Name	Reg. No	Class

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4EX

CHEMISTRY

6092/01

Paper 1 [40 marks]

PRELIMINARY EXAMINATION
August 2024
1 hour

Additional Materials: Electronic calculator

INSTRUCTIONS TO CANDIDATES:

Do not start reading the questions until you are told to do so.

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Write your name, class, and index number on the OTAS provided.

INFORMATION FOR CANDIDATES

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 **OTAS**.

Read the instructions on the OTAS 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.

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

A copy of the Periodic Table is printed on page 19

Setter: Mr Timothy Chen

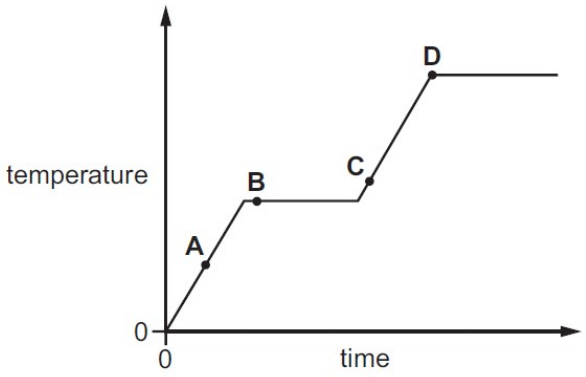
Vetter: Ms Jeevana Rani

Answer **all** questions on the **OTAS** answer sheet provided.

1 A solid substance is placed in a flask.

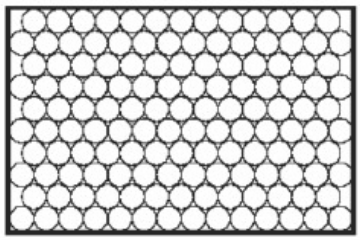
The flask is gently heated and the temperature of the substance is recorded at regular time intervals.

The diagram shows a graph of temperature against time for this experiment.

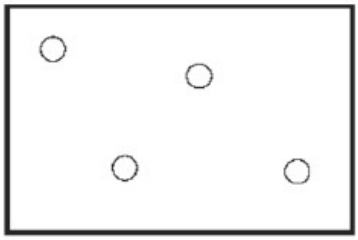


At which point does the flask contain both a solid and a liquid?

2 The diagrams below show the particles of a substance at atmospheric pressure but at two different temperatures.



at –85 °C



at –35 °C

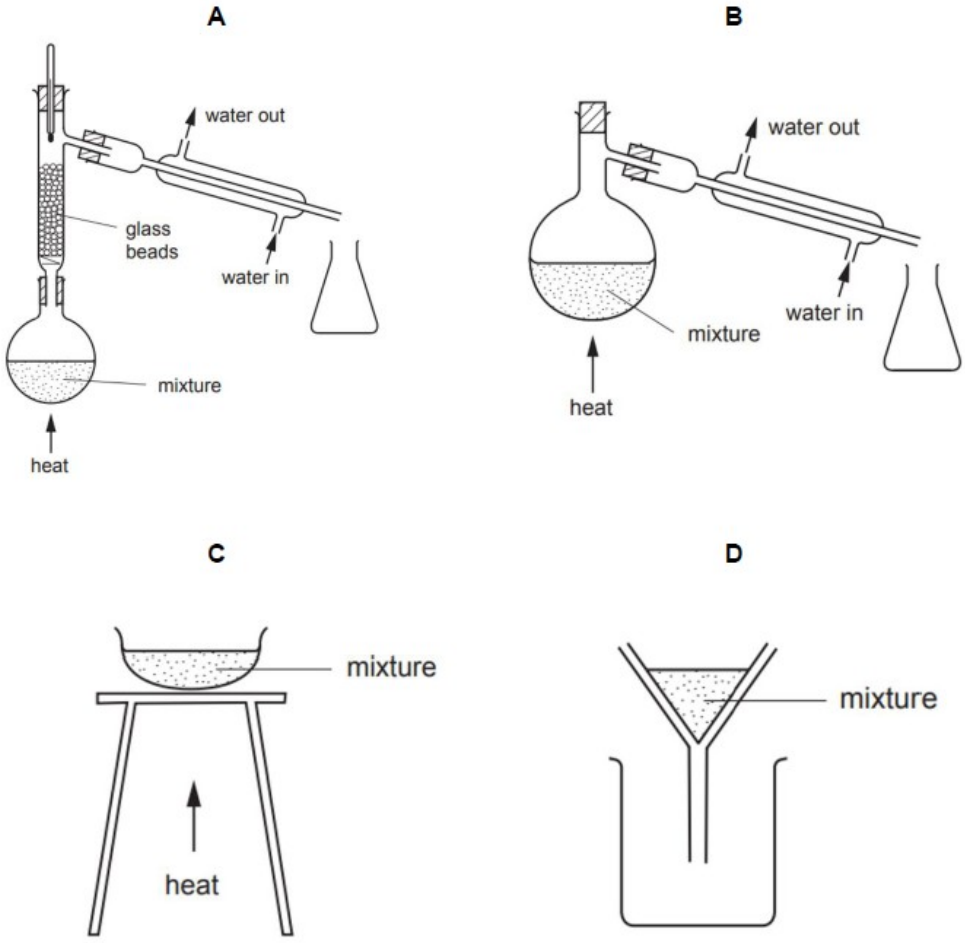
What is the melting and boiling point of the substance?

	melting point / °C	boiling point / °C
A	–80	–30
B	–80	–40
C	–85	–30
D	–85	–40

3 Some properties about substance M are as follows:

i. melting point: 42℃
ii. boiling point: 100℃
iii. does not dissolve or react when mixed with water

Which diagram shows the most suitable method to separate substance M from a mixture of M and water?

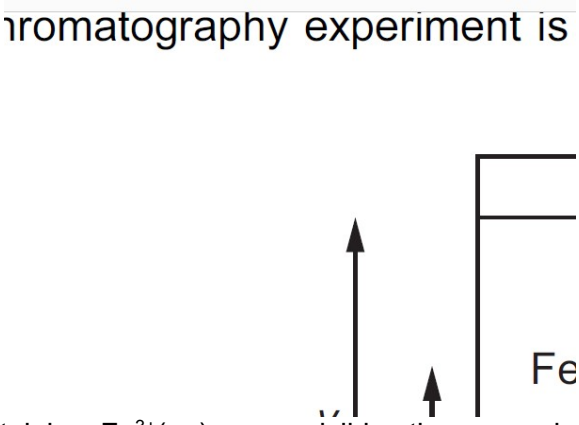


4 A pale green solution Z, gives a green precipitate with excess aqueous sodium hydroxide. An alkaline gas is only given off when the mixture is warmed with powdered aluminium.

Which ions does Z contain?

A ammonium and copper(II) ions
B ammonium and iron(II) ions
C copper(II) and nitrate ions
D iron(II) and nitrate ions

5 A paper chromatography experiment is carried out to find an Rf value for $Fe^{3+}(aq)$. The result is shown.



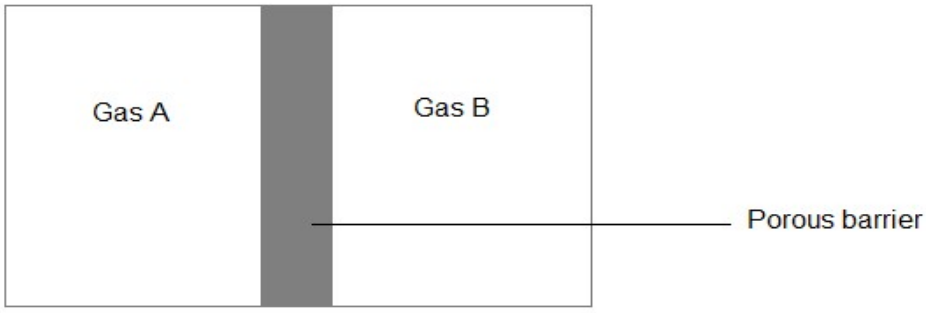
To make the spot containing $Fe^{3+}(aq)$ more visible, the paper is sprayed with aqueous sodium hydroxide so that a precipitate of iron(III) hydroxide forms.

Under the conditions of the experiment, the Rf of $Fe^{3+}(aq)$ is given by (a) and the colour of the precipitate is (b).

What accurately represents (a) and (b)?

	(a)	(b)
A	x/y	red-brown
B	x/y	green
C	y/x	red-brown
D	y/x	green

6 A student sets up the following experiment and measures the pressure in each chamber. The volumes of both chambers are the same and there is no temperature difference between them.



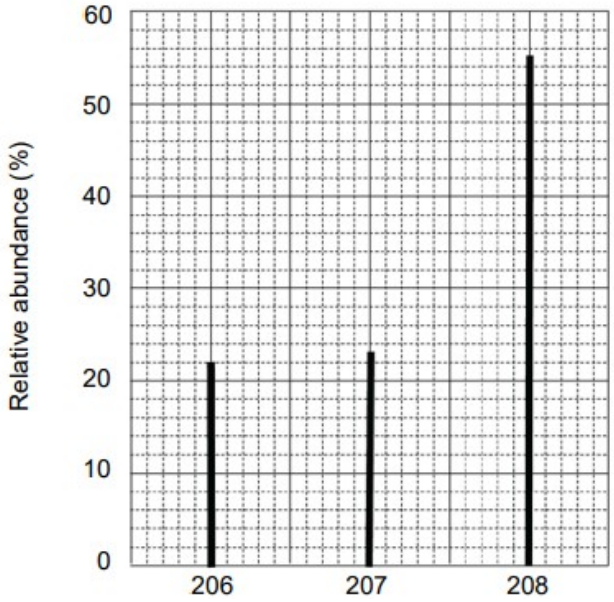
He finds that there is no change in the pressure of both chambers after 10 minutes.

Which of the following could be gases A and B?

	gas A	gas B
A	carbon monoxide	nitrogen
B	chlorine	carbon dioxide
C	hydrogen	oxygen
D	nitrogen	oxygen

7 Element T has three isotopes, ^{206}T, ^{207}T and ^{208}T.

The graph below shows the relative abundance of the three isotopes.



What is the relative atomic mass of T?

A 206.8
B 207.0
C 207.3
D 207.8

8 An ion X^{3-} has a mass number of m and n electrons.

What does the nucleus of an atom of X contain?

	number of protons	number of neutrons
A	n – 3	m – n
B	n – 3	m – (n – 3)
C	n + 3	m – (n – 3)
D	n + 3	m – (n + 3)

9 The table below shows the electronic configurations of five elements.

Element	Electronic configuration
P	2.8
Q	2.8.2
R	2.8.4
S	2.8.7

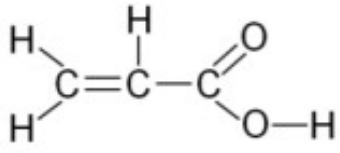
Which pair of elements combine chemically to form a compound which has a very high melting and boiling point?

A P and Q
B Q and S
C R and S
D P and S

10 Which two substances have similar molecular structures?

A carbon dioxide and sodium oxide
B diamond and methane
C silicon dioxide and diamond
D sodium chloride and potassium chloride

11 The bonding in acrylic acid can be represented by the structure shown.



What is the total number of electrons involved in covalent bonding in a molecule of acrylic acid?

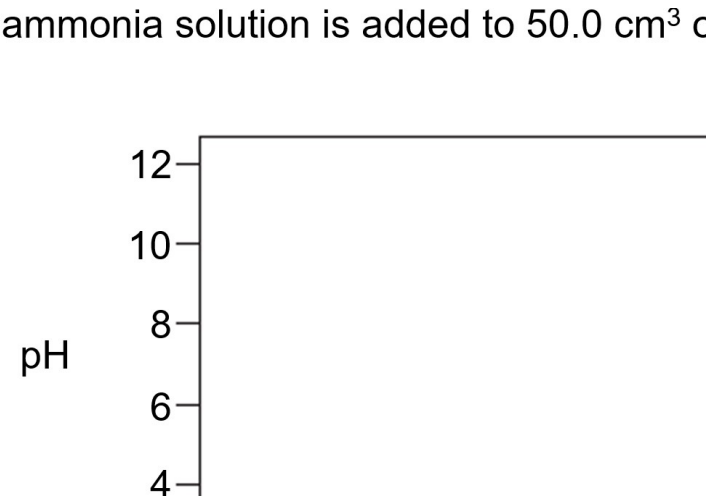
A 8
B 10
C 18
D 20

12 Solid copper metal, aqueous copper(II) sulfate, solid graphite and molten magnesium chloride will all conduct electricity.

Which pair will conduct electricity because they both contain mobile electrons?

A aqueous copper(II) sulfate and molten magnesium chloride
B aqueous copper(II) sulfate and solid copper metal
C molten magnesium chloride and solid graphite
D solid copper metal and solid graphite

13 The graph below shows the pH changes when 0.1 mol/dm^3 of aqueous ammonia solution is added to 50.0 cm^3 of 0.1 mol/dm^3 of hydrochloric acid.



Which of the following indicators is not suitable for use in determining the endpoint for the neutralisation reaction above?

	indicator	pH range of indicator
A	bromothymol blue	6.0 – 7.6
B	bromothymol red	5.2 – 6.8
C	methyl orange	3.1 – 4.4
D	phenolphthalein	8.3 – 10.0

14 Which of the following reactants when mixed produces a salt that can be obtained as a residue after filtration?

A aqueous copper(II) sulfate and aqueous sodium nitrate
B aqueous sodium hydroxide and dilute nitric acid
C dilute sulfuric acid and aqueous barium nitrate
D zinc metal and dilute hydrochloric acid

15 Analysis of a sample of a substance has the following composition by mass.

- percentage by mass of carbon is 41.9%
- percentage by mass of hydrogen is 3.1%
- percentage by mass of chlorine is 55%

What is its molecular formula?

A $C_3H_6Cl_4$
B $C_4H_9Cl_4$
C $C_8H_4Cl_9$
D $C_9H_8Cl_4$

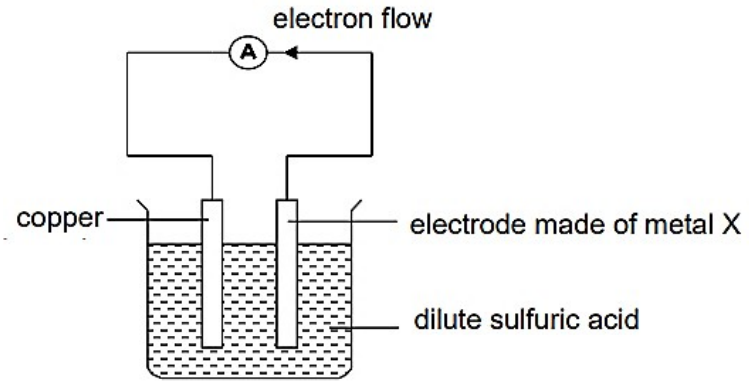
16 Three electrolytic cells are set up using inert electrodes. The electrolytes used are listed below.

cell 1: concentrated aqueous potassium chloride
cell 2: dilute sulfuric acid
cell 3: dilute copper (II) chloride

In which of these cell(s) is/are gases formed at both electrodes?

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

17 In the set-up below, a copper electrode, an electrode made of metal X and dilute sulfuric acid are used to produce electrical energy.



With reference to the set-up, which of the following statements is correct?

A Metal X is below copper in the reactivity series.
B The copper electrode is the negative electrode.
C The mass of the copper electrode decreases.
D The mass of the metal X electrode decreases.

18 In which pair of compounds does the underlined element have the same oxidation state?

A $\underline{Fe}I_2$ and $\underline{Fe}(OH)_3$
B $\underline{Mn}O_2$ and $\underline{Mn}Cl_2$
C $NaCl$ and $PbCl_2$
D $\underline{N}H_3$ and $\underline{N}O_2$

19 Chemical Z is a powerful reducing agent.

Which statement about Z is correct?

A Z decolourises acidified potassium manganate(VII) and gains electrons in the process.
B Z decolourises acidified potassium manganate(VII) and loses electrons in the process.
C Z reacts with aqueous potassium iodide producing a brown solution and gains electrons in the process.
D Z reacts with aqueous potassium iodide producing a brown solution and loses electrons in the process.

20 A reversible reaction gives out 196 kJ/mol in the forward direction and the activation energy for the forward direction is +75 kJ/mol as well.

What is the activation energy of the reverse direction?

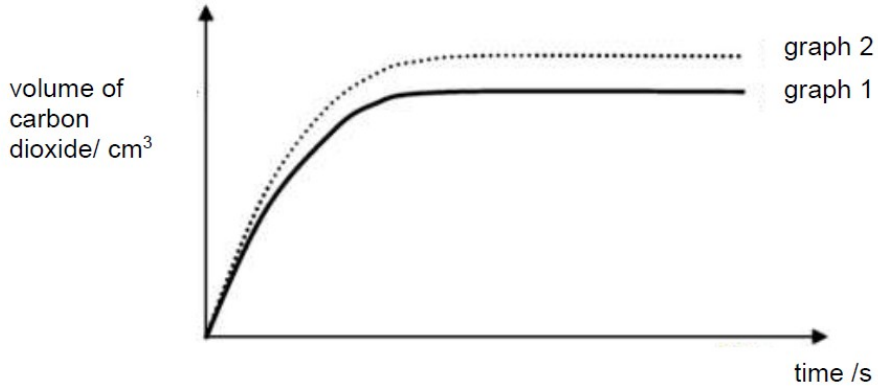
A +75 kJ/mol
B +121 kJ/mol
C +196 kJ/mol
D +271 kJ/mol

21 Which of the following acids and the quantity stated will produce the fastest initial rate of reaction when 4.00 g of magnesium ribbon is added to it at room temperature and pressure?

A 15.0 cm^3 of 2.00 mol/dm^3 nitric acid
B 20.0 cm^3 of 1.00 mol/dm^3 hydrochloric acid
C 20.0 cm^3 of 1.50 mol/dm^3 sulfuric acid
D 30.0 cm^3 of 2.00 mol/dm^3 ethanoic acid

22 In an experiment, an excess of 2 mol/dm^3 dilute hydrochloric acid was reacted with 50 cm^3 of 1 mol/dm^3 aqueous potassium carbonate.

The results of the experiment are shown in graph 1.



Which of the following changes to graph 1 would produce graph 2?

A adding a catalyst to the reaction mixture
B adding a small amount of solid potassium carbonate to the reaction mixture
C adding water to the reaction mixture
D increasing the concentration of hydrochloric acid

23 Which row shows the most suitable reaction to prepare the given salt?

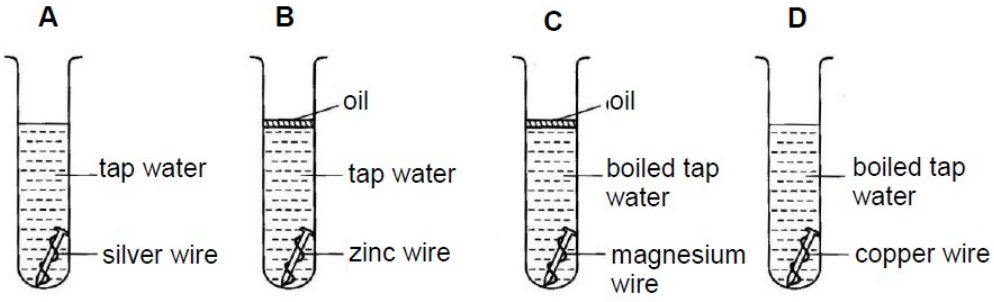
	salt	reaction
A	calcium sulfate	calcium chloride + sulfuric acid
B	copper(II) fluoride	copper + hydrofluoric acid
C	silver carbonate	silver + copper(II) carbonate
D	sodium chloride	sodium nitrate + silver chloride

24 A sample of an alloy containing two metals was subjected to the following tests.

What are the two metals present in the alloy?

A copper and zinc
B iron and copper
C iron and lead
D iron and zinc

25 An iron nail is placed in four different test tubes.



Which test tube would the iron nail rust the least?

26 The carbonates of four metals **P**, **Q**, **R** and **S** are heated to the same temperature. The results of the experiments are shown in the table below.

carbonates of	products of thermal decomposition
P	metal oxide and carbon dioxide
Q	no visible change
R	metal and carbon dioxide
S	metal oxide and carbon dioxide

When metal **S** reacts with steam, a bright white glow is observed. However, metal **P** is not affected by steam.

What is the correct order of reactivity of the four metals?

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

27 Lithium reacts with water to form solution P and gas Q.
When solution P reacts with hydrochloric acid, salt R is formed.

What are the formulae of P, Q and R?

	P	Q	R
A	Li_2O	H_2	$LiCl$
B	Li_2O	O_2	Li_2Cl
C	LiOH	H_2	$LiCl$
D	LiOH	O_2	Li_2Cl

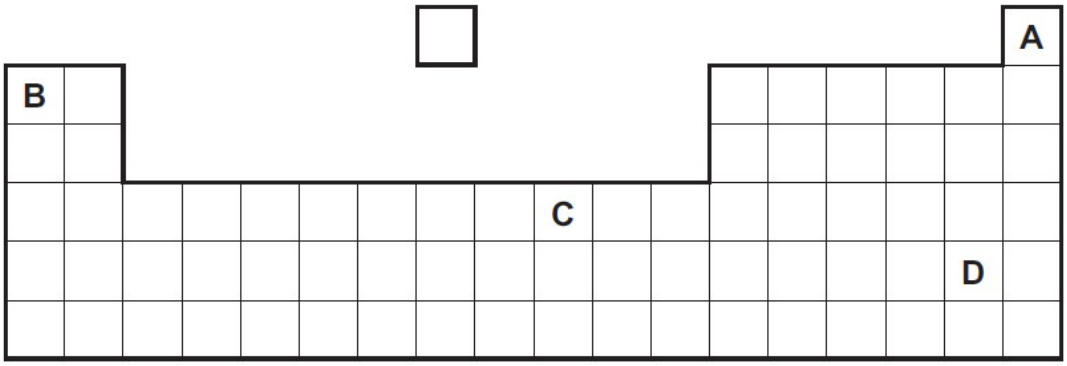
28 The results of three halogen displacement experiments are shown in the table.

experiment	halogen added	halide solution		
		X^-	Y^-	Z^-
1	X_2	–	Y_2 displaced	Z_2 displaced
2	Y_2	no reaction	–	no reaction
3	Z_2	no reaction	Y_2 displaced	–

What are halogens X, Y and Z?

	X	Y	Z
A	Br	C*l*	I
B	Br	I	C*l*
C	C*l*	Br	I
D	C*l*	I	Br

29 An element melts at 1455 ºC, has a density of 9.0 g/cm3 and forms both green and yellow chloride.



Where in the Periodic Table is this element found?

30 The rusting of iron can be prevented by coating the iron with another material.

Which statement explains why coating with zinc is more effective than painting?

A If the coating is damaged, zinc corrodes instead of iron.
B Iron is above zinc in the reactivity series.
C Zinc does not react with air or with water.
D Zinc forms an unreactive alloy coating with iron.

31 The list shows the position of metal X in the reactivity series of metals.

Na Al Fe X Cu Ag

Some methods to extract metals are shown below:

1 electrolysis of the solid metal oxide
2 heating the metal oxide with carbon
3 heating the metal oxide with copper

Which could be used to extract metal X?

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

32 Some statements on the Haber Process are shown below

1 Ammonia is liquefied after being formed.
2 Hydrogen is obtained from fractional distillation of liquid air.
3 The reaction is reversible.
4 The reaction involves the use of a compound of transition metal.

Which statements are true?

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

33 1 volume of gas X undergoes complete combustion with exactly 5 volumes of oxygen to produce carbon dioxide and water only.

What is gas X?

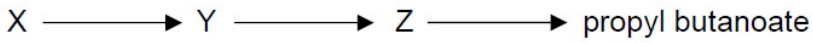
A butane
B ethane
C methane
D propane

34 A pure fat molecule has a relative molecular mass of 300.
75 g of the fat reacts with 320 g aqueous bromine.

How many double bonds are there in each fat molecule?

A 2
B 3
C 4
D 8

35 Propyl butanoate is prepared from compound X in a sequence of three reactions, one of which is oxidation.



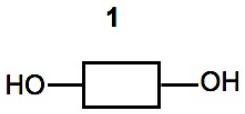
What is compound X?

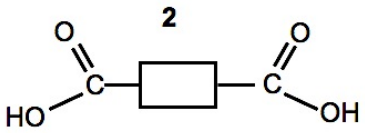
A butanol
B butene
C propanol
D propene

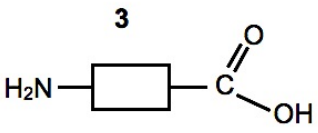
36 In the addition polymer poly(propene), what is the simplest ratio of carbon atoms to hydrogen atoms?

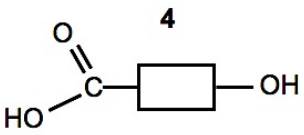
	carbon atoms	hydrogen atoms
A	1	2
B	2	1
C	2	3
D	2	5

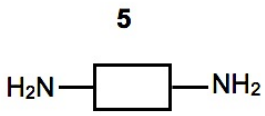
37 The structures of five monomers are shown.



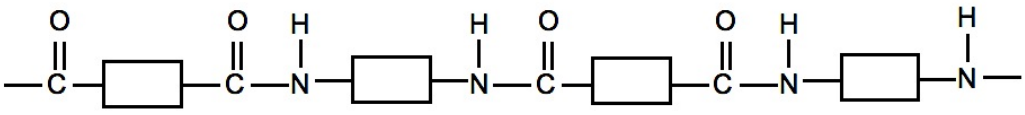








Which pair of monomers will form a polyamide with the following structure?



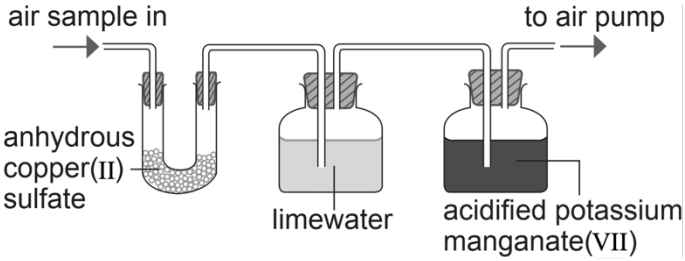
A 1 and 3
B 2 and 3
C 2 and 5
D 4 and 5

38 The table refers to the polymers nylon and poly(ethene).

Which row is correct?

	polymer	type	use
A	nylon	addition	cling film
B	nylon	condensation	parachutes
C	poly(ethene)	addition	parachutes
D	poly(ethene)	condensation	cling film

39 A sample of air was passed through the following set-up.



The anhydrous copper(II) sulfate turned blue, a white precipitate was observed in the limewater, and the acidified potassium manganate(VII) turned colourless.

Which set of gases was present in the sample of air?

A carbon dioxide, oxygen and nitrogen
B carbon dioxide, sulfur dioxide and water vapour
C carbon monoxide, nitrogen and sulfur dioxide
D carbon monoxide, nitrogen dioxide and sulfur dioxide

40 Some statements about the catalytic converters are shown below.

1 carbon monoxide can only be removed by the equation $2CO + 2NO \rightarrow N_2 + CO_2$.
2 carbon monoxide is the oxidizing agent used to remove oxides of nitrogen.
3 The gases produced in the catalytic converter can be an environmental issue.
4 Unburnt hydrocarbons are removed by catalytic converters.

Which of the following are true?

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

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											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 –

Key

proton (atomic) number
atomic symbol
name
relative atomic mass

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}