

Name: ()

Class: Sec



St. Gabriel's Secondary School

2024 'O' Preliminary Examination

Subject : Chemistry
Paper : 6092 / 01
Level/Stream : Secondary 4 (Express)
Duration : 1 hour
Date : 26 August 2024

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, index number and class on the Answer Sheet in the spaces provided unless this has been done for you.

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.

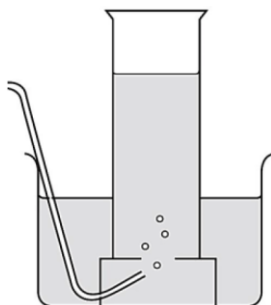
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 18.

The use of an approved scientific calculator is expected, where appropriate.

- 1 The setup shown is used to collect gas produced during a chemical reaction.



Which reaction is this setup best suited for?

- A $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
 B $\text{C}_6\text{H}_5\text{N}_2\text{Cl}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{C}_6\text{H}_5\text{OH}(\text{aq}) + \text{N}_2(\text{g}) + \text{HCl}(\text{aq})$
 C $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}(\text{s}) \rightarrow \text{CuSO}_4(\text{s}) + \text{H}_2\text{O}(\text{g})$
 D $\text{Na}_2\text{SO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow 2\text{NaCl}(\text{aq}) + \text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- 2 The table shows the R_f values for dyes P, Q, R and S in four different solvents.

dye	solvent			
	ethanol	propanone	tetrachloromethane	water
P	0.91	0.72	0.58	0.34
Q	0.82	0.65	0.20	0.00
R	0.75	0.65	0.13	0.59
S	0.66	0.42	0.20	0.00

Which statement is correct?

- A Dye P is the most soluble in all four solvents.
 B Dyes Q and R are the same dye as they have the same R_f value in propanone.
 C Dye S is the only dye that is insoluble in water.
 D Ethanol is the only solvent that can be used to separate a mixture of all four dyes.
- 3 Weather balloons are used in the study of the climate and atmosphere. A weather balloon filled with helium gas greatly increases in volume as it goes higher up in the sky.

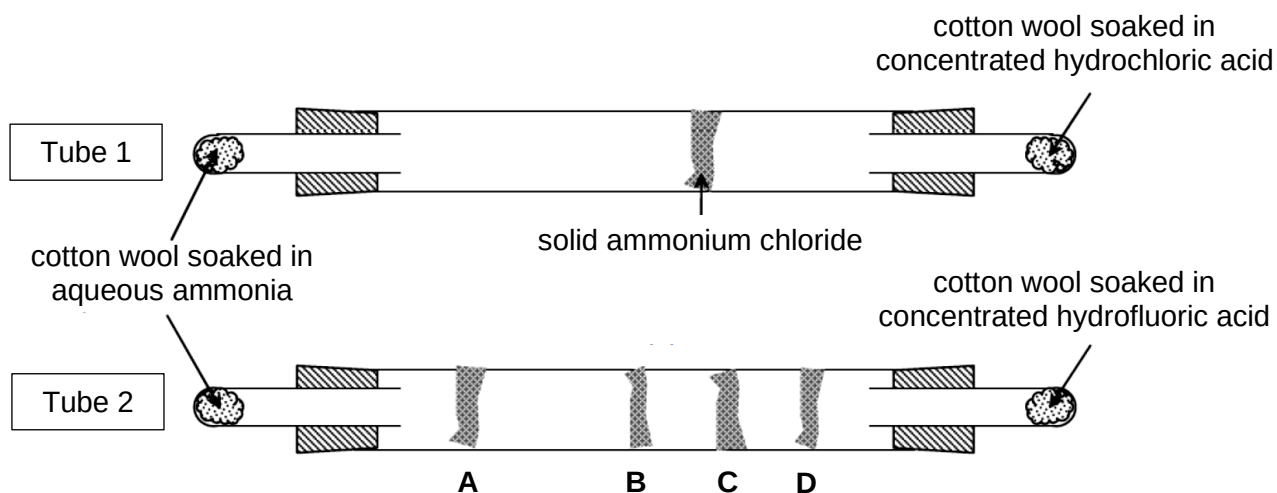
What is a likely reason for the expansion of the balloon as it goes higher?

- A The distance between particles in the balloon decreases.
 B The distance between particles in the balloon increases.
 C The energy of the particles in the balloon decreases.
 D The energy of the particles in the balloon increases.

- 4 Tube 1 shows the result of an experiment to investigate the formation of ammonium chloride from the reaction between ammonia gas and hydrogen chloride gas.

A similar experiment was set up in Tube 2 to investigate the reaction between ammonia gas and hydrogen fluoride gas.

At which position, **A**, **B**, **C** or **D**, is ammonium fluoride most likely to form?



- 5 How many electrons and neutrons are present in one hydroxide ion, OH^- ?

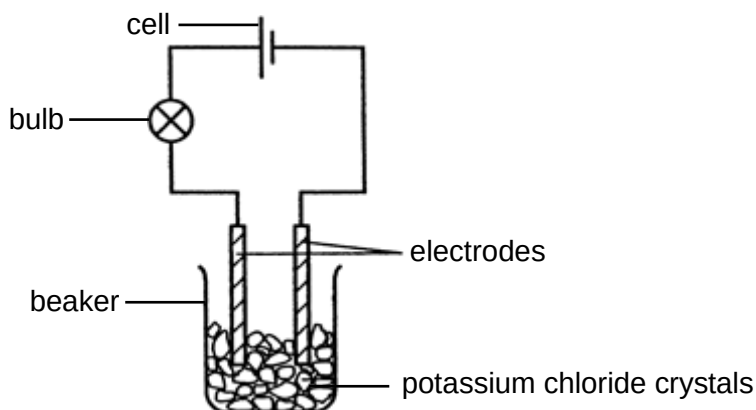
	electrons	neutrons
A	9	8
B	9	9
C	10	8
D	10	9

- 6 Element X exists as two naturally occurring isotopes, ^{51}X and ^{54}X . The relative isotopic abundance of ^{51}X is 77.8%.

What is the relative atomic mass of element X?

- A** 51.7
- B** 51.9
- C** 52.5
- D** 53.4

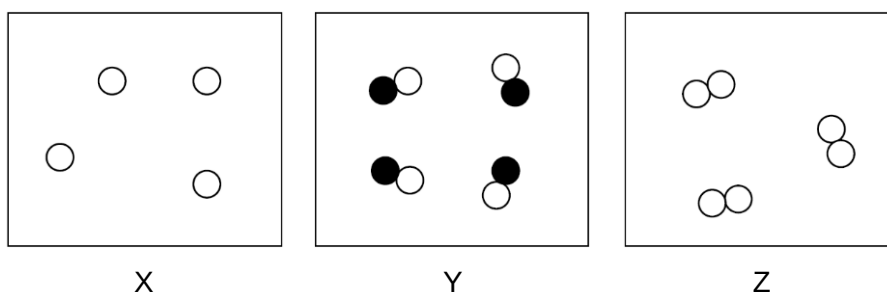
- 7 The setup shown is used to test if potassium chloride crystals can light up a bulb.



The bulb does not light up. Distilled water is then added to the beaker and the bulb lights up.

Which statement best explains this observation?

- A** Electrons are free to move in the solution when potassium chloride dissolves.
B Metal ions are free to move in the solution when potassium chloride melts.
C Only metal ions are free to move in the solution when potassium chloride reacts with water.
D Oppositely charged ions are free to move in the solution when potassium chloride dissolves.
- 8 Which pair of elements **cannot** be used to form an alloy?
- A** aluminium and magnesium
B copper and zinc
C lead and tin
D sodium and chlorine
- 9 The diagram shows three different substances, X, Y and Z.



Which row gives the correct classification of X, Y and Z?

	X	Y	Z
A	element	compound	element
B	element	compound	mixture
C	element	mixture	compound
D	compound	mixture	mixture

10 Which aqueous solution contains the greatest number of ions?

- A 1 dm³ of 0.1 mol/dm³ Al(NO₃)₃
- B 1 dm³ of 0.2 mol/dm³ H₂SO₄
- C 1 dm³ of 0.3 mol/dm³ MgCl₂
- D 1 dm³ of 0.4 mol/dm³ HCl

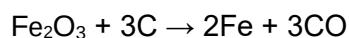
11 Elkinstantonite, a mineral obtained from an ancient meteorite that landed in Somalia, was found to have the following composition.

iron	phosphorus	oxygen
52.1%	14.4%	33.5%

What is its empirical formula?

- A Fe₂PO₂
- B Fe₂PO₅
- C Fe₄P₂O₉
- D Fe₈P₄O₉

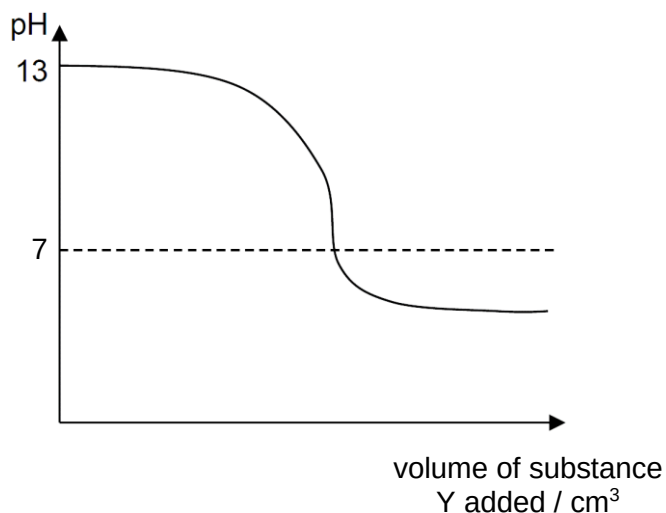
12 Iron can be extracted from its ore, Fe₂O₃, by reducing it with coal in a blast furnace.



What is the percentage purity of the iron ore if 1200 g of Fe₂O₃ produces 250 g of iron?

- A $\frac{56 \times 2}{250} \times \frac{1200}{160} \times 100$
- B $\frac{56}{250 \times 2} \times \frac{160}{1200} \times 100$
- C $\frac{250}{56 \times 2} \times \frac{160}{1200} \times 100$
- D $\frac{250 \times 2}{160} \times \frac{1200}{56} \times 100$

- 13 The graph shows the change in pH as substance Y is added from a burette to substance X.



What could substances X and Y be?

	X	Y
A	aqueous ammonia	dilute ethanoic acid
B	aqueous ammonia	dilute hydrochloric acid
C	aqueous sodium hydroxide	dilute ethanoic acid
D	aqueous sodium hydroxide	dilute hydrochloric acid

- 14 The table shows some information about the oxides of three elements, T, U and V, when added to water.

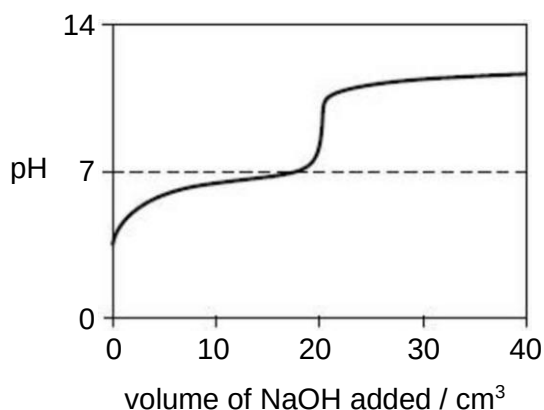
oxide of T	oxide of U	oxide of V
dissolved to form a solution of pH 2	insoluble	dissolved to form a solution of pH 13

The oxide of U is white in colour.

What could be the identity of T, U and V?

	T	U	V
A	calcium	aluminium	sulfur
B	calcium	copper	sulfur
C	sulfur	aluminium	calcium
D	sulfur	copper	calcium

- 15** Aqueous sodium hydroxide was added from a burette to an unknown acid in a conical flask. The graph shows the change in pH of the mixture in the flask recorded during the titration.



The table shows the range of colour change of some indicators.

indicator	pH range of colour change
alizarin yellow	10.1 – 12.0
bromothymol blue	6.0 – 7.6
cresolphthalein	8.1 – 9.7
methyl red	4.4 – 6.2

Which indicators can be used for this titration?

- A** alizarin yellow and bromothymol blue
B alizarin yellow and cresolphthalein
C bromothymol blue and methyl red
D cresolphthalein and methyl red
- 16** Four students each dissolved an indigestion tablet in 100 cm³ of water before titrating 25.0 cm³ of their indigestion tablet solutions with dilute hydrochloric acid using the same indicator. The table shows the results of all four students.

student	1	2	3	4
volume of HCl used / cm ³	24.50	24.40	24.30	25.00

Which could be a possible error made by student 4?

- A** The burette was rinsed with dilute hydrochloric acid solution.
B The conical flask was rinsed with indigestion tablet solution.
C The pipette was rinsed with dilute hydrochloric acid solution.
D There were air bubbles present while pipetting indigestion tablet solution.

17 How many different soluble salts can be prepared from the list of reactants?

- dilute hydrochloric acid
- dilute nitric acid
- dilute sulfuric acid
- solid calcium carbonate
- solid copper(II) carbonate

- A 3
B 4
C 5
D 6

18 Ammonia is produced industrially by the Haber process.

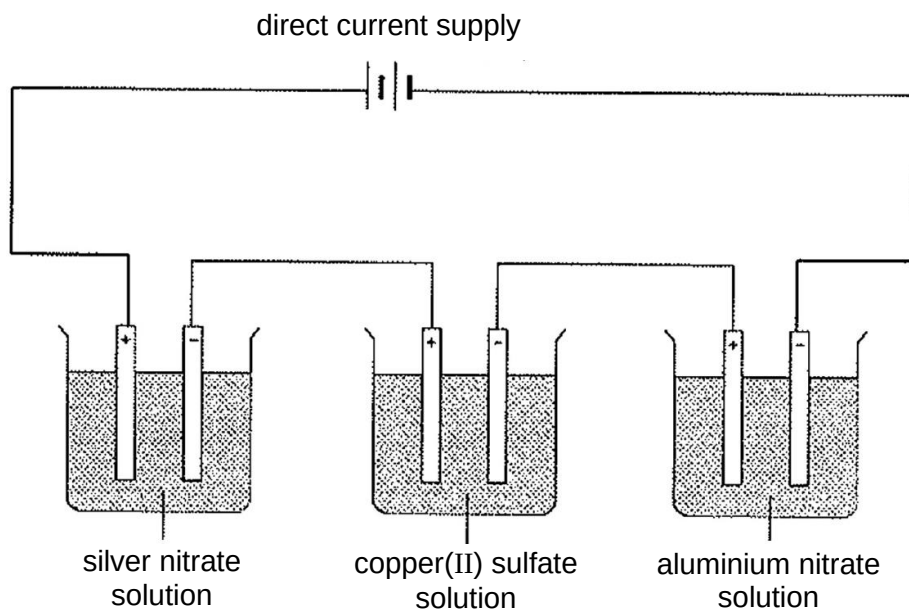
Which statement is true about the Haber process?

- A A catalyst is added to decrease the enthalpy change of the reaction.
B A relatively low pressure is applied to increase the yield of ammonia.
C A relatively high temperature is applied to overcome the activation energy.
D Hydrogen is obtained from fractional distillation of liquefied air.

19 Which underlined substance acts an oxidising agent?

- A $\text{CuCl}_2 + \underline{\text{Mg}} \rightarrow \text{MgCl}_2 + \text{Cu}$
B $\underline{\text{NH}_3} + \text{HCl} \rightarrow \text{NH}_4\text{Cl}$
C $\text{Mg} + 2\underline{\text{HNO}_3} \rightarrow \text{Mg}(\text{NO}_3)_2 + \text{H}_2$
D $\underline{\text{Zn}} + \text{H}_2\text{O} \rightarrow \text{Zn}(\text{OH})_2 + \text{H}_2$

- 20 The diagram shows three electrolytic cells are set up using graphite electrodes and different salt solutions.



What is the mass of silver and aluminium deposited if 16 g of copper was deposited at the negative electrode in the cell containing copper(II) sulfate solution as the electrolyte?

	mass of silver / g	mass of aluminium / g
A	54.0	0.0
B	54.0	4.5
C	54.0	13.5
D	108.0	27.0

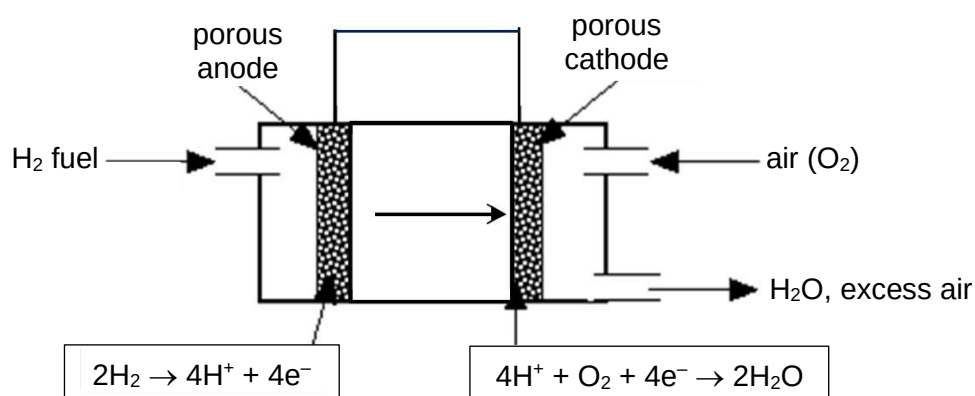
- 21 A student set up three different electrochemical cells each containing two of the metals, W, Y and Z, immersed in an electrolyte. The table shows the potential difference and the positive terminal of each cell.

electrochemical cell	metals used	positive terminal	potential difference / V
1	W, Y	W	+1.10
2	W, Z	W	+2.70
3	Y, Z	Y	+1.60

Which is the order of decreasing reactivity of metals W, Y and Z?

- A** W, Z, Y
B Y, W, Z
C Y, Z, W
D Z, Y, W

- 22 The diagram shows a hydrogen-oxygen fuel cell using aqueous phosphoric acid as the electrolyte.



Which statements about the substances are true?

- 1 Electricity is used to generate hydrogen and oxygen.
- 2 Electrons flow from the anode to the cathode through the electrolyte.
- 3 Hydrogen and oxygen undergo redox reactions to generate electricity.
- 4 The anode and cathode are the negative and positive electrodes respectively.

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

- 23 Electron affinity is the tendency of an element to attract electrons into its valence shell to form an anion. Electron affinity depends on two factors.

- attractive force of the nucleus
- distance of the valence shell from the nucleus

Which row describes the trend in electron affinity across the period and down the group?

	across the period	down the group
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

24 Element Q has the following properties.

- forms QCl_3 when heated with chlorine
- forms QSO_4 when reacted with dilute sulfuric acid

To which part of the Periodic Table does element Q belong?

- A Group 2
- B Group 13
- C Group 14
- D Transition elements

25 Elements Y and Z are consecutive elements in the Periodic Table. The ion of element Z in its compounds is Z^+ .

Which statement could be a description of element Y?

- A Y belongs to Group 16.
- B Y exists as a diatomic molecule.
- C Y forms coloured compounds.
- D Y is used to provide an inert environment.

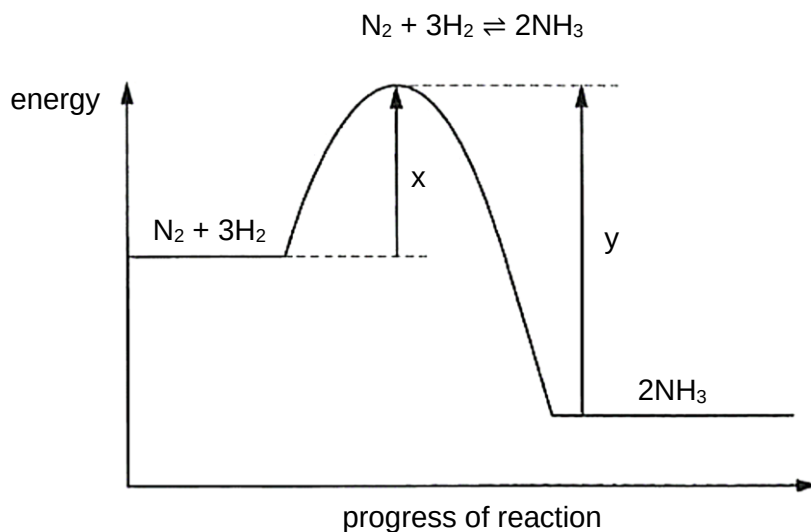
26 Metals P, Q, R and S have the following properties.

- 1 Only oxides of P and R can be reduced by heating with hydrogen.
- 2 P and Q react with acid but not with cold water.
- 3 R does not react with both acid and water.
- 4 Carbonate of S does not decompose under heat.

What is the order of reactivity of the metals?

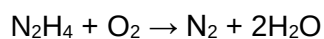
	most reactive → least reactive			
A	Q	S	P	R
B	R	P	Q	S
C	S	Q	P	R
D	S	R	Q	P

- 27 The energy profile diagram for the Haber process is as shown.



Which statement about the reaction is correct?

- A The activation energy for the forward reaction is y .
 - B The activation energy for the reverse reaction is x .
 - C The enthalpy change for the forward reaction is $x - y$.
 - D The enthalpy change for the reverse reaction is $x - y$.
- 28 The combustion of hydrazine, N_2H_4 , occurs according to the equation



The table shows the bond energies of the bonds present in hydrazine.

bond	bond energy / kJ mol^{-1}
N–N	U
$\text{N}\equiv\text{N}$	V
N–H	W
O–O	X
O=O	Y
O–H	Z

What is the enthalpy change of this reaction?

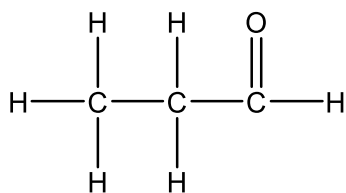
- A $(U + 2Z) - (V + 4W + X) \text{ kJ}$
- B $(U + 4W + Y) - (V + 4Z) \text{ kJ}$
- C $(V + 4W + X) - (U + 2Z) \text{ kJ}$
- D $(V + 4Z) - (U + 4W + Y) \text{ kJ}$

- 29** Which statement describes the function of catalysts in chemical reactions?
- A** Catalysts do not undergo any change during the chemical reaction.
 - B** Catalysts provide reactant particles with more energy.
 - C** Catalysts provide an alternative pathway with lower activation energy.
 - D** Catalysts used in industrial processes increase the yield of reactions.
- 30** Which statement explains why biofuels such as bioethanol and biodiesel are considered carbon neutral?
- A** Biofuels do not produce carbon dioxide when burned.
 - B** Carbon monoxide, instead of carbon dioxide, is produced.
 - C** Plants produce carbon dioxide during respiration.
 - D** Plants take in carbon dioxide during photosynthesis.
- 31** A methane gas burner was incorrectly adjusted. When used, the methane reacted with oxygen to form a mixture of carbon dioxide and carbon monoxide in a mole ratio of 9 : 1, together with water vapour.

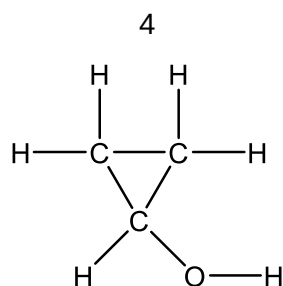
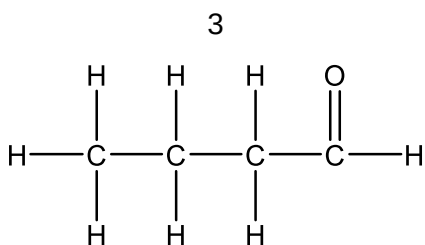
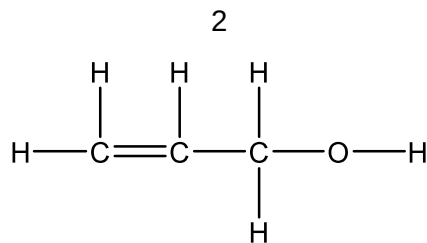
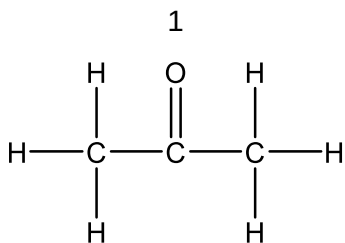
Which volume of oxygen was needed to burn 1 dm³ of methane in this burner?

- A** 1.55 dm³
- B** 1.75 dm³
- C** 1.95 dm³
- D** 3.90 dm³

- 32** Propanal is used in the manufacture of plastics and rubber. The structural formula of propanal is shown below.



Which compound(s) is/are isomer(s) of propanal?



- A** 1 only
B 1 and 2
C 1 and 3
D 1, 2 and 4
- 33** One mole of polyunsaturated vegetable oil is completely converted to margarine. After the reaction, the mass of the margarine formed was found to be 8.0 g more than the mass of vegetable oil.

How many carbon-carbon double bonds does each molecule of vegetable oil contain?

- A** 1
B 2
C 4
D 8

34 Compound X has the molecular formula C_2H_6O .

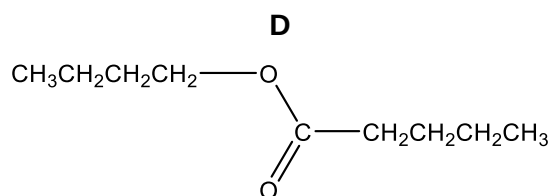
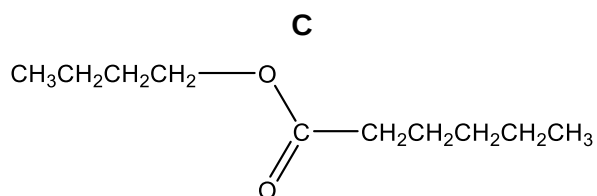
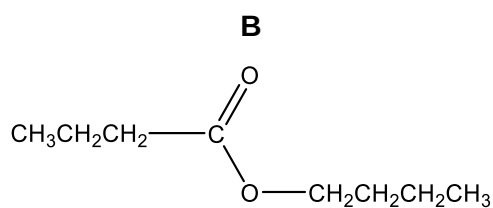
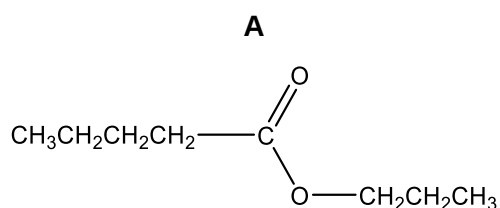
- X can be made by fermentation of glucose.
- X can be oxidised to form Y.
- X can react with Y to form Z and water.

To which homologous series do X, Y and Z belong?

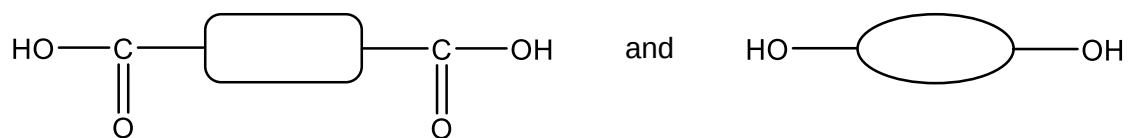
	X	Y	Z
A	alcohols	esters	carboxylic acids
B	alcohols	carboxylic acids	esters
C	carboxylic acids	esters	alcohols
D	carboxylic acids	alcohols	esters

35 Pentanoic acid has the formula $CH_3CH_2CH_2CH_2CO_2H$.

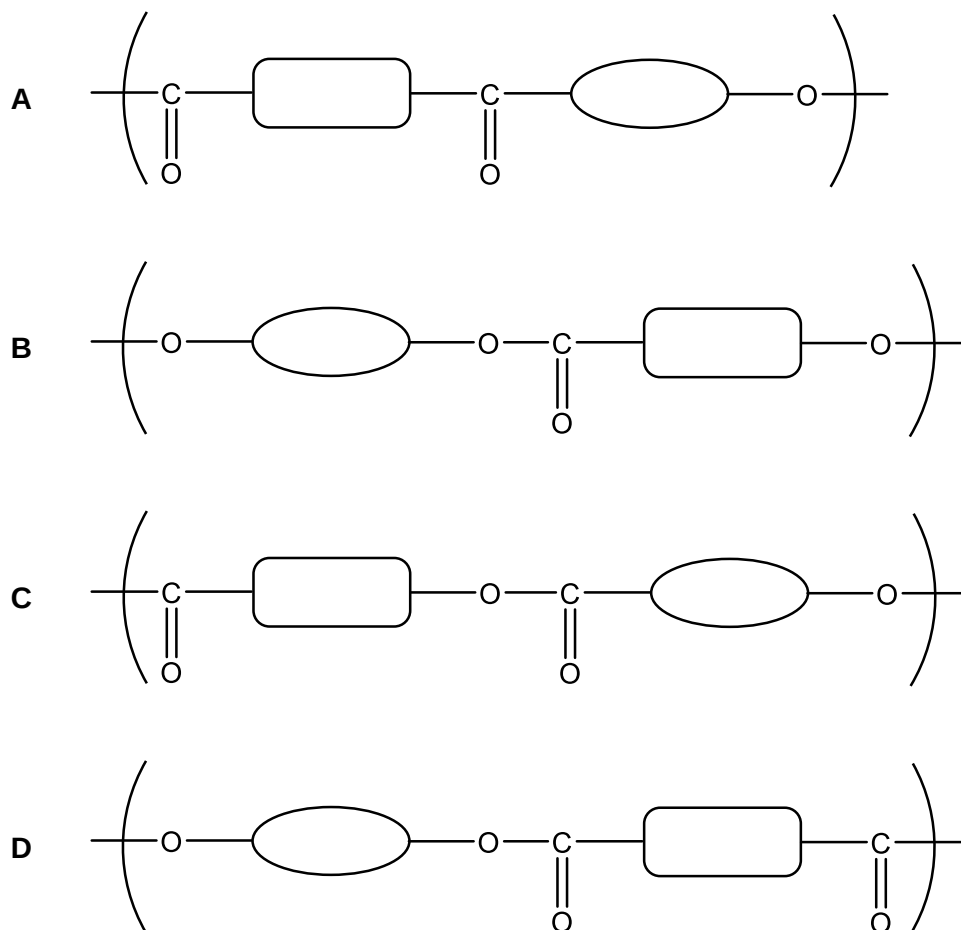
Which formula represents butyl pentanoate?



- 36 The structural formula of two monomers used to synthesis *Terylene* are shown.



What is the repeat unit of the polymer?



- 37 Which polymer contains the elements present in ammonia?

- A nylon
- B poly(ethene)
- C poly(styrene)
- D PVC

- 38** The pH of rainwater in a clean atmosphere typically ranges from 5.0 to 5.6.

Which gas(es) is/are responsible for rainwater having this range of pH values?

- 1 carbon dioxide
- 2 hydrogen
- 3 oxides of sulfur

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

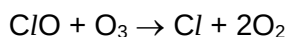
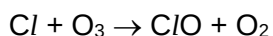
- 39** A catalytic converter is part of the exhaust system of modern cars.

Which reaction(s) occur in a catalytic converter?

- 1 $2\text{C}_8\text{H}_{18} + 25\text{O}_2 \rightarrow 16\text{CO}_2 + 18\text{H}_2\text{O}$
- 2 $2\text{CO} + 2\text{NO} \rightarrow 2\text{CO}_2 + \text{N}_2$
- 3 $\text{CO}_2 + \text{NO} \rightarrow \text{CO} + \text{NO}_2$

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

- 40** Chlorofluorocarbons (CFCs) are one of the main causes of ozone depletion. CFCs react with ozone in the atmosphere to form chlorine atoms which react with ozone molecules in a two-step process.



Which statement about ozone depletion by CFCs is true?

- A** Chlorine atoms are oxidised while ozone molecules are reduced in the overall reaction.
- B** Depletion of the ozone layer reduces the greenhouse effect because oxygen is produced.
- C** Depletion of the ozone layer is the main cause of climate change.
- D** Each chlorine atom can react with more than one molecule of ozone.

End of Paper

The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
Key proton (atomic) number atomic symbol name relative atomic mass							1 H hydrogen 1										2 He helium 4
												5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
												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
3 Li lithium 7	4 Be beryllium 9																
11 Na sodium 23	12 Mg magnesium 24	3	4	5	6	7	8	9	10	11	12						
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 —
s87 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 —

18

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
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 —

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
The Avogadro constant, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$.