Past Papers Nat 5 Chemistry

2014 Marking Scheme

Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	69+	29.5%
B	58+	23.7%
C	48+	19.7%
D	43+	7.9%
No award	<43	19.3%

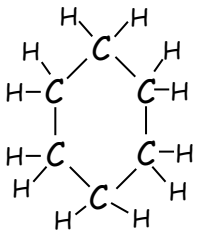
Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	13.9 /20	32.1 /60	12.3 /20

2014 National 5 Chemistry Marking Scheme

MC Qu	Answer	% Pupils Correct	Reasoning
1	A	91	$\text{rate} = \frac{\Delta\text{quantity}}{\Delta\text{time}} = \frac{60-0}{20-0} = 3\ \text{cm}^3\ \text{s}^{-1}$
2	D	83	☒A Molecule contains 2xH, 1xBr and 1xCl ∴ molecule is not chiral ☒B Molecule contains 3xH and 1xBr ∴ molecule is not chiral ☒C Molecule contains 2xH, 1xI and 1xCl ∴ molecule is not chiral ☑D Molecule contains 1xH, 1xBr, 1xI and 1xCl ∴ molecule is chiral
3	A	51	Phosphate PO_4^{3-} is listed in data booklet page 8 ∴ Total negative charge in $Zn_3(PO_4)_2$ formula is 6- as there are two phosphate ions All ionic compounds are neutral over all so the total positive charge must be 6+ ∴ Total positive charge in the 3 zinc ions = 6+ ∴ Positive charge on each zinc ion = $^{6+}/_{3}$ = 2+
4	C	89	$Fe_2O_3 + CO \rightarrow Fe + CO_2$ Fe: 2xFe before arrow but 1xFe after arrow ∴ *double Fe after arrow* $Fe_2O_3 + CO \rightarrow \mathbf{2}Fe + CO_2$ O: 4xO before arrow but 2xO after arrow ∴ *double CO_2 after arrow* $Fe_2O_3 + CO \rightarrow 2Fe + \mathbf{2}CO_2$ C: 1xC before arrow but 2xC after arrow ∴ *double CO before arrow* $Fe_2O_3 + \mathbf{2}CO \rightarrow 2Fe + 2CO_2$ O: 5xO before arrow but 4xO after arrow ∴ *increase CO to 3 before arrow* $Fe_2O_3 + \mathbf{3}CO \rightarrow 2Fe + 2CO_2$ C: 3xC before arrow but 2xFe after arrow ∴ *increase CO_2 to 3 after arrow* $Fe_2O_3 + 3CO \rightarrow 2Fe + \mathbf{3}CO_2$
5	C	75	☒A All aqueous solutions contain both hydrogen and hydroxide solutions ☒B All aqueous solutions contain both hydrogen and hydroxide solutions ☑C Acids contain more hydrogen ions than hydroxide ions ☒D Alkalis contain more hydroxide ions than hydrogen ions
6	A	59	☑A calcium oxide is a soluble metal oxide which dissolves to form an alkali ☒B nickel oxide is a non-soluble metal oxide so has no effect on pH ☒C nitrogen dioxide is a soluble non-metal oxide and dissolves to form an acid ☒D sulphur dioxide is a soluble non-metal oxide and dissolves to form an acid
7	D	82	☒A formed by the neutralisation of calcium hydroxide and nitric acid ☒B formed by the neutralisation of sodium hydroxide and hydrochloric acid ☒C formed by the neutralisation of potassium hydroxide and sulphuric acid ☑D magnesium hydroxide cannot be made by the neutralisation of an acid
8	A	88	Spectator ions appear chemically unchanged on both sides of a chemical equation: K^+ appears on both sides of equation $H^+_{(aq)} + NO_3^-{}_{(aq)} + K^+_{(aq)} + OH^-_{(aq)} \rightarrow K^+_{(aq)} + NO_3^-{}_{(aq)} + H_2O_{(l)}$ NO_3^- appears on both sides of equation

9 C 87

Cyclohexane is a 6 carbon cycloalkane with a ring of carbons inside it



10 B 83

☒A longest chain in structure is 4 carbons ∴ name must end in butane
☑B 2-methylbutane has 4 carbons in main chain and methyl CH_3- group on C_2
☒C methyl CH_3– group is on C_2 from right hand side ∴ 2-methyl at start of name
☒D 2-methylpentane would contain 6 carbons in total

11 C 77

☒A this would be a comparison of side group position on octane number
☒B there is no comparison to be made with this selection
☑C butane, pentane and hexane would be a valid comparison of chain length
☒D there is no comparison to be made with this selection

12 B 40

☒A reaction would form 1-bromobutane and 2-bromobutane
☑B reaction would form 2-bromobutane *only*
☒C reaction would form 1-bromopentane and 2-bromopentane
☒D reaction would form 2-bromobutane and 3-bromobutane

13 C 88

Alcohol	Propan-1-ol	Propan-2-ol	Butan-1-ol	Butan-2-ol
Boiling Point	97°C	82°C	118°C	100°C

14 C 47

☒A energy being required to start a reaction does indicate either exo/endothermic
☒B heat being given off indicates an exothermic reaction
☑C A temperature drop during a reaction indicates an endothermic reaction
☒D A temperature rise during a reaction indicates an exothermic reaction

15 A 75

Metal	**Potassium**	**Sodium**	**Lithium**	**Calcium**	**Magnesium**	**Aluminium**	**Zinc**	**Iron**	**Tin**	**Lead**	**Copper**	**Mercury**	**Silver**	**Gold**	**Platinum**
Reaction With Oxygen	**Burn In Oxygen to Form Metal Oxide**								**Slowly React With Oxygen**			**No Reaction With Oxygen**			
Reaction With Water	**Fast Reaction With Water**				**Slow Reaction With Water Faster Reaction With Steam**							**No Reaction with Water or Steam**			
Reaction With Acids	**Violent Reaction With dilute acids**				**React With dilute acids**				**Slow Reaction**			**No Reaction With dilute acids**			

16 D 73

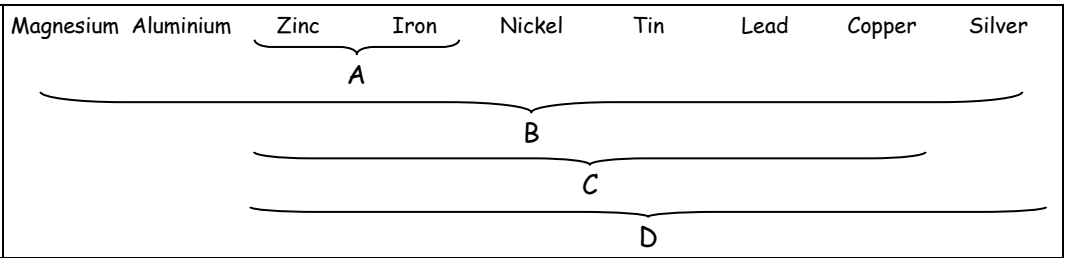
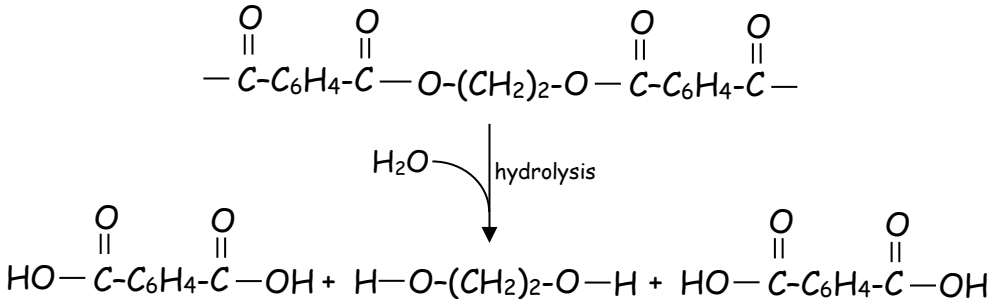
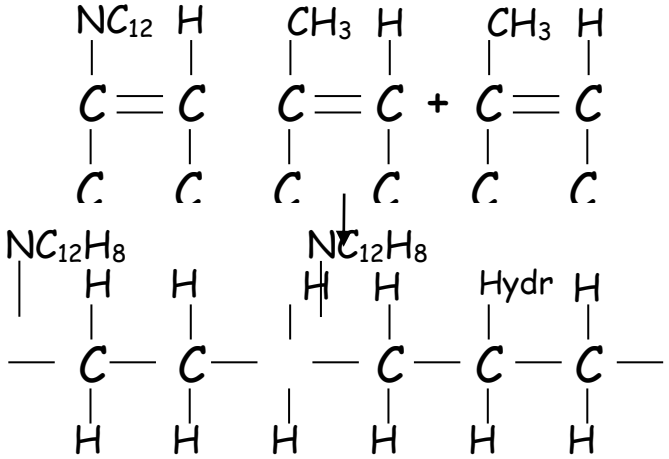
Method	Electrolysis		Heat With Carbon		Heat Alone	
Metals Made This Way	Potassium	Sodium	Zinc	Iron	Mercury	Silver
	Lithium	Calcium	Nickel	Tin	Gold	Platinum
	Magnesium	Aluminium	Lead	Copper		
Reason	most reactive metals		medium reactive metals		least reactive metals	

17 B 55

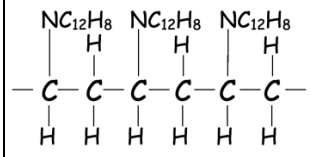
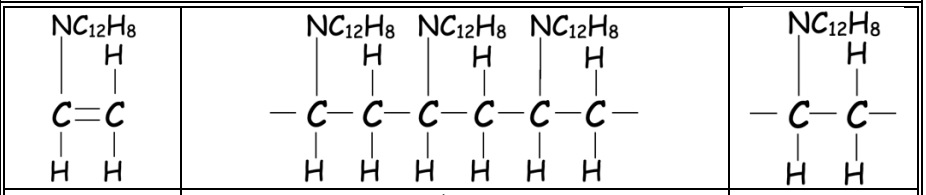
❶ $H_2O_{(l)} + SO_3^{2-}{}_{(aq)} \rightarrow SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} + 2e^-$
❷ $Fe^{3+}{}_{(aq)} + e^- \rightarrow Fe^{2+}{}_{(aq)}$

❶ $H_2O_{(l)} + SO_3^{2-}{}_{(aq)} \rightarrow SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} + 2e^-$
❷x2 $2Fe^{3+}{}_{(aq)} + 2e^- \rightarrow 2Fe^{2+}{}_{(aq)}$

Add ❶+❷′ (cancelling e^-) $H_2O_{(l)} + SO_3^{2-}{}_{(aq)} + 2Fe^{3+}{}_{(aq)} \rightarrow SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)} + 2Fe^{2+}{}_{(aq)}$

18	B	75	
19	B	43	
20	D	33	☒A addition: molecule added across a C=C double bond ☒B displacement: higher up metals displace lower down ions from compounds ☒C neutralisation: Hydrogen H^+ ions react to become water H_2O ☑D precipitation: insoluble substance formed when two solutions are mixed
			propene poly(propene) 

2014 National 5 Chemistry Marking Scheme

Long Qu	Answer	Reasoning
1a	Repulsion/deflection by (positive) nucleus	Positive (alpha) particles mainly travel straight through the layer of gold. Some of the positive (alpha) particles travel close to the nuclei of the gold atoms. The nuclei of the gold atoms are also positive and deflect the passing positive (alpha) particles by repulsion of positives charges.
1b(i)	79 79 118	Number of protons = atomic number = 79 Number of electrons = atomic number – charge = 79 – 0 = 79 Number of neutrons = mass no – atomic no. = 197 - 79 = 118
1b(ii)	Answer from:	Same atomic number / number of protons but different mass number / number of neutrons
2a	Covalent Network Ionic Lattice Metallic Lattice Discrete Covalent Molecular	Bonding Type / Features of Bonding Type Covalent Network: Substances with covalent bonding do not conduct electricity in any state. Covalent networks have very high melting points as covalent bonds in network must be broken before melting can take place Ionic Lattice: Ionic compounds are all solids at room temperature with high mpt. Ionic compounds do not conduct as solids as ions are not free to move but conduct electricity when molten or in solution as the ions become free to move. Metallic Lattice: All metallic substances conduct as solids or liquids. Metals have a range of melting point ranging from low to high e.g. mercury mpt = -39°C and iron mpt=1538°C Discrete Covalent Molecular: Substances with covalent bonding do not conduct electricity in any state. As there are weak bonds between molecules, melting and boiling points are low as there are no strong bonds to be broken between molecules.
2b	Electrons are delocalised	Graphene is made of carbon. Carbon has 4 outer electrons but in graphene only 3 of these electrons are used up in covalent bonds. The 4th electron is delocalised and able to jump from carbon atom to carbon atom allowing the conduction of electricity across grapheme.
3a	Humans cannot store potassium	Problem Solving: Retrieval of information from written passage
3b	0.022 mol	From passage: 0.86g of potassium in 100g of raisins no. of mol = $\frac{\text{mass}}{\text{gfm}} = \frac{0.86}{39} = 0.022$ mol
3c	Lilac	Element / Ion / Flame Colour: Barium / Ba^{2+} / green; Calcium / Ca^{2+} / orange-red; Copper / Cu^{2+} / blue-green; Lithium / Li^{+} / red; Potassium / K^{+} / lilac; Sodium / Na^{+} / yellow; Strontium / Sr^{2+} / red
3d	KNO_3	Write down Valency below each ion's symbol: K NO_3^- ; 1 1 Put in Cross-over Arrows: K NO_3^- ; 1 1 Follow arrows and cancel down to get formula: KNO_3
4a		 Monomer / Polymer / Repeating Unit
4b	Addition	Polymerisation / Description Addition: C=C double bonds in monomers join together to form a long chain of C-C single bonds. Condensation: Water molecules are removed as monomers join together to make larger polymer.

5a — Alpha

Radiation	Stopped by	Charge	Atomic Number	Mass Number
Alpha	Paper	Positive	2	4
Beta	Aluminium	Negative	-1	0
Gamma	lead	No charge	Gamma radiation is a wave not a particle	

5b — $\frac{1}{4}$

Time (days)	Fraction	
0	1	100%
8	$\frac{1}{2}$	50%
16	$\frac{1}{4}$	25%

5c — Sodium

Mass number of X = 28 – 4 = 24

Atomic number of X = 13 – 2 = 11 ∴ Element 11 = sodium

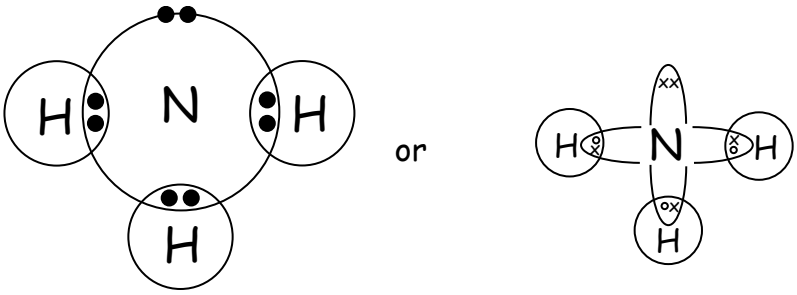
6 — Open Question Answer to include:

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.

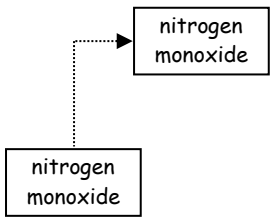
7a(i) — Haber Process

Nitrogen + Hydrogen $\xrightarrow{\text{iron catalyst}}$ Ammonia

7a(ii) — Diagram showing:



7b(i)



Arrow pointing from nitrogen monoxide produced by the absorber at the bottom of diagram leading to the nitrogen monoxide produced by the reactor.

7b(ii) — Water or H_2O

Nitric acid is made by dissolving nitrogen dioxide in water to form nitric acid. Some nitrogen monoxide is also formed during the reaction which is recycled back into the process.

7c(i) — Neutralisation

Neutralisation: Acid + Metal Hydroxide ⟶ Salt + Water

7c(ii) — Answer to include:

Place potassium nitrate solution in an evaporation basin and boil dry using a Bunsen burner

8a — One answer from:

Perfumes, flavourings or solvents

8b(i) — hydroxyl

The –OH group of the hydroxyl group.

8b(ii) — Any structure from:

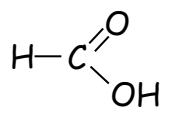
Correct $C_5H_{11}OH$ diagram of:

pentan-1-ol	pentan-2-ol	pentan-3-ol
2-methylbutan-1-ol	2,2-dimethylpropan-1-ol	
2-methylbutan-2-ol	3-methylbutan-2-ol	

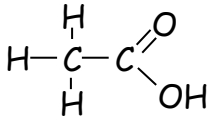
NB: diagram must be different from 3-methylbutan-1-ol in question and not a redrawing of same 3-methylbutan-1-ol structure.

8b(iii)

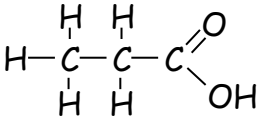
$C_nH_{2n+1}COOH$ or $C_nH_{2n+1}CO_2H$



methanoic acid
$HCOOH$
where n=0: $C_nH_{2n+1}COOH$



ethanoic acid
CH_3COOH
where n=1: $C_nH_{2n+1}COOH$



propanoic acid
C_2H_5COOH
where n=2: $C_nH_{2n+1}COOH$

8c

X= ethanol
Y= propanoic acid

Problem Solving: Deduction from information in a table

9a

✓	They have similar chemical properties	✓ Propane and butane are both members of the alkane family and have the same chemical properties.
	They have the same molecular formula	Propane is C_3H_8 and Butane is C_4H_{10}
✓	The have the same general formula	✓ All alkanes have the general formula C_nH_{2n+2}
	They have the same physical properties	Alkanes have gradually changing physical properties e.g. bpt of propane = -42°C and bpt of butane = -1°C
	The have the same formula mass	gfm propane C_3H_8 = 44g gfm butane C_4H_{10} = 58g

9b

Butane C_4H_{10} has more carbons than propane C_3H_8.
The larger the molecules the higher the boiling point due to
(Higher would be London Dispersal Forces but this is NAT5)

9c

3135

E_h	=	c	×	m	×	ΔT
Energy	=	specific heat capacity	×	mass	×	change in temperature
Energy	=	4.18	×	25	×	30
Energy	=	3135kJ				

9d

SO_2 produced or Acid Rain gas formed

Sulphur atoms in compound will burn to form sulphur dioxide.
Sulphur dioxide dissolves in rain water in the atmosphere to form sulphurous acid.

10a(i)

Increase in number of carbons gives increase in flash point

Problem Solving: Forming a conclusion from table of information

10a(ii)

48°C-50°C

Alkane	Hexane C_6H_{14}	Heptane C_7H_{16}	Octane C_8H_{18}	Nonane C_9H_{20}	Decane $C_{10}H_{22}$
Flash Point (°C)	-23	-4	13	31	-
Difference		19°C	17°C	18°C	17°C → 19°C
Prediction	-	-	-	-	48°C-50°C

10b

99g

gfm C_9H_{20} = (9x12)+(20x1) = 108+20 = 128g

$$\text{no of mol} = \frac{\textbf{mass}}{\textbf{gfm}} = \frac{32}{128} = 0.25\text{mol}$$

$$C_9H_{20} + 14O_2 \longrightarrow 9CO_2 + 10H_2O$$

1mol 0.25mol — 9mol 2.25mol

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

mass = **no** of mol x **gfm** = 2.25 x 44 = 99g

11a

$2Cl^- \rightarrow Cl_2 + 2e^-$

$2Cl^-$ — Chloride Cl^- ions are a reactant as chloride ions are pumped into the fuel cell.

$\longrightarrow$ Cl_2 — Chlorine Cl_2 gas is the product as it emerges from the fuel cell

\+ $2e^-$ — Oxidation: Cl^- ions must lose electrons to become neutral

11b(i) — sodium hydroxide

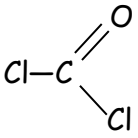
Solution X is the other product of the reaction happening around the negative electrode.

- Sodium ions are crossing the membrane into the right hand side
- Water is splitting into H^+ ions and OH^- ions
- $2H^+ + 2e^- \longrightarrow H_2$ leaving OH^- ions behind

11b(ii) — It is renewable or no CO_2/greenhouse gases produced

Hydrogen H_2 gas burns cleanly to form water H_2O. Hydrogen can then be regenerated from the water making hydrogen a renewable fuel. As there is no carbon in H_2, no poisonous carbon monoxide will be produces and no carbon dioxide, a greenhouse gas, is produced

11c



Element	Group	Valency	No of Bonds Element Makes
Carbon	4	4	4
Oxygen	6	2	2
Chlorine	7	1	1

12a — Reduction

Metal ores are compounds of metals and the metals are in the form of positive ions. Positive ions are turned back in atoms again be reduction where electrons are gained by the positive ions e.g. $Mg^{2+} + 2e^- \rightarrow Mg$

12b — 70%

$$\% \text{ Fe} = \frac{\text{total mass of Fe}}{\text{gfm } Fe_2O_3} \times 100 = \frac{(2\times56)}{(2\times56)+(3\times16)} \times 100 = \frac{112}{160} \times 100 = 70\%$$

12c — (molten) Electrolysis

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

13a — $16cm^3$

$$\text{Average Volume} = \frac{15.9 + 16.1}{2} = \frac{32.0}{2} = 16.0cm^3$$

NB: Ignore rough titre in the calculation of the average volume as it is inaccurate

13b — 0.08 mol l^{-1}

no. of mol = **v**olume x **c**oncentration = 0.016litres x 0.1 mol l^{-1} = 0.0016mol

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

2mol 1mol

0.0016mol 0.0008mol

$$\textbf{c}\text{oncentration} = \frac{\textbf{n}\text{o. of mol}}{\textbf{v}\text{olume}} = \frac{0.0008 \text{ mol}}{0.01 \text{ litres}} = 0.08 \text{ mol } l^{-1}$$

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