reduces pressure (2mol of gas → 1mol of gas)

∴ Increase in pressure favours reverse reaction
∴ Increase in pressure decreases concentration of C_2F_4

13c — depletion/break down of the ozone layer

Chlorofluorocarbons breaks down ozone, allowing harmful u.v. light through to cause skin cancer.

14a(i) — 1x10^{-5} or 10^{-5}

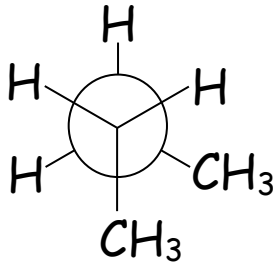
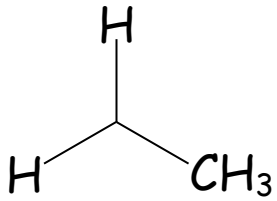
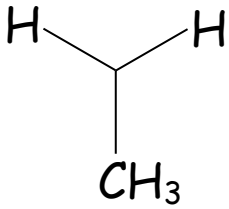
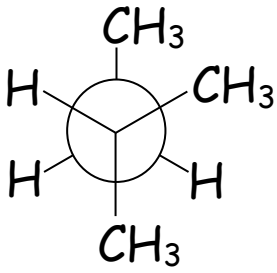
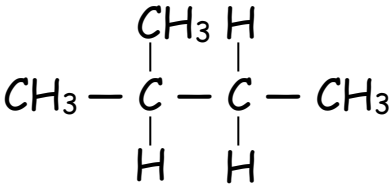
pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
$[H^+]$ (mol l^{-1})	1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}	10^{-10}	10^{-11}	10^{-12}	10^{-13}	10^{-14}
$[OH^-]$ (mol l^{-1})	10^{-14}	10^{-13}	10^{-12}	10^{-11}	10^{-10}	10^{-9}	10^{-8}	10^{-7}	10^{-6}	10^{-5}	10^{-4}	10^{-3}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

14a(ii) — Answer to include:

1st Mark	½ mark for $NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$ ½ mark for OH^- ions are removed by pairing up with NH_4^+ ions
2nd Mark	½ mark for $H_2O_{(l)} \rightleftharpoons H^+{}_{(aq)} + OH^-{}_{(aq)}$ ½ mark for water molecule dissociates increasing H^+ ion concentration

14b — Answer to include:

Description of a large volume/number of moles of gas is produced or
There is an increase in the number of moles of gas or
Oxygen gas is produced which can support combustion or
It is an oxidising agent

15a(i)	To keep the current/amps constant	The current must be kept constant throughout the experiment as a constant current value must be used in the equation Q=It
15a(ii)	Current ($\frac{1}{2}$) Time ($\frac{1}{2}$)	The Current (measured in Amps) and the Time (measured in seconds) are used in the equation Q=It to calculate the Charge (measured in Coulombs)
15b(i)	SO_2 can be recycled/reused back into step 1	Recycling of chemicals in a manufacturing process can reduce costs of chemical used in the process.
15b(ii)	$H_2O \rightarrow H_2 + \frac{1}{2}O_2$	❶ $I_2 + SO_2 + 2H_2O \rightarrow 2HI + H_2SO_4$ ❷ $2HI \rightarrow I_2 + H_2$ ❸ $H_2SO_4 \rightarrow SO_2 + H_2O + \frac{1}{2}O_2$ add ❶+❷+❸ final equation $H_2O \rightarrow H_2 + \frac{1}{2}O_2$
16a		 Carbon closest to eye has –CH_3 methyl group at 4 o'clock position  Carbon furthest from eye has –CH_3 methyl group at 6 o'clock position
16b	2-methylbutane	 Newman Projection of molecule  Structural formula of molecule