Past Papers Nat 5 Chemistry

2017 Marking Scheme

Grade Awarded	Mark Required (/100)	Mark Required %	% candidates achieving grade
A	74+	74%	35.2%
B	63+	63%	21.8%
C	52+	52%	19.4%
D	46+	46%	8.6%
No award	<46	<46%	15.0%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	14.6 /20	35.5 /60	14.7 /20

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MC Qu	Answer	% Pupils Correct	Reasoning
1	D	91	Rate = $\frac{\Delta \text{quantity}}{\Delta \text{time}} = \frac{2g}{30s} = 0.0667\ g\ s^{-1}$
2	C	90	☒A if atomic number = 24 then number of protons = 24 ☒B if atomic number = 45 then number of protons = 45 ☑C atomic number = no of protons = 21 and mass no.= protons+neutrons = 21+24 = 45 ☒D if atomic number = 24 then number of protons = 24
3	A	67	Dichromate ion formula is $Cr_2O_7^{2-}$ ∴ $Cr_2O_7^{2-}$ ion must be balanced by a 2+ ion ∴ Zn^{2+}
4	D	60	☒A Magnesium melts at 650°C ∴ temperature is 730°C so magnesium is liquid ☒B Magnesium melts at 650°C ∴ temperature is 730°C so magnesium is liquid ☒C Magnesium has density 1.74 g cm^{-3} and floats in magnesium chloride (2.32g cm^{-3}) ☑D Magnesium formed is a liquid at 730°C and floats in molten magnesium chloride as magnesium metal has a lower density.
5	A	58	A base is a chemical which neutralises an acid to form water e.g. metal hydroxides (alkalis), metal oxides and metal carbonates are bases
6	B	72	Spectator ions appear chemically unchanged on both sides of a chemical equation: K^+ appears on both sides of equation $Ag^+_{(aq)} + NO_3^-{}_{(aq)} + K^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)} + K^+_{(aq)} + NO_3^-{}_{(aq)}$ NO_3^- appears on both sides of equation
7	C	86	$2H_2O_2 \rightarrow 2H_2O + O_2$
8	B	70	**gfm** = $\frac{\textbf{mass}}{\textbf{no. of mol}} = \frac{7g}{0.25mol} = 28g\ mol^{-1}$ ☒A gfm C_2H_6 = (2x12)+(6x1) = 24+6 = 30g ☑B gfm C_2H_4 = (2x12)+(4x1) = 24+4 = 28g ☒C gfm C_3H_8 = (3x12)+(8x1) = 36+8 = 44g ☒D gfm C_3H_6 = (3x12)+(6x1) = 36+6 = 42g
9	A	56	☑A **n**o of mol = **v**olume x **c**oncentration = 0.1 litres x 0.4mol l^{-1} = 0.04mol ☒B **n**o of mol = **v**olume x **c**oncentration = 0.2 litres x 0.3mol l^{-1} = 0.06mol ☒C **n**o of mol = **v**olume x **c**oncentration = 0.3 litres x 1.0mol l^{-1} = 0.3mol ☒D **n**o of mol = **v**olume x **c**oncentration = 0.4 litres x 0.5mol l^{-1} = 0.2mol
10	A	85	☑A C_7H_{16} gives a general formula of C_nH_{2n+2}. Alkanes have general formula C_nH_{2n+2}. ☒B C_7H_{14} gives a general formula of C_nH_{2n}. Alkanes have general formula C_nH_{2n+2}. ☒C C_7H_{12} gives a general formula of C_nH_{2n-2}. Alkanes have general formula C_nH_{2n+2}. ☒D C_7H_{10} gives a general formula of C_nH_{2n-4}. Alkanes have general formula C_nH_{2n+2}.
11	D	83	☒A X is an alkene ∴ has C=C double bond ∴ will decolourise bromine solution quickly ☒B Y is a cycloalkane ∴ no C=C double bond ∴ does not decolourise bromine solution ☒C Y is a cycloalkane ∴ no C=C double bond ∴ does not decolourise bromine solution ☑D X (alkene) will decolourise bromine and Y (cycloalkane) will not decolourise
12	C	50	<table><tr><td>Element in Fuel</td><td>Carbon</td><td>Hydrogen</td><td>Sulphur</td></tr><tr><td>Product of Combustion</td><td>Carbon Dioxide</td><td>Water</td><td>Sulphur Dioxide</td></tr></table>
13	C	81	Vinegar is a dilute solution of ethanoic acid CH_3COOH
14	B	92	☒A endothermic reactions absorb energy from the surroundings (drops the temp) ☑B exothermic reactions release energy to the surroundings (raises the temp) ☒C energy required to start reaction not related to the energy given off ☒D a reaction must have an energy change to be exothermic

15	D	77	☒A Structure shown is a covalent network ☒B Structure shown is an ionic lattice ☒C Structure shown is a molecular covalent ☑D Structure shown is a metallic lattice
16	C	79	☒A tin is a medium reactivity metal and is found combined in the Earth's crust ☒B magnesium is a upper reactivity metal and found combined in the Earth's crust ☑C gold is a very unreactive metal and found uncombined in the Earth's crust ☒D sodium is a very reactivity metal and found combined in the Earth's crust
17	A	70	☑A Oxygen is not an essential element for healthy plant growth ☒B Nitrogen in an essential element for plants and found in fertilisers ☒C Potassium in an essential element for plants and found in fertilisers ☒D Phosphorus in an essential element for plants and found in fertilisers
18	B	95	☒A Nitric acid is made by the Ostwald Process ☑B Ammonium is made by the Haber Process ☒C Alkenes can be made by the dehydration reaction of alcohols by removing water ☒D Esters are made by the condensation of alcohols and carboxylic acids
19	A	64	☑A Barium sulphate is an insoluble salt and can be made by a precipitation reaction ☒B Lithium nitrate is soluble and cannot be made by a precipitation reaction ☒C calcium chloride is soluble and cannot be made by a precipitation reaction ☒D ammonium phosphorus is soluble and cannot be made by a precipitation reaction
20	C	40	A standard solution is a solution whose concentration is accurately known and used in titration to work out the number of moles or concentration of a second substance.

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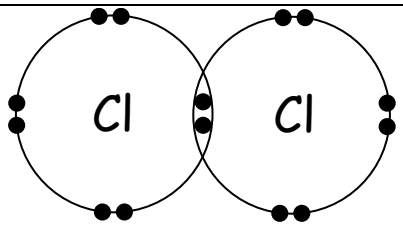
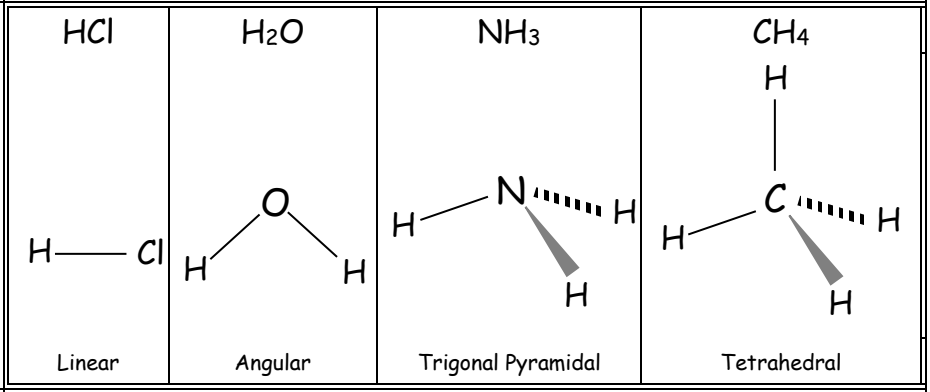
Long Qu	Answer	Reasoning
1a	Isotopes	Same atomic number / number of protons but different mass number / number of neutrons
1b	Different number of neutrons in each	<table><tr><th>Isotope</th><th>Protons</th><th>Neutrons</th><th>Electrons</th></tr><tr><td>$^{36}_{18}Ar$</td><td>18</td><td>36-18 = 18</td><td>18</td></tr><tr><td>$^{38}_{18}Ar$</td><td>18</td><td>38-18 = 20</td><td>18</td></tr><tr><td>$^{40}_{18}Ar$</td><td>18</td><td>40-18 = 22</td><td>18</td></tr></table>
1c	36	Relative atomic mass is the average mass of the different isotopes of the same element in a sample. As the average mass is 36.2 of isotopes with masses of 36, 38 and 40 the mass abundant isotope must be 36 as the average is closest to 36.
2a	Nanotube	Problem Solving: Selecting information from passage
2b	Lithium	Problem Solving: Selecting information from passage
2c	20.5	m=41g gfm H_2 = 2g mol^{-1} no of moles = $\frac{\text{mass}}{\text{gfm}} = \frac{41g}{2g\ mol^{-1}}$ = 20.5 mol
3a	Diagram showing:	
3b	tetrahedral	
3c	Gains one electron	$Cl + e^- \longrightarrow Cl^-$ 2,8,7 → 2,8,8
3d	low / no high / no	Chloromethane CH_3Cl is covalent molecular because it contains non-metals in the compound and is a gas at room temperature indicating a low melting point. Covalent substances do not conduct in any state. Sodium chloride is ionic because it is a compound of a metals and non-metal. Ionic compounds are all have high melting points and do no conduct in the solid state.
4a(i)	waste gases hot air impurities iron	Problem Solving: Completing diagram labels from passage
4a(ii)	Iron would turn into solid below 1538°C	The iron needs to be molten for it to be removed easily from the blast furnace. If the iron metal were to freeze into a solid then it would have to be scraped out of the furnace.
4b	$Fe^{2+} \rightarrow Fe^{3+} + e^-$	The reduction step $Fe^{3+} + e^- \rightarrow Fe^{2+}$ is in the data booklet. The reversal of the equation means the equation becomes oxidation
5a(i)	14 days	phosphorus-32 content = 100%, Time= 0days phosphorus-32 content = 50%, Time= 14days } half-life = 14 days

5a(ii) — 42days

Mass (g)	No of half lives
20	0
10	1
5	2
2.5	3

1 half life = 14 days
3 half lives = 42 days

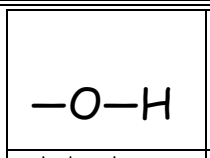
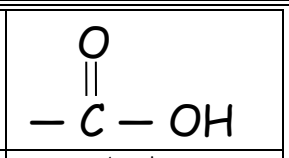
5b — Beta β

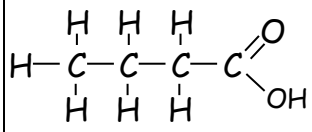
$$^{32}_{15}P \longrightarrow {}^{32}_{16}S + {}^{0}_{-1}e$$

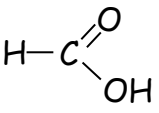
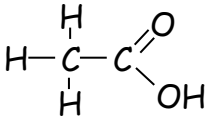
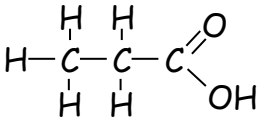
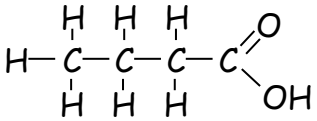
6 — Open Question

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 — Carboxyl group

	
hydroxyl group	carboxyl group

7b(i) — 

	
methanoic acid	ethanoic acid
	
propanoic acid	butanoic acid

7b(ii) — Answer to include: Propanoic acid has three carbons and butanoic acid has four carbons. As number of carbons increases, melting point increases.

8a(i) — Glowed very brightly: Magnesium is more reactive than zinc so would react faster and brighter.

8a(ii) — Faster reaction: Powders react faster than lumps as powder has lower particle size

8b — Magnesium: MgO contains Mg^{2+} ions $\therefore$ $Mg \longrightarrow Mg^{2+} + 2e^-$ (oxidation)

9a — Same chemical properties, Same general formula: Homologous series (e.g. alkanes, alkenes, cycloalkanes) have

9b — isomers: same molecular formula (formula) different structural formula (structure)

9c(i) — One answer from:

The longer the carbon chain the longer the time to get through column	Branched chain isomers take less time to travel through column compared to their straight chain isomers

9c(ii) — Line between 1st and 2nd peak: Propane would take longer to pass through the column than ethane (1st peak) as it has a longer chain length. Propane would pass through the column quicker than the 2nd set of peaks (isomers of butane) as it has a shorter chain length.

10a(i)

aluminium	copper
aluminium sulphate	copper sulphate

In an electrochemical cell, a metal is placed in a solution of that metal. Aluminium must be the metal on the left of the cell and copper the metal the right as electrons flow from the left to the right. This is because aluminium is higher up the electrochemical series than copper.

10a(ii) — $3Cu^{2+} + 2Al \downarrow 3Cu + 2Al^{3+}$

❶ $Al \rightarrow Al^{3+} + 3e^-$
❷ $Cu^{2+} + 2e^- \rightarrow Cu$
❶x2 $2Al \rightarrow 2Al^{3+} + 6e^-$
❷x3 $3Cu^{2+} + 6e^- \rightarrow 3Cu$
❶'+❷' $2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$

10b — 15.8

gfm $Al_2(SO_4)_3$ = (2x27)+(3x32)+(12x16) = 54+96+192 = 342

$$\%Al = \frac{\text{total mass of Al}}{\text{gfm } Al_2(SO_4)_3} \times 100 = \frac{(2\times27)}{342} \times 100 = \frac{54}{342} \times 100 = 15.8\%$$

11a — Answer to include:

Non-metal oxides like SO_2 dissolve in water to form acids.
As acid is formed the pH number will decrease below 7

11b — As temp increases solubility decreases

Problem Solving: Drawing conclusion from a line graph

12a — C=C double bond or –OH group

C=C double bonds are the functional groups found in alkenes
Hydroxyl -OH groups are the functional group found in alcohols

12b — Esters

Geraniol is an alcohol due to its –OH hydroxyl group.
Alcohols react with carboxylic acid to form esters e.g.

geraniol + propanoic acid ⟶ geranyl propanoate + water
alcohol + carboxylic acid ⟶ ester + water

12c — 21.0g

1mol geraniol = (10x12)+(18x1)+(1x16) = 120+18+16 = 154g

$$\text{no. of mol} = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{15.4}{154} = 0.1\text{mol}$$

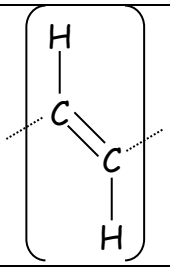
geraniol + propanoic acid ⟶ geranyl propanoate + water
$C_{10}H_{18}O$ + $C_3H_6O_2$ ⟶ $C_{13}H_{22}O_2$ + H_2O
1mol 1mol
0.1 mol 0.1mol

1mol geranyl propanoate = (13x12)+(22x1)+(2x16) = 156+22+32 = 210g

mass = **no.** of mol x **gfm** = 0.1 x 210 = 21.0g

13a — C_nH_{2n-2}

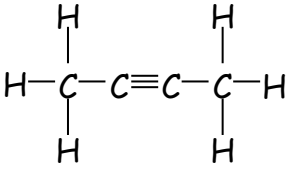
Alkyne	Propyne	But-1-yne	Pent-1-yne
Molecular Formula	C_3H_4	C_4H_6	C_5H_8
General Formula	If n=3 2n-2 = (2x3)-2 = 4 ∴ C_nH_{2n-2}	If n=4 2n+2 = (2x4)-2 = 6 ∴ C_nH_{2n-2}	If n=5 2n+2 = (2x5)-2 = 8 ∴ C_nH_{2n-2}

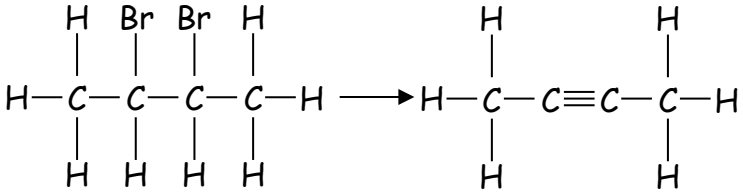
13b(i) — 

The repeating units can be joined together and when the brackets are removed the original polymer is drawn.

13b(ii) — Addition

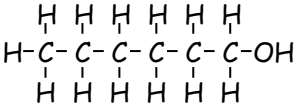
Addition polymerisation usually involves a C=C double bond opening up to leave a C-C single bond as the monomers join together to form the polymer.
The C≡C triple bond in ethyne opens up to leave a C=C double bond as the monomers join together to form the polymer poly(ethyne)

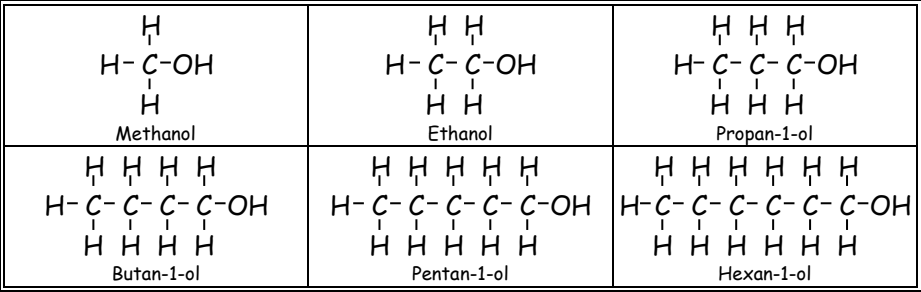
13c(i) — 



13c(ii) — Bromines must be on adjacent carbons

The bromine atoms must be on carbons next door to each other if the triple bond is to form.

14a(i) — 



14a(ii) — 188kJ

Alcohol	Propan-1-ol	Butan-1-ol	Pentan-1-ol	Hexan-1-ol	Heptan-1-ol
Energy Released (kJ)	158	170	179	185	-
Difference		18kJ	9kJ	6kJ	(3kJ)
Prediction	-	-	-	-	188kJ

14b — 3.91

$$E_h = cm\Delta T \therefore c = \frac{E_h}{m \times \Delta T} = \frac{13.3}{(0.1 \times 34)} = 3.91 \text{ kJ kg}^{-1} {}^{o}C^{-1}$$

15 — Open Question

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