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Past Papers Nat 5 Chemistry

2019 Marking Scheme

Grade Awarded	Mark Required (/125)	Mark Required %	% candidates achieving grade
A	89+	71.2%	34.6%
B	74+	59.2%	21.6%
C	59+	47.2%	20.7%
D	44+	35.2%	15.9%
No award	<44	<35.2%	7.2%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	17.2 /25	41.5 /75	18.2 /25

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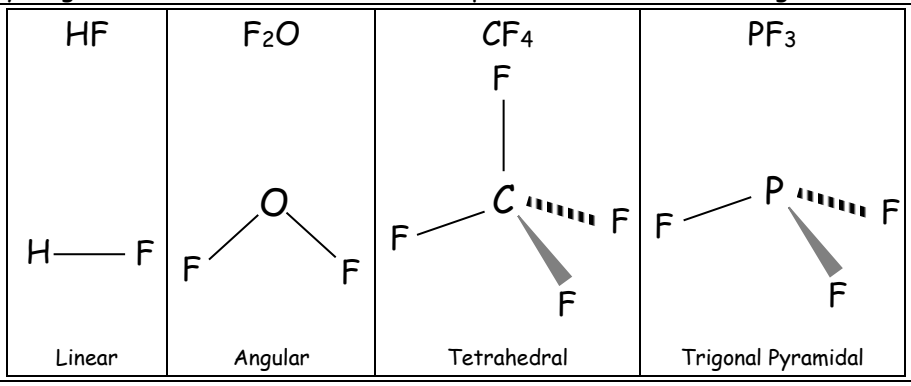
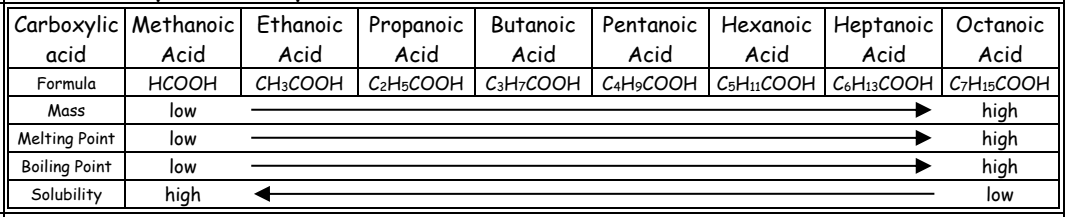
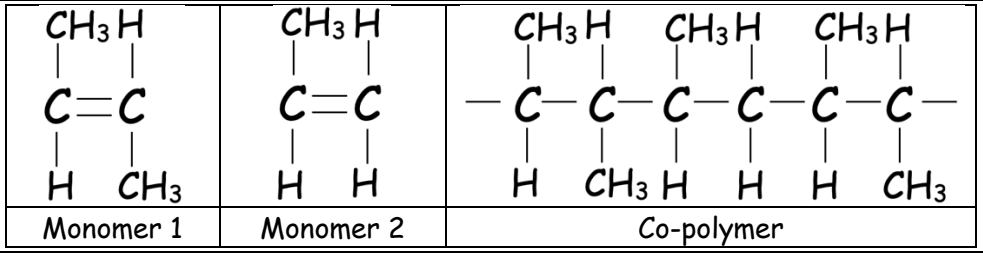
MC Qu	Answer	% Pupils Correct	Reasoning
1	C	87	Rate = $\frac{\Delta \text{Quantity}}{\Delta \text{Time}} = \frac{5\ cm^3}{2\ min} = 2.5\ cm^3\ min^{-1}$
2	B	64	
3	C	90	☒A All elements in group 1 have 1 electron in outer shell ☒B All elements in group 2 have 2 electrons in outer shell ☑C All elements in group 7 have 7 electrons in outer shell ☒D All elements in group 8 (apart from Helium) have 8 electrons in outer shell
4	D	72	☒A This ion has a negative charge as it has more electrons than protons ☒B This atom has no charge as it has equal numbers of protons and electrons ☒C This atom has no charge as it has equal numbers of protons and electrons ☑D This ion has a 2+ positive charge as it has 2 less electrons than protons
5	B	76	☒A 40°C is above the critical temperature to CO_2 is a gas at 40°C ☑B NH_3 and CO_2 are compounds and have the highest critical temperatures ☒C Ammonia NH_3 has the highest critical temperature but is medium in mass ☒D Hydrogen H_2 is has a lower critical temperature than the noble gas Helium He
6	D	80	
7	A	45	☑A Na^+ electron arrangement is 2,8 and O^{2-} electron arrangement is 2,8 ☒B Li^+ electron arrangement is 2 and F^- electron arrangement is 2,8 ☒C K^+ electron arrangement is 2,8,8 and Br^- electron arrangement is 2,8,18,8 ☒D Mg^{2+} electron arrangement is 2,8 and Cl^- electron arrangement is 2,8,8
8	B	66	☒A ionic copper sulphate in the solid state is a non-conductor ☑B ionic compounds will conduct is both the molten/liquid state and in solution ☒C ionic potassium nitrate in the solid state is a non-conductor ☒D hexane C_6H_{14} is a hydrocarbon and is covalent molecular and is a non-conductor
9	A	58	☑A Calcium hydroxide is the solute as it is the solid which is dissolved ☒B Water is the solvent as it is the liquid doing the dissolving ☒C Calcium hydroxide solution is the solution with the solute dissolved in solvent ☒D Calcium hydroxide must be soluble if it dissolves
10	B	73	**gfm** NH_4NO_3 = (1x14)+(4x1)+(1x14)+(3x16) = 14+4+14+48 = 80 $\%N = \frac{\text{mass of nitrogen}}{\textbf{gfm}} \times 100 = \frac{28}{80} \times 100 = 35\%$
11	D	78	☒A The pH of an alkaline solution will decrease to pH=7 on dilution ☒B The pH of an alkaline solution will decrease to pH=7 on dilution ☒C The concentration of OH^- ions decreases on dilution ☑D The concentration of OH^- ions decreases on dilution

12	A	57	☑A sodium oxide is a metal oxide (a type of base) and neutralises an acid to form water ☒B calcium chloride does not react with acids and is not a base ☒C potassium nitrate does not react with acids and is not a base ☒D ammonium sulphate does not react with acids and is not a base
13	D	65	☒A Cyclopropane C_3H_6 has an isomer called propene C_3H_6 ☒B But-1-ene C_4H_8 has isomers including but-2-ene C_4H_8 ☒C Pentane C_5H_{12} has isomers including 2-methylbutane C_5H_{12}. ☑D Ethene C_2H_4 has no isomers
14	C	63	☒A Formula is C_6H_{12} so does not fit the general formula of alkanes C_nH_{2n+2} ☒B Formula is C_6H_{12} so does not fit the general formula of alkanes C_nH_{2n+2} ☑C C=C double bond between C_2 & C_3 (numbered from right) and methyl group on C_3 ☒D C=C takes the lower number system so Pent-3-ene should be pent-2-ene
15	A	39	☑A Oct-2-ene produces two products on hydration (octan-2-ol and octan-3-ol) ☒B Hex-3-ene produces one product on hydration (hexan-3-ol) ☒C But-2-ene produces one product on hydration (butan-2-ol) ☒D Ethene produces one product on hydration (ethanol)
16	B	88	Reaction removes the C=O group and replaces it with a CH_2 group. Alkane produced has 6 carbons in main chain and a methyl group on C_2 ∴ 2-methylhexane produced
17	B	65	
18	D	82	☒A Largest voltage = largest separation on electrochemical series (magnesium-silver) ☒B 2nd Largest voltage = 2nd largest separation on electrochemical series (zinc-silver) ☒C 3rd Largest voltage = 3rd largest separation on electrochemical series (iron-silver) ☑D Smallest voltage = smallest separation on electrochemical series (copper-silver)
19	C	66	☒A Metal Z is more reactive than metal X as metals Z reacts with water ☒B Metal Y is least reactive metal as it is only one which had no reaction with acid ☑C Metal Y is least reactive metal and Metal Z is most reactive metal ☒D Metal Y is least reactive metal as it is only one which had no reaction with acid
20	C	47	
21	C	29	☒A Nitrogen dioxide is soluble and would dissolve in water rather than collect. ☒B Nitrogen dioxide is soluble and would dissolve in water rather than collect. ☑C Nitrogen dioxide is more dense than air and would collect in bottom of cylinder ☒D Nitrogen dioxide is more dense than air and would escape out of the cylinder
22	A	95	☑A Ba^{2+} ions give a green colour in a flame test ☒B Ca^{2+} ions give a orange-red colour in a flame test ☒C K^+ ions give a lilac colour in a flame test ☒D Na^+ ions give a yellow colour in a flame test
23	D	84	☒A oxygen gas relights a glowing splint ☒B nitrogen does not turn lime water milky/burn with a pop/relight a glowing splint ☒C hydrogen gas burns with a pop ☑D carbon dioxide turns limewater milky

24	C	66	☒A Addition reactions happen when a molecule adds across as C=C double bond ☒B Combustion reactions happen when chemicals split up and react with oxygen ☑C Precipitation reactions form an insoluble solid when solutions are added together ☒D Neutralisation reactions happen when an acid reacts with a base to form water
25	B	77	$AgNO_{3(aq)} + NaBr_{(aq)} \rightarrow NaNO_{3(aq)} + AgBr_{(s)}$ Split solutions into ions $Ag_{(aq)} + NO_3^-{}_{(aq)} + Na^+{}_{(aq)} + Br^-{}_{(aq)} \rightarrow Na^+{}_{(aq)} + NO_3^-{}_{(aq)} + AgBr_{(s)}$ Indentify Spectator Ions and cancel out Spectator Ions $Ag_{(aq)} + \cancel{NO_3^-{}_{(aq)}} + \cancel{Na^+{}_{(aq)}} + Br^-{}_{(aq)} \rightarrow \cancel{Na^+{}_{(aq)}} + \cancel{NO_3^-{}_{(aq)}} + AgBr_{(s)}$ Re-write equation without spectator ions $Ag_{(aq)} + Br^-{}_{(aq)} \rightarrow AgBr_{(s)}$

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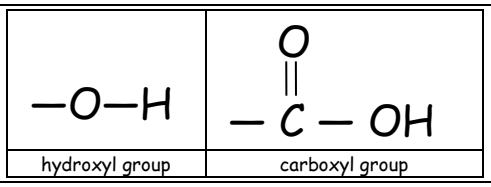
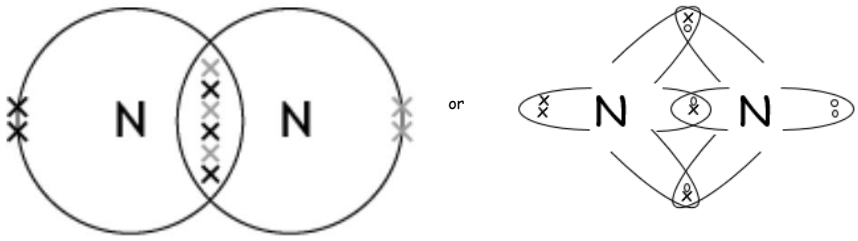
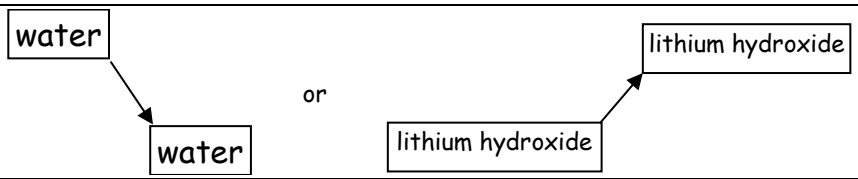
Long Qu	Answer	Reasoning
1a	network	SiO_2 is a covalent compound as both elements in the compound are non-metals. If the covalent compound has a high melting point it is a covalent network compounds. If it has a low melting and boiling point then it is covalent molecular.
1b(i)	Isotope	Same: Atomic number, Number of protons — Different: Mass number, Number of neutrons
1b(ii)	Different number of neutrons	Both isotopes of boron have 5 protons as they have an atomic number of 5. The ^{10}B isotope has 5 neutrons and the ^{11}B isotope has 6 neutrons, calculated by number of neutrons = mass number – atomic number
1b(iii)	More ^{11}B isotope	The RAM (Relative Atomic Mass) is the average mass of the different isotopes. As the average is much closer to 11, there must be more ^{11}B isotope in the sample.
1c	120	24% of 500g = $\frac{24}{100}$ x 500 = 120g
2a	Hydroxyl	
2b	enzyme	Problem Solving: Retrieving information from a passage
2c	calcium oxalate	Acids react with bases to form salts. Oxalic acid reacts with calcium ions to form the salt calcium oxalate
2d	90	Lactic acid is the harmless product mentioned in the text. Formula of lactic acid = $C_3H_6O_3$ 1 mol = (3x12) + (6x1) + (3x16) = 36 + 6 + 48 = 90
3a	One diagram from:	
3b	Blue or purple	Ammonia NH_3 gas dissolves in water to form alkaline ammonium hydroxide solution. Alkali on the damp/moist pH paper will turn blue/purple. $NH_{3(g)}$ (ammonia) + $H_2O_{(l)}$ (water) → $NH_4^+{}_{(aq)}$ (ammonium ion) + $OH^-{}_{(aq)}$ (hydroxide ion)
3c(i)	Increase in temperature decrease in percentage	One From: As the temperature increases yield/% decreases. / As the temperature decreases the yield/% increases. / The yield/% increases as the temperature decreases. / The yield/% decreases as the temperature increases. Cause and Effect: It must be a change of temperature and its effect on yield so "as yield of ammonia decreases, temperature gets higher" is incorrect
3c(ii)	Graph showing:	1 mark: One mark is awarded for a graph which shows points plotted rather than bars. 1 mark: The axis/axes of the graph has/have suitable scale(s). • plotted points occupies at least half of the width and half of the height of the graph paper • The axes have suitable scales. 1 mark: The axes of the graph have suitable labels and units. 1 mark: All data points plotted accurately (within a half box tolerance) with either a line of best fit drawn or plots joined by curve. This mark can only be accessed if linear scales for both axes have been provided.
3d(i)	Electrolysis and lithium nitride	Processes are in the circular boxes. Electrolysis is the circular box answer Chemicals are in the square boxes. Lithium nitride is formed from lithium and nitrogen.

3d(ii) — One arrow drawn from:



4a — nucleus

All nuclear reactions take place in the nucleus.

4b(i) — One answer from:

The time for half of the mass to decay	The time for half of the (radio)activity to decay	The time for half of the nuclei to decay

4b(ii) — 87.5%

Time (days)	Percentage Remaining
0	100%
8	50%
16	25%
24	12.5%

12.5% remaining after 24 days

87.5% must have decayed by 24 days

4b(iii) — Stays the same

Half-life is independent of concentration, temperature and state of matter (solid, liquid, gas or solution)

5a — Bromine decolourises

Bromine adds across C=C double bonds and bromine is decolourised in the process.

5b(i) — Hydrogenation

The addition of hydrogen across C=C double bond is known as hydrogenation.
The addition of water across C=C double bond is known as hydration.

5b(ii) — Chlorine

Two chlorine atoms have joined across the location of where the C=C double bond used to be. Cl_2 is the reactant in formation of compound Y (1,2-dichloropropane)

5b(iii) — Poly(propene)

If propene is the monomer then the polymer is poly(propene)

5c(i) — 140

1mol C_6H_{10} = (6x12) + (10x1) = 72 + 10 = 82g

$$\textbf{no. of mol} = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{410g}{82g\ mol^{-1}} = 5mol$$

$$C_2H_4 + C_4H_6 \longrightarrow C_6H_{10}$$

1mol 1mol
5mol 5mol

1mol C_2H_4 = (2x12) + (4x1) = 24 + 4 = 28g

$$\textbf{mass} = \textbf{no. of mol} \times \textbf{gfm} = 5\ mol \times 28g\ mol^{-1} = 140g$$

5c(ii) — Answer to include:

1 mark:	Cyclopentene has weaker (forces of attraction)
1 mark:	Forces between molecules/intermolecular attractions mentioned

6 — Open Question:

3 mark answer	2 mark answer	1 mark answer
Demonstrates a **good understanding** of the chemistry involved. A good comprehension of the chemistry has provided in a logically correct, including a statement of the principles involved and the application of these to respond to the problem.	Demonstrates a **reasonable understanding** of the chemistry involved, making some statement(s) which are relevant to the situation, showing that the problem is understood.	Demonstrates a **limited understanding** of the chemistry involved. The candidate has made some statement(s) which are relevant to the situation, showing that at least a little of the chemistry within the problem is understood.

7a — Same/similar chemical properties and same general formula.

Members of the same homologous series have the same/similar properties e.g. all alkenes will decolourise bromine solution quickly.
The general formula must fit all members of the homologous series e.g. all alkanes fit the general formula C_nH_{2n+2} e.g. methane CH_4, ethane C_2H_6, propane C_3H_8.

7b(i) — Alkane

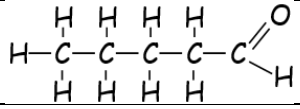
The hydrocarbon $C_{25}H_{52}$ must belong to the alkane family as it fits the general formula of alkanes of C_nH_{2n+2}.
In n=35 then 2n+2 = (2x25) +2 = 50+2 = 52 $\therefore$ $C_{25}H_{52}$

7b(ii) — $C_{35}H_{72}$

General Formula C_nH_{2n+2} where number of H atoms = 72.
Hydrogen number 2n+2 = 72 $\therefore$ 2n = 70 $\therefore$ n=35 $\therefore$ formula = $C_{35}H_{72}$

7c — 391-394 (inclusive)

No. of Carbons	20	21	22	23	24
Boiling Point (°C)	343	356	369	381	-
Difference:		12	13	13	Predicted 13
Prediction:	-	-	-	-	394

<table>
<tr><td>8a</td><td>Supernova</td><td>Problem Solving: Gathering information from a passage</td></tr>
<tr><td>8b</td><td>beryllium aluminium
silicon oxygen</td><td>Beryl is beryllium aluminium silicate.
Silicate means both silicon and oxygen are also found in the compound.</td></tr>
<tr><td>8c</td><td>$BeCl_2 + K \rightarrow Be + KCl$</td><td>Beryllium chloride + Potassium → Beryllium + Potassium chloride
$BeCl_2 + K \rightarrow Be + KCl$
$BeCl_2 + 2K \rightarrow Be + 2KCl$</td></tr>
<tr><td>8d</td><td>Reduction</td><td>Beryllium ions → Beryllium atoms
Turn information in question in to chemical formulae
$Be^{2+} \rightarrow Be$
Balance charge difference by adding electrons to the most positive side
$Be^{2+} + 2e^- \rightarrow Be$</td></tr>
<tr><td>8e</td><td>$^{1}_{0}n$</td><td><table><tr><td>Particle</td><td>Proton</td><td>Neutron</td><td>Electron</td><td>Alpha</td><td>Beta</td></tr><tr><td>Symbol</td><td>$^{1}_{1}p$</td><td>$^{1}_{0}n$</td><td>$^{0}_{-1}e$</td><td>$^{4}_{2}He$</td><td>$^{0}_{-1}e$</td></tr></table></td></tr>
<tr><td>9a</td><td>Exothermic</td><td><table><tr><td>Type of Reaction</td><td>Definition</td></tr><tr><td>Exothermic</td><td>Reaction which releases energy</td></tr><tr><td>Endothermic</td><td>Reaction which takes in energy from the surroundings</td></tr></table></td></tr>
<tr><td>9b(i)</td><td>0.05</td><td>heat energy = specific heat capacity × mass × change in Temperature
$E_h = C \times m \times \Delta T$
$8.36 = 4.18 \times m \times 40$
$m = \frac{8.36}{4.18 \times 40} = 0.05kg$</td></tr>
<tr><td>9b(ii)</td><td>Both answers:</td><td>Copper is a better conductor of heat
Lower heat loss to surroundings</td></tr>
<tr><td>9c(i)</td><td>One answer from:</td><td><table><tr><td>if the –OH group is at the end of alcohols an aldehyde is produced</td><td>if the –OH group is in the middle of alcohol an ketone is produced</td></tr></table></td></tr>
<tr><td>9c(ii)</td><td>  </td><td>If OH is on the end carbon then an aldehyde is formed. Starting chemical is pentan-1-ol with –OH hydroxyl group on the end of molecule.
Five carbon aldehyde is formed with C=O group on the end carbon.</td></tr>
<tr><td>10a</td><td>Ion bridge
or salt bride</td><td>The ion bridge is a piece of filter paper soaked in electrolyte. Electrolyte is a salt solution which provides the ions to complete the circuit and allow current to flow through the wires.</td></tr>
<tr><td>10b(i)</td><td>Arrow
through wires
from right to left</td><td>Electrons flow through wires and ions flow through the solution.
Electrons are generated in the reaction in beaker B:
$2I^-_{(aq)} \rightarrow I_{2(l)} + 2e^-$
Electrons flow through voltmeter to Beaker A and join up by the Fe^{3+} ions
$Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)}$</td></tr>
<tr><td>10b(ii)</td><td>oxidation</td><td>$2I^-_{(aq)} \rightarrow I_{2(l)} + 2e^-$</td></tr>
</table>

10b(iii)

$2Fe^{3+} + 2I^- \downarrow 2Fe^{2+} + I_2$

$2I^- \rightarrow I_2 + 2e^-$

$Fe^{3+} + e^- \rightarrow Fe^{2+}$

Multiple equations to get same number of electrons

$2I^- \rightarrow I_2 + 2e^-$

$2Fe^{3+} + 2e^- \rightarrow 2Fe^{2+}$

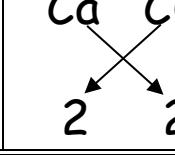
Cancel out electrons add equations together

$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$

10c Conducts electricity

Graphite has delocalised electrons that do not take part in the covalent bonding and are free to jump from atom to atom to allow electrical conduction.

11a $Ca^{2+}CO_3^{2-}$

Write down Valency below each element's symbol	Put in Cross-over Arrows	Follow arrows to get formula
$Ca\ CO_3$ $2\ \ 2$		$Ca_2(CO_3)_2$ Cancel Down $CaCO_3$

11b propanoic acid

acid + metal carbonate → salt + water + carbon dioxide

propanoic acid + calcium carbonate → calcium propanoate + water + carbon dioxide

11c One answer from:

no more solid reacts/ until it no longer reacts	solid remains/is left (at bottom of the beaker)	a gas is no longer produced no more fizzing/bubbling
calcium carbonate left (at the bottom)	no more calcium carbonate reacts	neutral/neutralised with a description of testing pH.

11d Filtration Evaporation

Filtration is needed to separate the unreacted calcium carbonate from the products. The residue of filtration is calcium propanoate solution. The solid propanoate is recovered by evaporating the water in the solution using an evaporating basin and a Bunsen burner.

12a(i) standard

A standard solution is a solution whose concentration is accurately know. It can then be used to work out the concentration of another solution with which it reacts with.

12a(ii) 21.2

no. of mol = **v**olume x **c**oncentration = $0.2_{litres} \times 1_{mol\ l^{-1}} = 0.2_{mol}$

gfm $Na_2CO_3 = (2x23)+(1x12)+(3x16) = 46 + 12 + 48 = 106g\ mol^{-1}$

mass = **n**o of mol x **gfm** = $0.2mol \times 106\ g\ mol^{-1} = 21.2g$

12b(i) One answer from:

Move burette/ sodium carbonate (reading) to eye level	Reduce distance between flask and burette	Use white tile/paper	Clamp the burette towards the centre

12b(ii) One answer from:

To show the end-point	To show point of neutralisation	To show completion of the reaction

12b(iii) concordant

Titrations using a burette allow exact volumes of solutions to be worked out. After the initial titration to allow a rough volume for the reaction to be found, the experiment is repeated exactly in a more accurate way to work out the exact volume of solution needed to completely react. This is repeated until two volumes within $\pm 0.2cm^3$ of each other are achieved. These are described as concordant.
The concordant volumes are averaged and the rough titre is ignored.

12b(iv) 1.5

no. of mol Na_2CO_3 = **v**olume x **c**oncentration = $0.015_{litres} \times 1_{mol\ l^{-1}} = 0.015_{mol}$

$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

1mol 2mol

0.015mol 0.030mol

$$\text{concentration} = \frac{\text{no of moles}}{\text{volume}} = \frac{0.030_{mol}}{0.02_{litres}} = 1.5\ mol\ l^{-1}$$

13 Open Question:

3 mark answer	2 mark answer	1 mark answer
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