Name: …….. ( ) Class: Sec 4 SG 1 / 2

Queenstown Secondary School

Preliminary Examination 2024
Secondary Four Express
Chemistry
6092/01

28 August 2024
Wednesday

Time: 1145 – 1245h
Duration: 1 hour

Setter:

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
A copy of the Periodic Table is printed on page 21.
The use of an approved scientific calculator is expected, where appropriate.

1 The reaction of manganate(VII) ions with ethanedioate ions in acid solution may be represented by the following equation.

$$2MnO_4^-\ (aq) + 16H^+\ (aq) + 5C_2O_4^{2-}\ (aq) \rightarrow 2Mn^{2+}\ (aq) + 8H_2O\ (l) + 10CO_2\ (g)$$

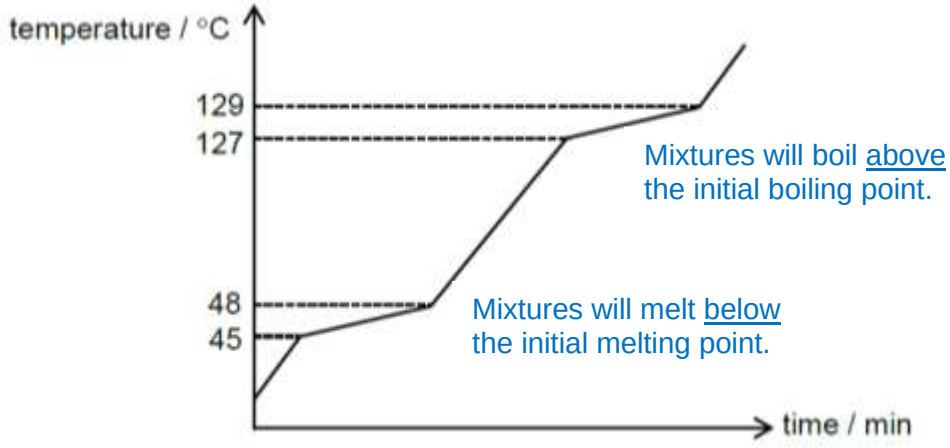
A student is exploring various ways to measure the rate of the reaction by measuring changes in different variables of the reaction.

Which of the following methods of monitoring the rate of reaction are suitable?

1 volume of gas produced ✓
2 pH of the reaction mixture ✓
3 mass of the reaction mixture ✓
4 amount of precipitate obtained ✗
5 intensity of the purple colour of the reaction mixture ✓

A 1, 2 and 3 **B** 1, 3 and 4 **C** **1, 2, 3 and 5** **D** 2, 3, 4 and 5

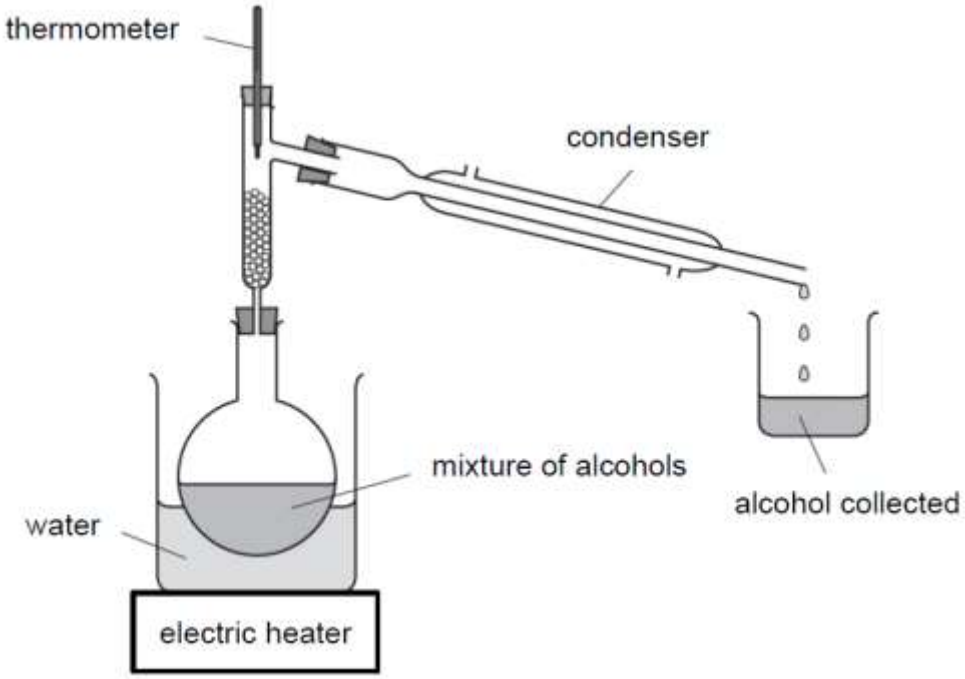
2 The heating curve of an impure sample of substance X is shown below.



What are the melting point and boiling point of pure substance X?

	melting point / °C **[above]**	boiling point / °C **[below]**
A	45	129
B	47	128
C	**48**	**127**
D	49	130

3 A student carried out an experiment using the set-up shown below to separate a mixture containing four alcohols.



The table gives the boiling points of the four alcohols used.

alcohol	butanol	ethanol	pentanol	propanol
boiling point / °C	117	79	138	97

Despite repeated attempts, the student only managed to obtain two alcohols from the mixture.

Which alcohols did he fail to obtain?

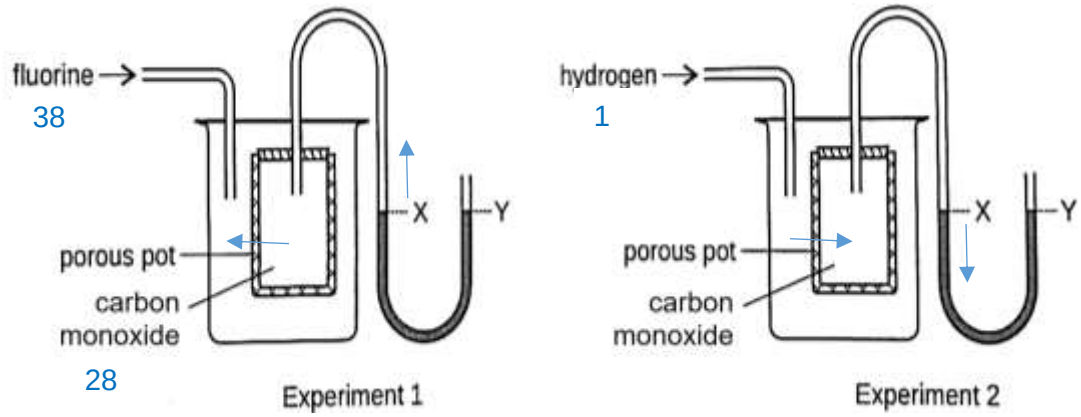
A butanol and ethanol

B butanol and pentanol

C ethanol and propanol

D pentanol and propanol

4 Two experimental set-ups used to demonstrate the diffusion of gases are shown in the diagrams below. In each porous pot is carbon monoxide.
In the first experiment, the gas introduced into the beaker is fluorine gas, while in the second experiment, hydrogen gas was introduced.



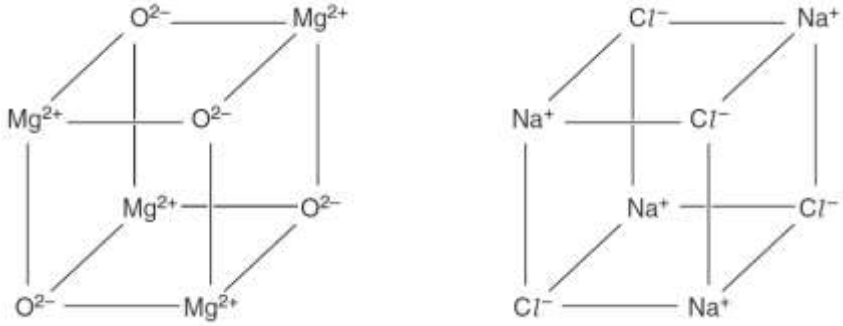
What changes, if any, to the water levels X and Y would you expect to see in both experiments?

	experiment 1	experiment 2
A	Y is higher than X	X is higher than Y
B	**X is higher than Y**	**Y is higher than X**
C	X and Y remain the same	Y is higher than X
D	X and Y remain the same	X and Y remain the same

5 An ion, X^{2-}, has a mass number of m and it contains n electrons.
What does the nucleus of an atom of X contain?

	number of protons	number of neutrons
A	n – 2	m – n
B	**n – 2**	**m – n + 2**
C	n + 2	m – n + 2
D	n + 2	m – n – 2

6 Part of the giant lattice structure of magnesium oxide and sodium chloride is shown.

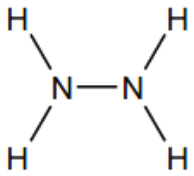


The structure repeats to make a giant lattice.

In the giant lattice, how many negative ions directly surround each positive ion?

A 3 **B** 4 **C** 5 **D** 6

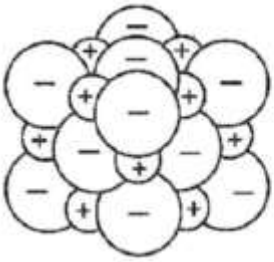
7 The diagram shows the structural formula of the covalent molecule hydrazine, N_2H_4.



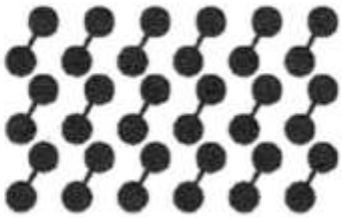
Which row is correct?

	total number of electrons involved in bonding **[5 pairs = 10 e-]**	total number of electrons **not** involved in bonding **[4 from each N atom]**
A	5	4
B	5	8
C	10	4
D	**10**	**8**

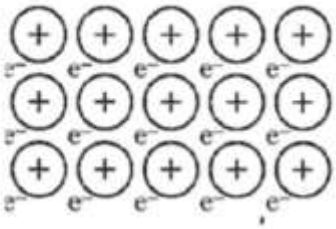
8 The structures of three substances P, Q and R are shown below.



P **[ionic]**



Q **[simple covalent]**



R **[metal]**

Which statements are correct?

1 P and R can conduct electricity in the molten state. ✓

2 Q is an element while P and R are compounds. ✗ **[R is an element.]**

3 P has a giant structure while Q has a simple structure. ✓

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 1, 2 and 3

9 The information below shows the percentage of carbon in two samples of steel, Q and R. Q consists of 60% carbon **[harder]** while R consists of 20% carbon **[softer]**.

Which statement is correct about the two samples of steel?

A Q has higher strength and less brittle than R.

B R has higher strength and more brittle than Q.

C Q has lower strength and more brittle than R.

D R has lower strength and less brittle than Q.

10 Upon strong heating, a metal nitrate compound undergoes decomposition according to the following equation:

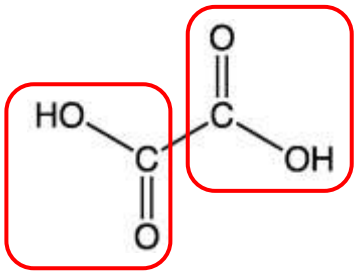
$$2XNO_3\ (s) \rightarrow 2X\ (s) + 2NO_2\ (g) + O_2\ (g)$$

Complete decomposition of 3.40 g of the nitrate gives 240 cm^3 of oxygen **[0.01 mol]**, measured at room temperature and pressure. **[M_r = 3.40 g ÷ 0.02 mol = 170]**

What is the relative atomic mass of X? **[A_r = 170 – 14 – 3(16) = 108]**

A 85 **B** 108 **C** 133 **D** 170

11 The structure of oxalic acid is shown.



A 25.0 cm^3 solution of oxalic acid reacts completely with 15.0 cm^3 of 2.50 mol/dm^3 aqueous sodium hydroxide **[0.0375 mol]**.

What is the concentration of the oxalic acid? **[conc. = 0.01875 mol ÷ 0.025 dm^3]**

A **0.750 mol/dm^3** **B** 2.08 mol/dm^3 **C** 1.50 mol/dm^3 **D** 4.17 mol/dm^3

12 Aspirin, $C_9H_8O_4$, is made from salicylic acid, $C_7H_6O_3$ according to the equation:

$$C_7H_6O_3 + C_4H_6O_3 \rightarrow C_9H_8O_4 + CH_3COOH$$

Assuming a 70% yield, what is the mass of salicylic acid required to make an aspirin tablet of 325 mg? **[100% = 464.29 mg; mass of $C_7H_6O_3$ = 464.29/180 x 138 = 355 g]**

[M_r: $C_7H_6O_3$, 138; $C_9H_8O_4$, 180]

A 174 mg **B** 249 mg **C** **356 mg** **D** 424 mg

13 50.0 cm^3 of hydrochloric acid has a pH of 1.0.
This acid requires 25.0 cm^3 of aqueous sodium hydroxide to be neutralised.
A second 50.0 cm^3 solution contains the weak acid, ethanoic acid.
The hydrochloric acid and ethanoic acid have the same concentration.

How will the pH of ethanoic acid and the volume of NaOH needed for neutralisation differ, if at all, from the hydrochloric acid?

	pH	volume of NaOH needed for neutralisation
A	higher than HC*l*	lower than for HC*l*
B	**higher than HC*l***	**equal to HC*l***
C	lower than HC*l*	lower than for HC*l*
D	lower than HC*l*	equal to HC*l*

14 What is a characteristic property of all bases?

A Alkalis are bases which are insoluble in water.

B They dissolve in water to produce hydroxide ions.

C **They form salts with acids.**

D They react with ammonia to form ammonium salts.

15 Which statements about oxides are correct?

1 An aqueous solution of sulfur dioxide has a pH less than 7. ✓

2 An aqueous solution of potassium oxide turns blue litmus paper red. ✗ **[blue]**

3 Carbon dioxide reacts with ammonia to make a salt. ✓

4 Carbon monoxide reacts with hydrochloric acid to make a salt. ✗ **[CO = neutral]**

A 1 and 2 **B** **1 and 3** **C** 2 and 3 **D** 3 and 4

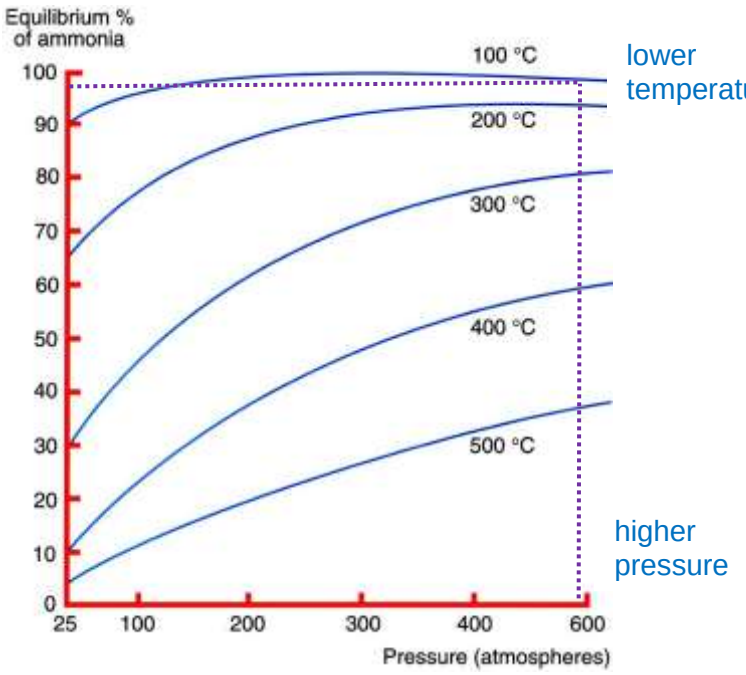
16 Which of the following method could **not** be used to prepare a dry sample of lead salt?

	name of salt	method
A	lead(II) carbonate	add aqueous sodium carbonate to aqueous lead(II) nitrate
B	lead(II) chloride	add hydrochloric acid to aqueous lead(II) nitrate
C	lead(II) iodide	add nitric acid to lead(II) carbonate, then add aqueous potassium iodide
D	lead(II) sulfate	add sulfuric acid to lead(II) carbonate **[insoluble]**

17 Ammonia is produced from Haber Process using a suitable catalyst.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The following graph shows the different yields of ammonia at different temperature and pressure.



Which of the following is **not** true?

A A higher percentage yield of ammonia can be obtained at higher pressure.

B A higher percentage yield of ammonia can be obtained at lower temperature.

C Some of the ammonia formed will decompose to form hydrogen and nitrogen. **[reversible]**

D **At the right conditions of temperature and pressure, all of the hydrogen and nitrogen can be converted into ammonia.**

18 Three tests are carried out on salt X.

S/N	test	result
1	To 2 cm^3 of salt X, add aqueous sodium hydroxide until no further change. Warm the mixture. Keep the mixture for Test 4.	White precipitate, soluble in excess giving a colourless solution. **[Al^{3+} / Pb^{2+} / Zn^{2+}]**
2	To 2 cm^3 of salt X, add aqueous ammonia until no further change.	White precipitate, soluble in excess giving a colourless solution. **[Zn^{2+}]**
3	To 2 cm^3 of salt X, add dilute nitric acid followed by aqueous silver nitrate.	No visible reaction. **[no Cl^-]**
4	To 2 cm^3 of the mixture in test 1, add aluminium foil.	Gas evolved turns damp litmus paper blue. **[NO_3^-]**

What is the identity of salt X?

A aluminium chloride

B ammonium nitrate

C zinc chloride

D **zinc nitrate**

19 A disproportionation reaction occurs when the same element undergoes both oxidation and reduction simultaneously in a chemical reaction.

Which of the following is **not** a disproportionation reaction?

A **$Mg + FeCl_2 \rightarrow MgCl_2 + Fe$**

B $H_2SO_4 + Cu_2O \rightarrow Cu + CuSO_4 + H_2O$

+1 0 +2

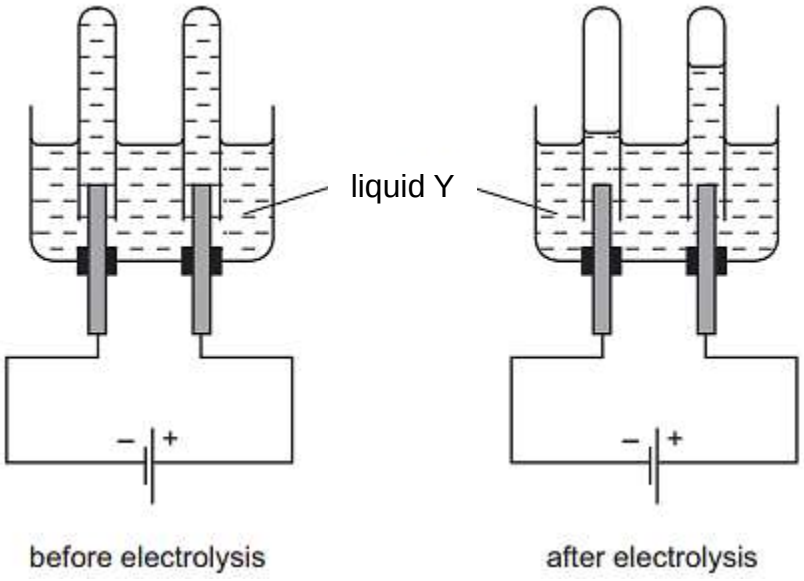
C $2H_2O_2 \rightarrow O_2 + 2H_2O$

-1 0 -2

D $2NO_2 + H_2O \rightarrow HNO_2 + HNO_3$

+4 +3 +5

20 The diagrams show an electrolysis set-up using inert electrodes.



Which could be liquid Y? **[$2H_2O$ (*l*) → $2H_2$ (g) + O_2 (g)]**

2 **1**

1 aqueous magnesium nitrate **[$\boxed{H^+}$, $\boxed{OH^-}$, Mg^{2+}, NO_3^-]**

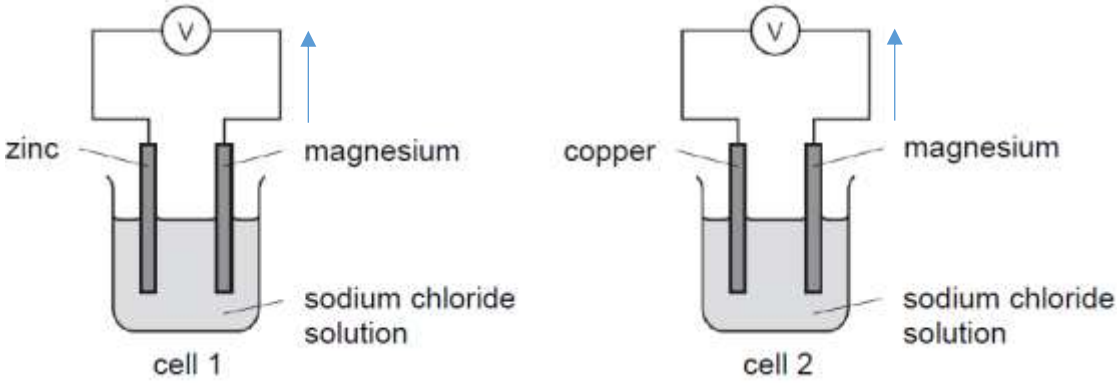
2 aqueous copper(II) sulfate **[H^+, $\boxed{OH^-}$, $\boxed{Cu^{2+}}$, SO_4^{2-}]**

3 concentrated hydrochloric acid **[$\boxed{H^+}$, OH^-, $\boxed{Cl^-}$]**

4 dilute sulfuric acid **[$\boxed{H^+}$, $\boxed{OH^-}$, SO_4^{2-}]**

A **1 and 4 only** **B** 2 and 4 only **C** 1, 2 and 4 only **D** 1, 3 and 4 only

21 A student set up two simple cells as shown below.



He recorded four statements in his notebook.

statement 1: In cell 1, sodium ions gain electrons to form sodium. ✗ **[H^+ ions]**

statement 2: In cell 2, copper(II) ions gain electrons to form copper. ✗ **[H^+ ions]**

statement 3: In both cells, magnesium loses electrons to form magnesium ions. ✓

statement 4: The voltage of cell 1 is greater than cell 2. ✗ **[smaller]**

Which statements are **incorrect**?

A 1 and 2 **B** 1 and 4 **C** 1, 2 and 4 **D** 2, 3 and 4

22 Which statement regarding the Periodic Table is correct?

A The elements are arranged by increasing relative atomic mass. **[proton no.]**

B **Across a period from left to right, elements have weaker reducing power.**

C Down Group 1, the elements become stronger oxidising agents. **[reducing]**

D Down Group 17, the elements become weaker reducing agents. **[oxidising]**

23 Excess bromine is shaken with a mixture of sodium chloride and sodium iodide solutions. Which substances will the final mixture contain?

Br_2 + NaC*l* → no reaction

Br_2 + 2NaI → 2NaBr + I_2

A bromine, iodine, sodium bromide

B **bromine, iodine, sodium bromide, sodium chloride**

C bromine, iodine, sodium bromide, sodium iodide

D iodine, sodium bromide, sodium chloride

24 The properties of the element vanadium, V, can be predicted from its position in the Periodic Table. **[transition metal]**

Which row identifies the properties of vanadium?

	can be used as a catalyst	conducts electricity at r.t.p.	forms coloured compounds	has a low density
A	✓	✓	✓	✗
B	✓	✓	✗	✓
C	✓	✗	✓	✓
D	✗	✓	✓	✓

[key: ✓ = yes; ✗ = no]

25 The table below shows three unknown metals and their method of extraction.

metal	method of extraction	**e.g.**
P	reduction of ore by carbon	**Fe**
Q	electrolysis	**Na**
R	mining from the ground	**Au**

Which statement regarding the three metals is true?

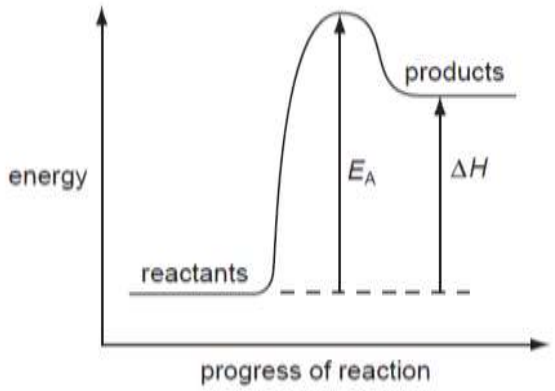
A **Metal Q should be found high up in the reactivity series.**

B Metal R is most likely to be found above hydrogen in the reactivity series. ✗ **[below]**

C Metal R is the most reactive metal among all three. ✗ **[least]**

D The oxide of P must be the most stable compared to the oxides of the other two metals. ✗ **[Q]**

26 The diagram shows the energy profile for a chemical reaction.



What is the correct description of the reaction?

	sign of E_A	sign of ΔH	overall energy change
A	-	-	exothermic
B	**+**	**+**	**endothermic**
C	-	+	endothermic
D	+	+	exothermic

27 Methane burns in excess oxygen to produce carbon dioxide and water.

$$CH_4\,(g) + 2O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(g)$$

Given the following information of the bond energies, calculate the enthalpy change of the reaction.

bond	C — H	O = O	C = O	O – H
bond energy / kJmol^{-1}	410	496	805	460

A –359 kJ/mol **B** **–818 kJ/mol** **C** +102 kJ/mol **D** +818 kJ/mol

energy absorbed = 4(410) + 2(496) = 2632 kJ/mol

energy released = 2(805) + 4(460) = 3450 kJ/mol

enthalpy change = 2632 + (-3450) = -818 kJ/mol

28 In which reaction is pressure **least** likely to affect the rate of reaction?

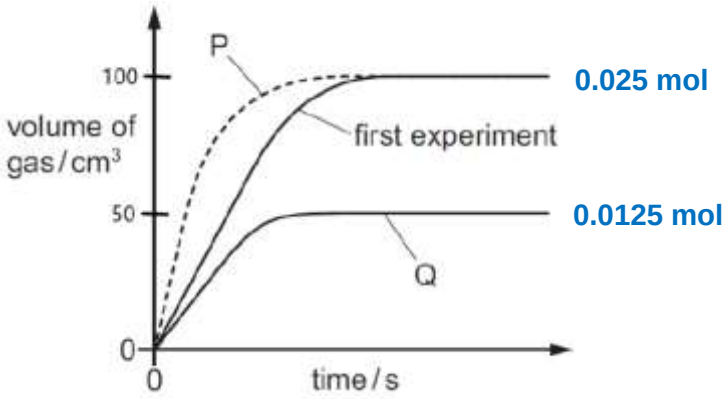
A $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

B $HCl(g) + NH_3(g) \rightarrow NH_4Cl(s)$

C $CO_2(g) + Ca(OH)_2(aq) \rightarrow CaCO_3(s) + H_2O(l)$

D $K_2CO_3(s) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + H_2O(l) + CO_2(g)$

29 In the first experiment, excess magnesium reacts with 25 cm^3 of 1.0 mol/dm^3 hydrochloric acid **[0.025 mol]** to produce hydrogen gas. The volume of hydrogen produced is measured and shown in the graph.



Graphs P and Q show the volume of hydrogen produced under different conditions. What changes in conditions produce graphs P and Q?

A P uses a higher temperature and Q uses a lower temperature.

B P uses 25 cm^3 of 1.5 mol/dm^3 hydrochloric acid **[0.0375 mol]** and Q uses 25 cm^3 of 0.5 mol/dm^3 hydrochloric acid **[0.0125 mol]**.

C **P uses a catalyst and Q uses 25 cm^3 of 0.5 mol/dm^3 hydrochloric acid [0.0125 mol].**

D P uses smaller strips of magnesium of the same mass and Q uses a lower temperature.

30 The table shows the boiling points of four fractions P, Q, R and S, obtained when crude oil is distilled.

fraction	boiling point range / °C
P	35 – 75
Q	80 – 145
R	150 – 250
S	> 250

How is fraction P different from fraction S?

A Fraction P is in less demand than S.

B Fraction P is more viscous than fraction S.

C **Fraction P is more flammable than fraction S.**

D Fraction P contains molecules of larger relative molecular masses than fraction S.

31 Biodiesel, an alternative fuel made from vegetable oil, can be used as a fuel for vehicles. Although carbon dioxide is released during the combustion of biodiesel, scientists still claim that it is a carbon neutral fuel.

Which is the basis for this claim?

A Biodiesel is not a carbon compound.

B Biodiesel produces less carbon dioxide when it burns.

C Plants release carbon dioxide during respiration.

D **Plants absorb carbon dioxide during photosynthesis.**

32 Pentane, C_5H_{12}, and octane, C_8H_{18}, are alkanes present in the petrol fraction.

Which statements about alkanes are correct?

1 They are unsaturated hydrocarbons. ✗ **[saturated]**

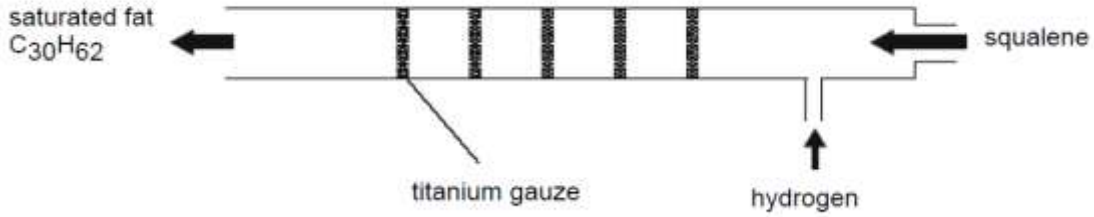
2 Their general formula is C_nH_{2n+2}. ✓

3 Pentane has a higher boiling point than octane. ✗ **[lower]**

4 Both pentane and octane undergo substitution reaction with chlorine in the presence of light. ✓

A 1 and 2 **B** 1 and 4 **C** 2 and 3 **D** **2 and 4**

33 Squalene, a naturally occurring polyunsaturated oil present in sharks can be reduced to form a saturated hydrocarbon using titanium as a catalyst.

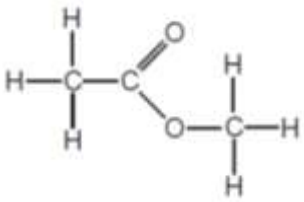


A 0.100 mol sample of squalene reacted with 14.4 dm^3 of hydrogen **[0.6 mol]** at room temperature and pressure to form a saturated hydrocarbon, $C_{30}H_{62}$. **[1:6 ratio]**

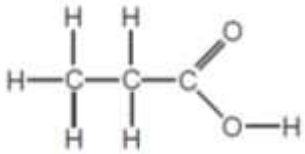
What is the molecular formula of squalene?

A $C_{30}H_{50}$ **B** $C_{30}H_{52}$ **C** $C_{30}H_{54}$ **D** $C_{30}H_{56}$

34 The displayed formulae of two compounds are shown.



$C_3H_6O_2$



$C_3H_6O_2$

Which statement(s) about the compounds is/are correct?

1 Both compounds are from the same homologous series. ✗ **[ester vs acid]**

2 Both compounds have the same molecular formula. ✓ **[$C_3H_6O_2$]**

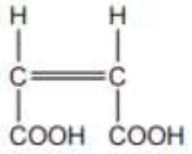
3 Both compounds have the same percentage mass of carbon. ✓

4 Both compounds undergo the same type of reactions. ✗ **[different]**

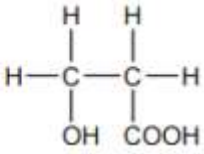
A 1 and 2 only **B** 1 and 4 only **C** 2 and 3 only **D** 3 and 4 only

35 The structures of compounds W, X, Y and Z are shown below.

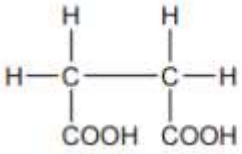
W



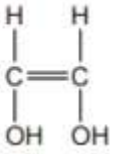
X



Y



Z



What reactions do compounds W, X, Y and Z undergo?

	decolourises aqueous bromine **[C=C]**	decolourises acidified aqueous potassium manganate(VII) **[–OH]**	effervescence with aqueous sodium carbonate **[–COOH]**
A	X and Y	X and Z	W and Y
B	X and Y	W, X and Y	W and Y
C	**W and Z**	**X and Z**	**W, X and Y**
D	W and Z	W, X and Y	W, X and Y

36 Two esters have the same molecular formula, $C_3H_6O_2$.

What are the names of these two esters?

1 methyl ethanoate **3C**

2 ethyl methanoate **3C**

3 ethyl propanoate **5C**

4 propyl methanoate **4C**

A **1 and 2** **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

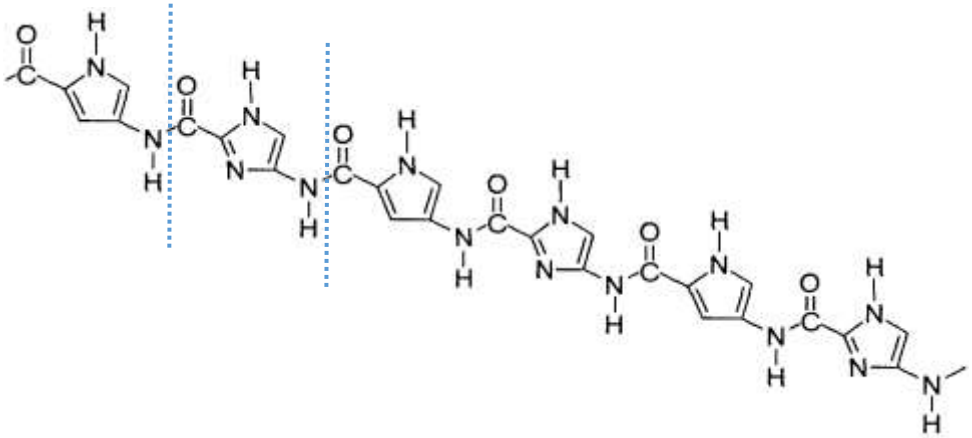
37 Engine oil is used to lubricate the car engine. Certain polymers are added to improve the viscosity of engine oil. A portion of the chain of one such polymer is shown below.

$$–CH_2–CH(CH_2CH_2CH_3)–CH_2–CH(CH_2CH_2CH_3)–CH_2–CH(CH_2CH_2CH_3)–$$

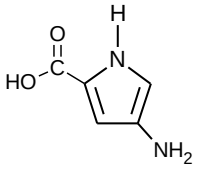
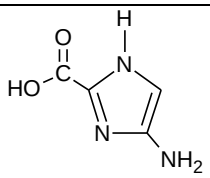
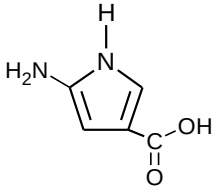
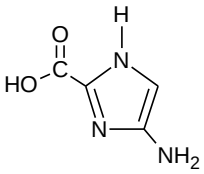
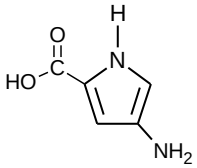
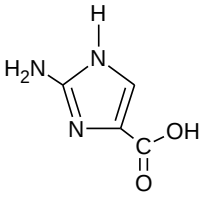
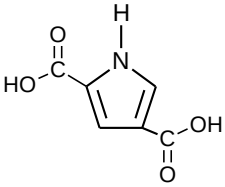
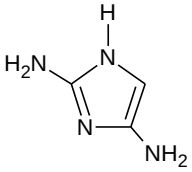
A molecule of this polymer contains 40 carbon atoms. How many molecules of monomer are required to form one molecule of this polymer? **[40 ÷ 5 = 8]**

A 4 **B** 5 **C** **8** **D** 10

38 The structure below shows part of a polymer.



Which one of the following options show the correct monomers?

A		
B		
C		
D		

39 A sample of air is slowly passed through aqueous sodium hydroxide **[remove CO_2]** and then over heated copper **[removes O_2]**.

Which gases are removed by this process?

A carbon dioxide and water vapour

B carbon dioxide and oxygen

C nitrogen and oxygen

D nitrogen and water vapour

40 Nitrogen monoxide, NO, is formed in the engines of petrol-powered cars. One constituent of petrol is pentane, C_5H_{12}. Nitrogen monoxide is removed from exhaust fumes by catalytic converters.

Which row identifies the reactants that produce nitrogen monoxide and a reaction that removes it in the catalytic converter?

	reactants that produce NO	reaction that removes NO
A	pentane + one gas found in air	$NO + CO \rightarrow ½N_2 + CO_2$
B	pentane + one gas found in air	$NO + CO_2 \rightarrow NO_2 + CO$
C	**two gases found in air** **$N_2 + O_2 \rightarrow 2NO$**	**$NO + CO \rightarrow ½N_2 + CO_2$**
D	two gases found in air	$NO + CO_2 \rightarrow NO_2 + CO$

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		Key: proton (atomic) number; atomic symbol; name; relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)
The Avogadro constant, $L = 6.02 \times 10^{23} mol^{-1}$.

MARK SCHEME

1	2	3	4	5	6	7	8	9	10
C	C	B	B	B	D	D	B	D	B
11	12	13	14	15	16	17	18	19	20
A	C	B	C	B	D	D	D	A	A
21	22	23	24	25	26	27	28	29	30
C	B	B	A	A	B	B	D	C	C
31	32	33	34	35	36	37	38	39	40
D	D	A	C	C	A	C	A	B	C

Tally

A – 8

B – 12

C – 11

D – 9