Past Papers Nat 5 Chemistry

2023 Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	(/100)	%	
A	+	%	%
B	+	%	%
C	+	%	%
D	+	%	%
No award	<	<%	%

Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	/25	/75	No Assignment in 2023

2023 National 5 Chemistry Marking Scheme

MC Qu	Answer	Reasoning
1	D	Rate = $\frac{\Delta \text{Quantity}}{\Delta \text{Time}} = \frac{\mathbf{300\ cm^3}}{60\ s} = 5\ cm^3\ s^{-1}$
2	A	**Particle** / **Location** / **Charge** / **Mass** proton / inside nucleus / +1 / 1 amu neutron / inside nucleus / 0 / 1 amu electron / outside nucleus / -1 / approx 0
3	C	A: CCl_4 — tetrahedral B: NCl_3 — trigonal pyramidal C: SCl_2 — angular D: FCl — linear
4	B	Lithium Chloride is ionic as compound has metal bonded to non-metal. ☒A Diagram shows metallic bonding (positive ions surrounded by delocalised electrons) ☑B Diagram shows ionic bonding (positive ions and negative ions) ☒C Diagram shows covalent molecular (separate molecules with covalent bonds inside molecule) ☒D Diagram shows covalent network (long network of covalent bonds)
5	B	A: Fe O → 2 2 → FeO — valency of Fe = **2** B: Fe P → 3 3 → FeP — valency of Fe = **3** C: Fe NO_3^- → 2 1 → $Fe(NO_3)_2$ — valency of Fe = **2** D: Fe PO_4^{3-} → 2 3 → $Fe_3(PO_4)_2$ — valency of Fe = **2**
6	D	☒A **n**o. of mol = **v**olume x **c**oncentration = $0.1_{litres} \times 1.00_{mol\ l^{-1}} = 0.1$mol ☒B **n**o. of mol = **v**olume x **c**oncentration = $0.15_{litres} \times 0.75_{mol\ l^{-1}} = 0.1125$mol ☒C **n**o. of mol = **v**olume x **c**oncentration = $0.2_{litres} \times 0.60_{mol\ l^{-1}} = 0.12$mol ☑D **n**o. of mol = **v**olume x **c**oncentration = $0.25_{litres} \times 0.25_{mol\ l^{-1}} = 0.0625$mol
7	B	☒A aluminium oxide is insoluble ∴ no change to pH of water ☑B barium oxide is a soluble metal oxide ∴ dissolves in water to form alkaline pH>7 ☒C nitrogen oxide is a non-metal oxide ∴ dissolves in water to form pH<7 ☒D hydrogen oxide H_2O is water with a pH=7 ∴ does not change pH of water when added
8	C	nickel carbonate + sulfuric acid → **nickel sulfate** + water + carbon dioxide nickel hydroxide + sulfuric acid → **nickel sulfate** + water nickel + sulfuric acid → **nickel sulfate** + hydrogen ☒A nickel hydroxide does not produce a gas when reacted with sulfuric acid ☒B nickel does not produce a gas when reacted with sulfuric acid ☑C nickel sulfate is produced in all three reactions ☒D no water produced in reaction of nickel and sulfuric acid ∴ not a neutralisation reaction

9 B

$(Na^+)_2CO_3^{2-}{}_{(aq)} + 2H^+Cl^-{}_{(aq)} \rightarrow 2Na^+Cl^-{}_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

Split solutions into ions

$2Na^+{}_{(aq)} + CO_3^-{}_{(aq)} + 2H^+{}_{(aq)} + 2Cl^-{}_{(aq)} \rightarrow 2Na^+{}_{(aq)} + 2Cl^-{}_{(aq)} + H_2O_{(l)} + CO_{2(g)}$

Identify Spectator Ions and cancel out Spectator Ions

~~$2Na^+{}_{(aq)}$~~ + $CO_3^-{}_{(aq)}$ + $2H^+{}_{(aq)}$ + ~~$2Cl^-{}_{(aq)}$~~ → ~~$2Na^+{}_{(aq)}$~~ + ~~$2Cl^-{}_{(aq)}$~~ + $H_2O_{(l)} + CO_{2(g)}$

Re-write equation without spectator ions

$CO_3^-{}_{(aq)} + 2H^+{}_{(aq)} \rightarrow + H_2O_{(l)} + CO_{2(g)}$

10 A

Carbon number: ❺ ❹ ❸ ❷ ❶

$CH_3CH(CH_3)CH_2C(CH_3)_2CH_3$

↑ 1x methyl group on C_4 ↑ 2x methyl group on C_2

Name of compound: 2,2,4-trimethylpentane

NB: Overall formula is of alk**ane** as formula C_8H_{18} fits general formula C_nH_{2n+2}

11 C

☒A This structure is also 2-methylbut-2-ene but drawn differently

☒B This structure has formula C_5H_{12} but 2-methylbut-2-ene has formula C_5H_{10}

☑C Both have formula C_5H_{10} and have different structures ∴ isomers

☒D This structure has formula C_6H_{12} but 2-methylbut-2-ene has formula C_5H_{10}

12 B

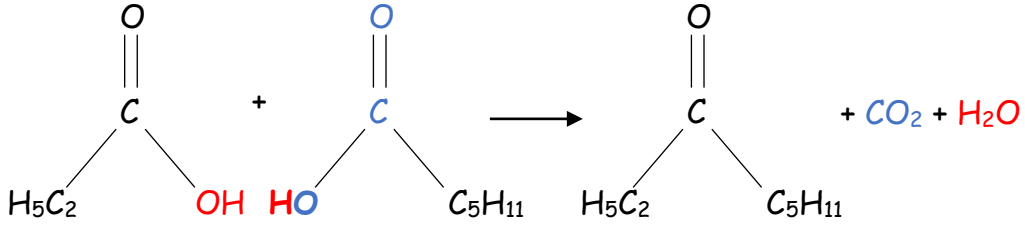
☒A Addition of H_2 across the C=C double bond in but-2-ene produces butane C_4H_{10}

☑B Butan-1-ol cannot be produced as -OH group must be added to C_2 to form butan-2-ol

☒C Addition of H_2O across the C=C double bond in but-2-ene produces butan-2-ol

☒D Addition of Br_2 across the C=C double bond in but-2-ene produces 2,3-dibromobutane

13 A



14 D

☒A methanol CH_3OH has a lower formula mass compared to octan-1-ol $C_8H_{17}OH$

☒B CH_3OH has a higher solubility than $C_8H_{17}OH$ as methanol has a shorter carbon chain

☒C methanol CH_3OH has a lower formula mass compared to octan-1-ol $C_8H_{17}OH$

☑D methanol CH_3OH has a **lower** formula mass and **higher** solubility than octan-1-ol $C_8H_{17}OH$

15 D

Chemistry	**butane**	**cyclobutane**
General Formula	C_4H_{10} fits C_nH_{2n+2}	C_4H_8 fits C_nH_{2n}
Melting Point	-138°C	-90°C
Solubility in water	insoluble in water	insoluble in water
Saturation	Saturated (no C=C double bonds)	Saturated (no C=C double bonds)

16 C

Acid + Metal Oxide → Salt + Water

methanoic acid + **sodium oxide** → sodium methanoate + water

17 A

☑A conducts as solid and liquid ∴ metallic bonding

☒B does not conduct as solid or liquid and has low m.pt. and b.pt. ∴ covalent molecular

☒C conducts as liquid but not solid ∴ ionic bonding

☒D does not conduct as solid or liquid and has high m.pt. ∴ covalent network

18 B

☒A Y is least reactive as it is only metal not to react with acid. (Least reactive comes first in list)

☒B Y is least reactive and Z is most reactive ∴ Y then X then Z

☒C Z is most reactive as it is only metal to react with water. (Most reactive comes last in list)

☒D Z is most reactive as it is only metal to react with water. (Most reactive comes last in list)

19 — D

☒A Nickel(A) is lower than zinc(B) in Electrochemical series so electrons flow from B to A
☒B Zinc(A) is lower than aluminium(B) in Electrochemical series so electrons flow from B to A
☒C Aluminium(A) is lower than magnesium(B) in Electrochemical series so electrons flow from B to A
☑D Aluminium(A) is higher than nickel(B) in Electrochemical series so electrons flow from A to B

20 — A

As Magnesium is higher up the electrochemical series. Magnesium will oxidise into Mg^{2+} ions and Ag^{+} ions will reduce back to silver atoms in a redox reaction.

Oxidation $Mg_{(s)} \longrightarrow Mg^{2+}_{(aq)} + 2e^-$

Reduction $Ag^{+}_{(aq)} + e^- \longrightarrow Ag_{(s)}$

Oxidation $Mg_{(s)} \longrightarrow Mg^{2+}_{(aq)} + 2e^-$

Reduction x2 $2Ag^{+}_{(aq)} + 2e^- \longrightarrow 2Ag_{(s)}$

Redox $Mg_{(s)} + 2Ag^{+}_{(aq)} \longrightarrow Mg^{2+}_{(aq)} + 2Ag_{(s)}$

21 — C

Process	Reactants	Products	Catalyst
Haber	**Nitrogen** + Hydrogen	**Ammonia**	Iron
Ostwald	Ammonia + oxygen	Nitric acid (ultimately)	Platinum

22 — C

$^{227}_{90}Th \xrightarrow{\alpha} {}^{223}_{88}Ra \xrightarrow{\alpha} {}^{219}_{86}Rn \xrightarrow{\alpha} {}^{215}_{84}Po \xrightarrow{\alpha} {}^{211}_{82}Pb$

23 — C

☒A Barium sulfate is insoluble and can be collected in a precipitation reaction by filtration
☒B Lead(II) sulfate is insoluble and can be collected in a precipitation reaction by filtration
☑C Calcium chloride is soluble so will not form a precipitate
☒D Silver Chloride is insoluble and can be collected in a precipitation reaction by filtration

24 — A

☑A Glucose gives blue to orange with Benedict's and sodium chloride gives yellow flame test
☒B Starch is not present as there was no change in the iodine test
☒C Flame test gave yellow flame but strontium chloride would give a red flame test result
☒D Starch is not present as there was no change in the iodine test

25 — B

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

2mol 1mol
0.004mol 0.002mol

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Long Qu	Answer	Reasoning
1a	7	Diatomic Element: Hydrogen, Nitrogen, Oxygen, Fluorine, Chlorine, Bromine, Iodine Formula: H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2
1b	35	Chlorine 35 is the common isotope in sample as the average is closer to 35 than 37
1c	One from: Fluorine / Bromine Iodine / Astatine	Elements in the same chemical group have similar chemical properties due to having the same number of outer electrons.
1d	10 | | 20	$^{24}_{12}Mg^{2+}$ No. of protons = atomic number = 12 No of neutrons = mass number – atomic number = 24 – 12 = 12 No of electrons = atomic number – charge = 12 – (2) = **10** $^{37}_{17}Cl^-$ No. of protons = atomic number = 17 No of neutrons = mass number – atomic number = 37 – 17 = **20** No of electrons = atomic number – charge = 17 – (-1) = **18**
2a	Hydrocarbon	A hydrocarbons is a compounds containing carbon and hydrogen only.
2b(i)	Hydrogen	$C_2H_6 \longrightarrow C_2H_4 + H_2$
2b(ii)	decolourises bromine solution	Unsaturated compounds will decolourise bromine solution quickly. Bromine adds across the double bond in ethene to form 1,2-dibromoethane
2c(i)	H–C≡C–H	Carbon has valency of 4 and makes four bonds per carbon atom Hydrogen has valency of 1 and make only one bond per hydrogen atom
2c(ii)A	carbon dioxide and water	Ethyne is a hydrocarbon containing only carbon and hydrogen atoms. • Complete combustion of carbon produced carbon dioxide. • Complete combustion of hydrogen produced water.
2c(ii)B	Gives out heat	Exothermic reactions are reactions where heat is given out to the surroundings. Endothermic reactions are reactions where heat is taken in from the surroundings
3a	Group 2	Only Groups 2 contains metals only. Group 1 starts with the non-metal hydrogen. The remaining groups 3-0 all start with a non-metal at the top of the group
3b(i)	$KMnO_4$	Write down Symbols and valency below: K MnO_4^- / 1 1 Cross-Over arrows to work out formula: K MnO_4^- / 1 1 Work out chemical formula (Cancel down if necessary): $KMnO_4$
3b(ii)	Aluminium or zinc	Observation: Blinding white light / Bright light / Red glow with few sparks / Dull red glow Metal: Magnesium / X / Iron / Copper Reactivity: High → Low Conclusion: X must have reactivity between Magnesium and Iron ∴ 2 possible metals: aluminium or zinc
3c	Hydrogen Burns with a pop	Gas: Hydrogen / Oxygen / Carbon Dioxide Test: Burns with a pop / Relights a glowing splint / Turns limewater cloudy
3d(i)	Voltage between 0.5 and 2.7	As Iron is between magnesium and tin on the electrochemical series, the voltage of an iron/copper cell will be between the voltage of a magnesium/copper cell and a tin/copper cell
3d(ii)	Electrically conducting solutions containing ions	An electrolyte is an ion containing solution which completes the circuit in a cell and allows electricity to flow.

3d(iii) one answer from:

temperature	concentration	Type of electrode	Distance between electrodes	Surface area of electrodes

4a From air

Problem Solving: Extracting information from a passage

4b Lowers temperature or don't get used up

A catalyst speeds up a chemical reaction but does not get used up in the reaction. This often means that a chemical reaction can proceed at a lower temperature.

4c 534.1

1 litre jet fuel made from 4700g CO_2

5 litres jet fuel made from 5x4700g CO_2 = 23500g CO

gfm CO_2 = (1x12)+(2x16) = 12+32 = 44g

$$\text{no. of mol} = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{23500}{44} = 534.1\text{mol}$$

5 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.

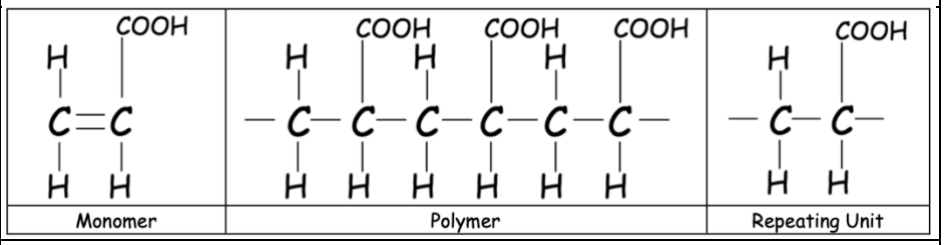
6a(i) carboxyl group

	
hydroxyl group	carboxyl group

6a(ii) Addition Polymerisation

C=C double bonds in monomer open up and join together to form polymer

6a(iii) Polymer diagram:



Monomer	Polymer	Repeating Unit

6b(i) CsCl and Material A

Problem Solving: Prediction of value and completion of bar graph

6b(ii) Bar bigger than 18 and lower than 32

As strontium is the metal between calcium and barium in group 2, the prediction for $SrCl_2$ would be between $CaCl_2$ (18) and $BaCl_2$ (32).

6c(i) measuring cylinder or pipette

Beakers are less accurate than measuring cylinders at measuring volumes of liquid. Pipettes are the most accurate device for measuring exact volumes.

6c(ii) Line Graph Showing:

1 mark	1 mark	1 mark	1 mark
One mark is awarded for a graph which shows points plotted rather than bars.	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	The axes of the graph have suitable labels and units.	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.

7a Trisilane

Prefix	Mono-	Di-	Tri-	Tetra-	Penta-	Hexa-	Hepta-	Octa-
Meaning	1	2	3	4	5	6	7	8

7b Si_5H_{12}

General Formula of silanes is Si_nH_{2n+2} in line with alkanes C_nH_{2n+2}

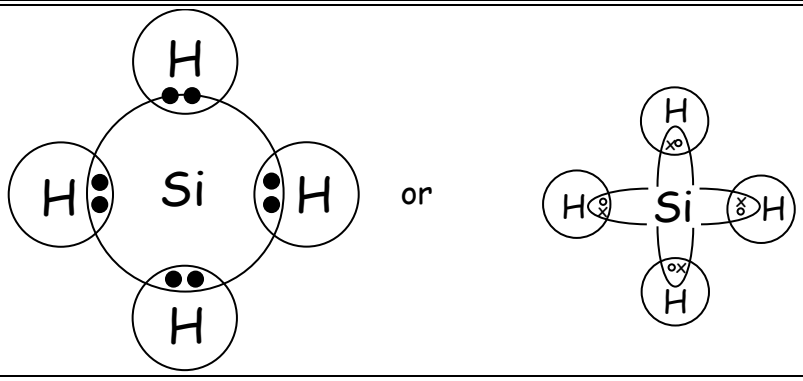
For pentasilane, n=5 $\therefore$ 2n+2 = (2x5)+2 = 12

$\therefore$ Pentasilane formula = Si_5H_{12}

7c — 185

Compound	Monosilane	Disilane	Trisilane	Tetrasilane	Pentasilane	Hexasilane
Formula	SiH_4	Si_2H_6	Si_3H_8	Si_4H_{10}	Si_5H_{12}	Si_6H_{14}
Boiling Point (°C)	-112	-15	53	108	153	-
Difference		97	68	55	45	(35)
Prediction (°C)	-	-	-	-	-	185

7d — One diagram from:



7e — Stronger intermolecular forces due to longer silicon chain

1st Mark: pentasilane has stonger/larger forces of attraction.
2nd Mark: forces of attractions are intermolecular/between molecules
The longer the silicon chain, the greater the number of atoms within the molecule. Bigger molecules have stronger intermolecular bonds between molecules which raises the boiling point of pentasilane over tetrasilane

7f — 3.1

gfm SiO_2 = (1x28)+(2x16) = 28+32 = 60g

$$\text{no. of mol} = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{6}{60} = 0.1\text{mol}$$

$$7Mg + 2SiO_2 + 14HCl \longrightarrow Si_2H_6 + 7MgCl_2 + 4H_2O$$

2mol : 1mol
0.1mol : 0.05mol

gfm Si_2H_6 = (2x28)+(6x1) = 56+6 = 62g

mass = **no.** of mol x **gfm** = 0.05mol x 62 = 3.1g

8a — Fluorapatite

Problem Solving: extracting information from a passage

8b — $C_6H_{12}O$

As there are no metals in the formula, any order of the non-metal elements is acceptable although most tend to list C then H then O.

8c(i) — Nitrogen

ADP has the formula $NH_4H_2PO_4$ contains nitrogen and phosphorus. Both are essential elements for plant growth. The 3rd essential element for plant growth is potassium.

8c(ii) — Soluble

Fertilisers must contain at least one of the three essential elements nitrogen, phosphorus or potassium and be soluble in water.

8d — 31.6

gfm H_3PO_4 = (3x1)+(1x31)+(4x16) = 3+31+64 = 98g

$$\%\ P = \frac{\text{mass of P}}{\textbf{gfm}} \times 100 = \frac{31}{98} \times 100 = 31.6\%$$

8e — Filtration

Solid calcium sulfate can be separated from a liquid by filtration.

8f — ½mol or 0.5mol

$CaSO_4.2H_2O$: $CaSO_4.\frac{1}{2}H_2O$
1mol : 2mol
1mol : ½mol

9a(i) — 0.627

heat energy = specific heat capacity x mass x change in Temperature

$E_h = C \times m \times \Delta T$

$E_h = 4.18 \times 0.01 \times 15$

$E_h = 0.627$ kJ

9a(ii) — One from:

No draft shield	Energy lost to surroundings	Temperature not consistent in water
Glass absorbs heat	Incomplete combustion	

9b — 150

1g biscuit releases 20.9 kJ
30g biscuit releases 20.9 kJ x $^{30}/_{1}$
= 627 kJ

4.18kJ equals 1 kilocalorie
627 kJ equals 1 kilocalorie x $^{627}/_{4.18}$
= 150 kilocalorie

10a(i) — electrolysis

As caesium is more reactive than potassium then electrolysis would be the method to extract caesium from its ore.

Method	Electrolysis	Heat With Carbon	Heat Alone
Metals Made This Way	Potassium, Sodium, Lithium, Calcium, Magnesium, Aluminium	Zinc, Iron, Nickel, Tin, Lead, Copper	Mercury, Silver, Gold, Platinum
Reason	most reactive metals	medium reactive metals	least reactive metals

10a(ii) — Reduction

Metal ores contain metal ions which are reduced to produce metal atoms

$$Cs^+ + e^- \rightarrow Cs$$

10b(i) — $^{0}_{-1}e$

Particle	Proton	Neutron	Electron	Alpha	Beta
Symbol	$^{1}_{1}p$	$^{1}_{0}n$	$^{0}_{-1}e$	$^{4}_{2}He$	$^{0}_{-1}e$

10b(ii) — Alpha particles cannot pass through paper

Radiation	Alpha	Beta	Gamma
Mass	4	0	No mass
Charge	2	-1	No charge
Stopped by	Paper	Aluminium	Thick lead
Deflection	Towards negative	Towards positive	No defection
Use	Smoke detectors	Measuring thickness of paper in paper mill	Radiotherapy cancer treatment

10b(iii)A — One answer from:

Time taken for half the atoms in a sample to radioactively decay

Time for the radioactivity in. a sample to half

10b(iii)B — $\frac{15}{16}$

Time	No. of half-lives	Fraction Remaining	
0 years	0	1	(100%)
30 years	1	$^{1}/_{2}$	(50%)
60 years	2	$^{1}/_{4}$	(25%)
90 years	3	$^{1}/_{8}$	(12.5%)
120 years	4	$^{1}/_{16}$	(6.25%)

% Remaining = $^{1}/_{16}$
% Decayed = 1 – $^{1}/_{16}$
= $^{15}/_{16}$
% Remaining = 6.25%
% Decayed = 100% - 6.25%
= 93.75%

11a — covalent / molecular

Tungsten is a metal. Metals and non-metal compounds usually form ionic compounds. All ionic compounds are solid at room temperature.
Tungsten(VI) fluoride is a gas at room temperature and this means that tungsten(VI) fluoride must be covalent molecular.

11b(i) — $WF_6 + 3H_2O \rightarrow WO_3 + 6HF$

$$WF_6 + 3H_2O \rightarrow WO_3 + 6HF$$

11b(ii) — concentration of hydrogen ions greater than concentration of hydroxide ions

Type	Relationship between Concentration of Hydrogen ions and Hydroxide Ions		
acid	Concentration of hydrogen ions	**greater than**	Concentration of hydroxide ions
neutral	Concentration of hydrogen ions	**equal to**	Concentration of hydroxide ions
alkali	Concentration of hydrogen ions	**less than**	Concentration of hydroxide ions

11c — $W^{6+} + 2e^- \rightarrow W^{4+}$

When balancing an ion-electron equation, adding electrons will balance the charge by adding to the most positive side of the equation.

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