

NORTHBROOKS SECONDARY SCHOOL
Preliminary Examination 2023
Secondary 4 Express



CANDIDATE NAME			
CLASS		INDEX NUMBER	

CHEMISTRY

6092/01

Paper 1

15 September 2023

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.

Write in soft pencil.

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

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 Multiple Choice Answer Sheet.

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 16.

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

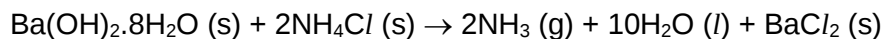
DO NOT TURN THE PAGE UNTIL YOU ARE TOLD TO DO SO.

This document consists of 16 printed pages.

Setter: Miss Agnes Mok

Use the following information to answer Questions 1 and 2.

When solid hydrated barium hydroxide is added to a known quantity of solid ammonium chloride, the temperature of the mixture decreases. The chemical reaction is represented by the balanced chemical equation shown below.



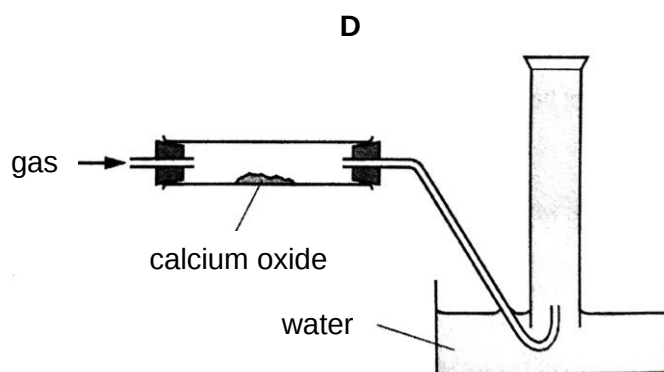
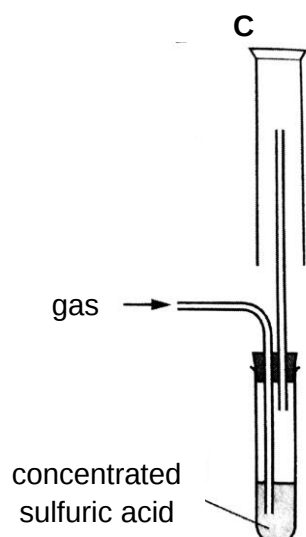
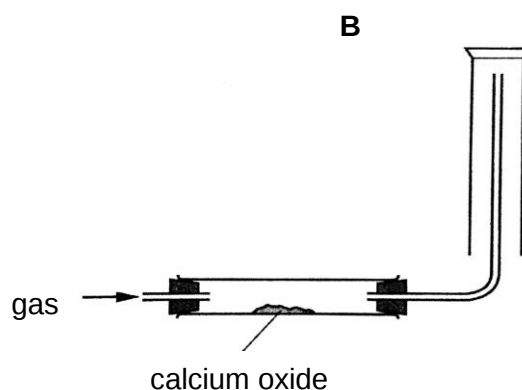
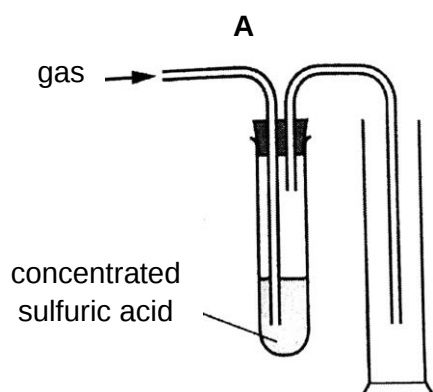
- 1 An experiment is designed to measure the temperature change when all the solid hydrated barium hydroxide reacts with the ammonium chloride. The following pieces of apparatus are available.

- 1 gas syringe
- 2 stopwatch
- 3 electronic mass balance
- 4 Styrofoam cup

Other than a thermometer, which piece(s) of apparatus is(are) needed for this experiment?

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

- 2 Which diagram shows the correct way of drying and collecting the gas produced?



- 3** Caffeine is a white solid that melts at 235 °C. A sample of impure caffeine is found to be contaminated with sugar.

Propanone is an organic solvent with a low boiling point. Caffeine and sugar have different solubilities in water and propanone.

substance	solubility in water	solubility in propanone
caffeine	moderate	high
sugar	high	insoluble

The following steps could be carried out to obtain pure caffeine from a mixture of caffeine and sugar.

- I add excess water
- II add excess propanone
- III cool and crystallise
- IV filter the mixture
- V heat the filtrate

In what order should the steps be carried out?

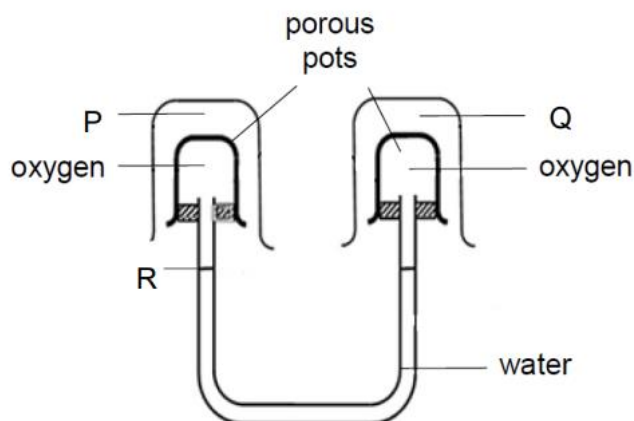
- A** I, IV, III and V
 - B** I, IV, V and III
 - C** II, IV, III and V
 - D** II, IV, V and III
- 4** R_f values are used to identify unknown substances using paper chromatography. Which statements about R_f values are correct?
- 1 R_f values are always less than 1.0.
 - 2 R_f value = distance travelled by solvent $\div$ distance travelled by unknown substance.
 - 3 The higher the R_f value, the further the unknown substance travels.
 - 4 R_f value is not affected by the solubility of the unknown substance.
- A** 1 and 2 only
 - B** 1 and 3 only
 - C** 2 and 3 only
 - D** 3 and 4 only
- 5** Substance M melts at -7.0 °C and is a brown liquid at room temperature.
- At which temperature(s) will pure M boil?
- A** -77.0 °C
 - B** -7.0 °C to 7.0 °C
 - C** 48.0 °C to 65.0 °C
 - D** 59.0 °C

- 6 An aqueous solution of zinc sulfate is tested by adding reagents.

Which observation is correct?

	reagent added to zinc sulfate	result
A	aqueous sodium hydroxide	forms a white precipitate, soluble in excess of the reagent
B	aqueous ammonia	forms white precipitate, insoluble in excess of the reagent
C	acidified aqueous barium nitrate	forms a yellow precipitate
D	powdered copper	forms a grey precipitate

- 7 The diagram shown is set up using different gases in two beakers P and Q. The inverted smaller beakers both contain oxygen gas.



Which gases, when placed in beakers P and Q respectively, will cause the water level at R to rise initially?

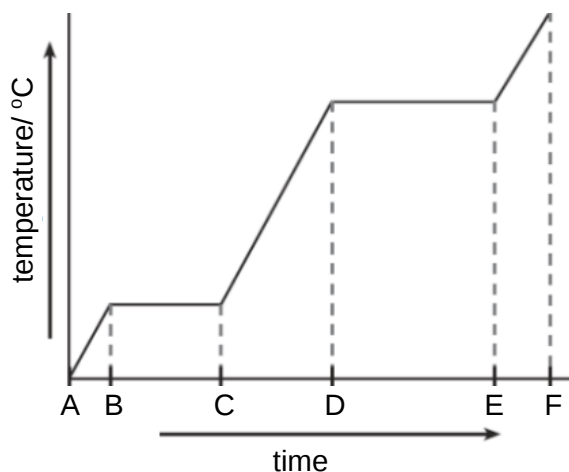
	P	Q
A	ammonia	nitrogen
B	argon	oxygen
C	carbon dioxide	nitrogen
D	oxygen	carbon dioxide

- 8 The table below shows information about elements flerovium, *Fl*, and livermorium, *Lv*.

element	<i>Fl</i>	<i>Lv</i>
proton number	114	116
nucleon number	289	292

Which statement about the elements is correct?

- A A Lv^{2+} ion has the same number of electrons as an atom of *Fl*.
B A Fl^{2+} ion has the same number of protons as an atom of *Lv*.
C An atom of *Fl* has two more electrons as an atom of *Lv*.
D An atom of *Lv* has one fewer neutron than an atom of *Fl*.
- 9 A sample of a pure solid substance was heated until it turns completely gaseous. The graph below shows the heating curve obtained from the experiment.



Which statement is **not** correct?

- A At time interval AB, the average kinetic energy of the particles remains the same.
B At time interval BC, the substance exists in both solid and liquid states.
C At time interval CD, heat is absorbed by the particles.
D At time interval EF, the particles are moving rapidly in any direction.
- 10 Naturally-occurring bromine has a relative atomic mass of 80 and consists entirely of two isotopes of relative atomic masses 79 and 81.

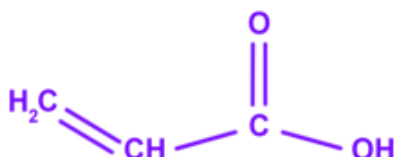
What can be deduced about naturally-occurring bromine from the given information?

- A Bromine is radioactive.
B Bromine has different oxidation states.
C Bromine isotopes have different number of protons.
D Bromine contains the two isotopes in equal proportions.

11 Which statement about metals is correct?

- A Layers of electrons can slide over one another making metals malleable.
- B Metals consist of a lattice of positive ions in a sea of delocalised electrons.
- C Metals consist of a lattice of positive ions in a sea of delocalised negative ions.
- D Metals conduct electricity because positive ions are free to move.

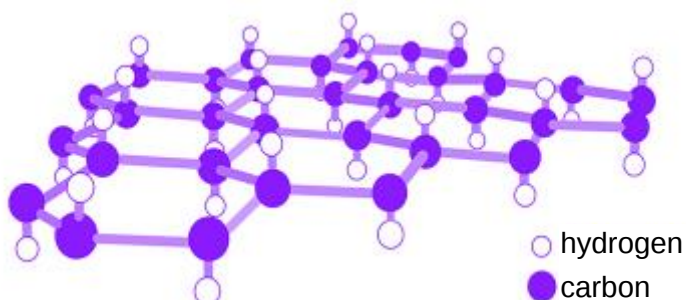
12 Poly(acrylic acid) is a very absorbent organic compound used in diapers. The structure of the monomer, acrylic acid, is shown below.



How many **outer** shell electrons of acrylic acid are **not** involved in bonding?

- | | | | |
|---|----|---|----|
| A | 0 | B | 8 |
| C | 18 | D | 20 |

13 Graphane, an allotrope of carbon, has a structure similar to graphite. Graphane, however, has one hydrogen atom attached to each carbon as shown in the diagram.



Which set of properties will graphane have?

- 1 It is soluble in water.
 - 2 It has a high melting point.
 - 3 It has a giant covalent structure.
 - 4 It conducts electricity in the solid state.
- A 1 and 2 only
B 2 and 3 only
C 1, 2 and 3 only
D 1, 2, 3 and 4

- 14 The chemical formula of sodium chlorate(VII) is NaClO_3 and the chemical formula of thallium chlorate(VII) is $\text{Tl}(\text{ClO}_3)_3$.

What is the chemical formula of thallium sulfate?

- A TlSO_4
B Tl_3SO_4
C $\text{Tl}(\text{SO}_4)_2$
D $\text{Tl}_2(\text{SO}_4)_3$
- 15 Which quantity contains the least number of atoms?
- A 0.6 moles of oxygen gas
B 0.75 moles of lithium
C 0.25 moles of ammonia
D 0.25 moles of methane

- 16 N_2O_4 is a poisonous gas. It can be removed safely by reaction with aqueous sodium hydroxide.



What is the minimum volume of 0.8 mol/dm^3 aqueous sodium hydroxide needed to remove 0.02 mol of N_2O_4 ?

- A 12.5 cm^3
B 25.0 cm^3
C 50.0 cm^3
D 100.0 cm^3
- 17 Which pair of statements **correctly** describes the differences between the conduction of electricity by electrolytes and the conduction of electricity by metals during electrolysis?

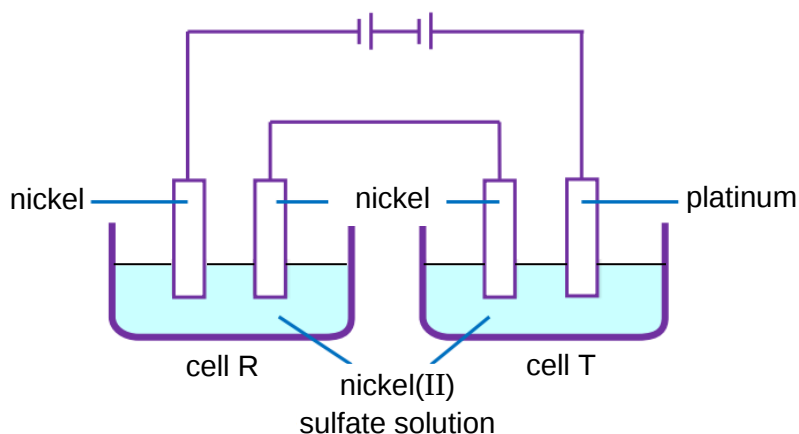
	conduction by electrolytes	conduction by metals
1	the current is due to the movement of ions	the current is due to the movement of positive ions and electrons
2	charged particles move towards both electrodes	charged particles move in one direction only
3	it never results in a chemical change	it never results in a chemical change

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

18 A current is passed through two electrolytic cells, R and T, for some time.

The electrolyte in both cells is green nickel(II) sulfate solution of the same concentration. Cell R has two nickel electrodes, while Cell T has a nickel and a platinum electrode.

The results are summarised in the table below.



cell	cathode	anode
R	5.0 g of nickel is deposited.	Nickel dissolves.
T	Nickel is deposited.	Oxygen is evolved.

Which statement about the reaction above is **not** true?

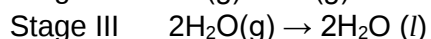
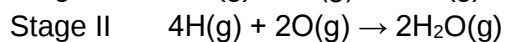
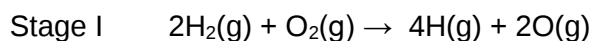
- A** The oxygen evolved at the anode of cell T does not burn the platinum.
- B** The cathode in cell R increases in mass by 5.0 g.
- C** The concentration of the nickel(II) sulfate solution in cell R decreases.
- D** The green colour of the nickel(II) sulfate solution in cell T fades slowly and eventually disappears.

19 The table shows the energy released by the complete combustion of some compounds used as fuels.

Which fuel produces the most energy when 1 g of the compound is completely burned?

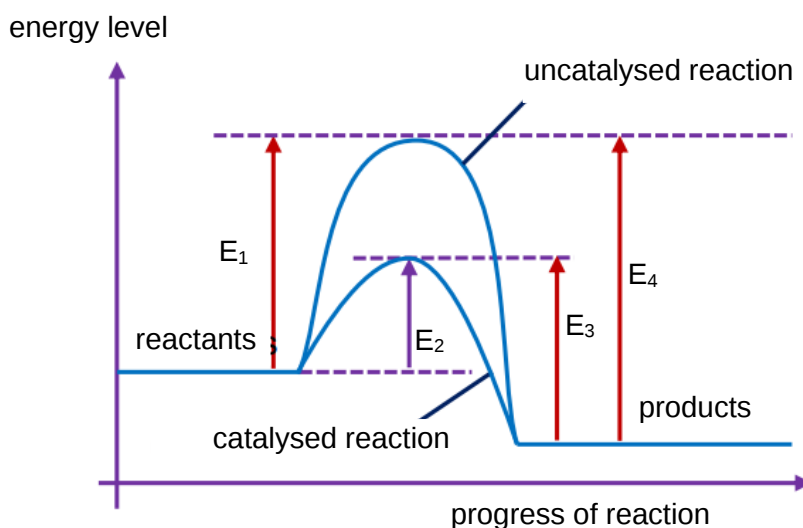
	compound	M_r	ΔH in kJ/mol
A	methane	16	-880
B	ethanol	46	-1380
C	propane	44	-2200
D	heptane	100	-4800

- 20 Hydrogen is a clean fuel which burns to form only water. This process may occur in three stages.



Which stages are endothermic?

- A I only
B II only
C II and III only
D I and III only
- 21 The energy profile diagram below shows a reversible reaction that occurred in the absence, and in the presence, of a catalyst.



Which statement is correct when describing the energy changes involved in the reactions?

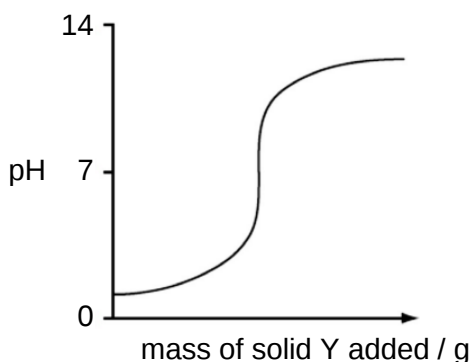
- A The forward catalysed reaction is endothermic.
B $(E_4 - E_1)$ is the enthalpy change of the reverse reaction.
C E_2 is the activation energy for the reverse catalysed reaction.
D The enthalpy change of the reaction is decreased by using a catalyst.
- 22 What modification to a catalytic converter would result in lower concentrations of nitrogen oxides?
- A Using smaller exhaust pipes.
B A higher temperature of combustion in the engines.
C An increase in the rate of flow of gas through the converter.
D An increase in the surface area of the catalyst in the converter.

- 23 The table below shows the colour changes when a few drops of aqueous potassium iodide and acidified aqueous potassium manganate (VII) were added separately into four different solutions.

solution	potassium iodide	potassium manganate(VII)
1	colourless to brown	purple to colourless
2	colourless to brown	no change
3	no change	purple to colourless
4	no change	no change

Which solutions is/are oxidising agent(s)?

- A 1 only
 B 1 and 2
 C 1 and 3
 D 4 only
- 24 Which of the following is **not** a redox reaction?
- A $2\text{Ag} + \text{Br}_2 \rightarrow 2\text{AgBr}$
 B $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$
 C $\text{Fe} + 2\text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2$
 D $\text{Na}_2\text{CO}_3 + \text{CuCl}_2 \rightarrow 2\text{NaCl} + \text{CuCO}_3$
- 25 Solid Y was added bit by bit with stirring to an aqueous solution of Z. The changes in pH of the mixture are shown in the graph.



Identify Y and Z.

	Y	Z
A	soluble metal oxide	hydrochloric acid
B	soluble metal oxide	ethanoic acid
C	insoluble metal oxide	nitric acid
D	insoluble metal oxide	aqueous ammonia

- 26** Three elements represented by the letters, X, Y and Z, are in the same period in the Periodic Table.

The oxide of X dissolves in water to form a solution with a pH 12.5. The oxide of Y forms a solution with a pH less than 4.5. The oxide of Z is soluble in both aqueous potassium hydroxide and dilute nitric acid.

Which of the following shows the position of the elements in order of decreasing atomic number?

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

- 27** While performing some simple experiments, a student recorded the following observations.

- no fizzing
- solution changes colour
- no precipitate forms

Which two reactants have the student mixed?

	reactant 1	reactant 2
A	dilute sulfuric acid	potassium carbonate
B	aqueous sodium hydroxide	aqueous copper(II) sulfate
C	aqueous sodium sulfate	aqueous barium chloride
D	warm sulfuric acid	copper(II) oxide

- 28** Farmers should not add calcium hydroxide and ammonium fertilisers at the same time.

What is the reason?

- A** Calcium hydroxide causes the soil to be more alkaline.
- B** Calcium hydroxide increases the absorption of nitrogen to the soil.
- C** Calcium hydroxide displaces ammonia from ammonium fertiliser.
- D** Calcium hydroxide reacts with the ammonium fertiliser to form insoluble compounds and this prevent the absorption of nitrogen by plants.

- 29** A new indicator has just been produced in the laboratory. It changes colours according to the table below:

pH	colour
0 – 3	red
4 – 7	green
8 – 14	dark blue

Which pair of substances can this indicator be used to distinguish?

- A** aqueous sodium chloride and water
 - B** aqueous ammonia and sodium hydroxide
 - C** aqueous sodium nitrate and sodium hydroxide
 - D** dilute hydrochloric acid and dilute sulfuric acid
- 30** In the Periodic Table, how does the metallic character of the elements vary from left to right across a period?
- A** It decreases.
 - B** It increases.
 - C** It increases then decreases.
 - D** It stays the same.
- 31** Which statement about alloys is correct?
- A** They can all be represented by a chemical formula.
 - B** Their structures contain a 'sea' of electrons.
 - C** They are good conductors of electricity as they have mobile ions.
 - D** They are formed by chemically combining two metals.
- 32** Metal M will displace iron from aqueous iron(II) sulfate solution but not calcium from calcium nitrate. M is extracted from its oxide by electrolysis. M reacts with water.

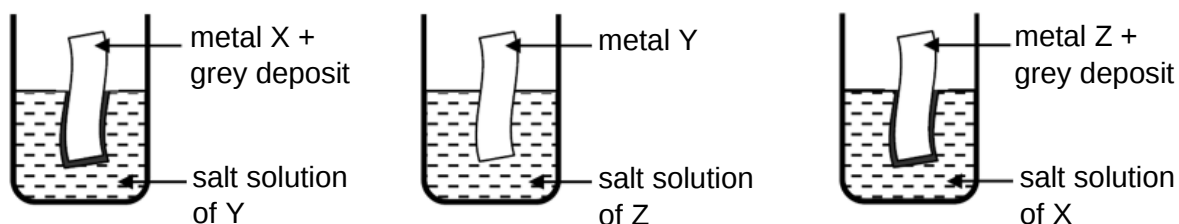
What could M be?

- A** magnesium
- B** zinc
- C** sodium
- D** aluminium

- 33** Pieces of metal X, Y and Z are dipped into three salt solutions.

The results after half an hour are shown in the diagrams below.

Metals X and Z are coated with a layer of shiny grey deposit but metal Y stays the same.



Which of the following lists the metals in order of decreasing reactivity?

- A** X, Y, Z
B Y, X, Z
C Z, X, Y
D Z, Y, X
- 34** Iron is extracted from its ore, haematite, in a blast furnace.
Which statement about the extraction process is correct?
- A** At the bottom of the blast furnace, a layer of molten iron floats on top of a layer of molten slag.
B More iron can be obtained from haematite than recycling scrap steel of the same mass.
C Nitrogen leaves the blast furnace as a waste gas.
D When air is blown into the blast furnace to react with coke, the temperature inside the blast furnace decreases.
- 35** Cars are installed with either diesel or petrol engines. The combustion of fuels such as diesel and petrol produces air pollutants.

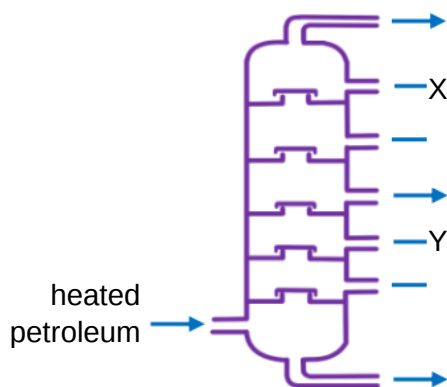
The table shows the mass of air pollutants found in exhaust fumes when 1 kg of each fuel is combusted under identical conditions.

air pollutant produced	mass of air pollutant after diesel is combusted / g	mass of air pollutant after petrol is combusted / g
carbon monoxide	15	300
unburnt hydrocarbons	20	25
oxides of nitrogen	95	40

Which of the following can be inferred from the above data?

- A** A diesel engine has a higher temperature than a petrol engine.
B Burning of petrol contributes more towards formation of acid rain.
C Combustion of petrol is more exothermic than that of diesel.
D Petrol requires less oxygen for complete combustion.

36 The diagram shows the fractional distillation of petroleum.



Which statements about fraction X and Y are correct?

	X is less flammable than Y	X burns with a less sooty flame than Y	X is more viscous than Y
A	yes	no	no
B	yes	yes	yes
C	no	yes	no
D	no	no	yes

37 Under certain conditions, 1 mole of ethane reacts with chlorine. Which is **not** a possible product of this reaction?

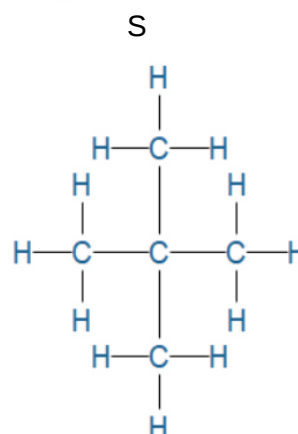
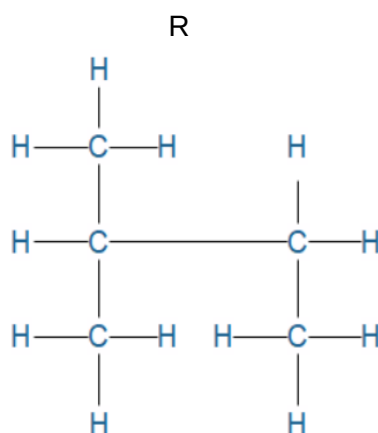
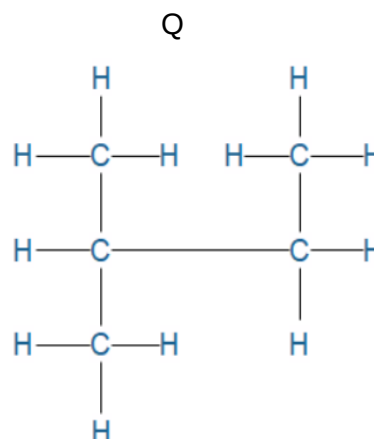
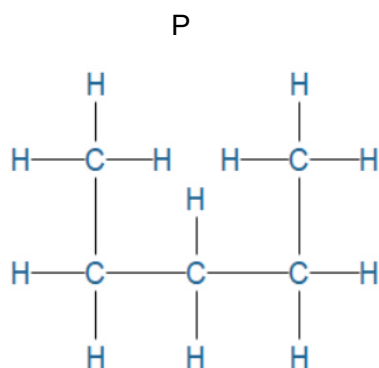
- A** $\text{C}_2\text{H}_4\text{Cl}_2$
- B** $\text{C}_2\text{H}_2\text{Cl}_4$
- C** $\text{C}_2\text{H}_2\text{Cl}_2$
- D** C_2Cl_6

38 5 g of vegetable oil ($M_r = 800$) reacted completely with 900 cm^3 of hydrogen gas (measured at room temperature and pressure) to form margarine which is a saturated fat.

How many carbon-carbon double covalent bonds are there in one molecule of the oil?

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

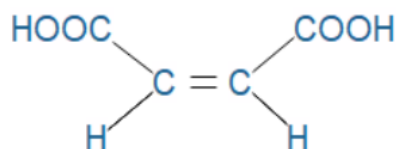
39 Four structural formulae are shown below.



Which formulae are isomers of each other?

- A P and Q only
- B Q and R only
- C P, Q, and R only
- D P, R, and S only

40 The structure shown below represents maleic acid, which is found in some fruits.



Which statement is true?

- A It can undergo addition polymerisation with $\text{HN}_2\text{CH}_2\text{CH}_2\text{NH}_2$.
- B It can undergo condensation polymerisation with $\text{CH}_3\text{CH}_2\text{OH}$.
- C When maleic acid undergoes addition polymerisation, it loses water molecules.
- D When maleic acid undergoes addition polymerisation, the product is able to react with aqueous sodium carbonate.

End of Paper

The Periodic Table of Elements

Group																																																																						
I	II											III	IV	V	VI	VII	0																																																					
Key proton (atomic) number atomic symbol name relative atomic mass												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	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
		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 –			114 Fl flerovium –			116 Lv livermorium –																																																		
lanthanoids																																																																						
actinoids																																																																						
<table><tr><td>57 La lanthanum 139</td><td>58 Ce cerium 140</td><td>59 Pr praseodymium 141</td><td>60 Nd neodymium 144</td><td>61 Pm promethium –</td><td>62 Sm samarium 150</td><td>63 Eu europium 152</td><td>64 Gd gadolinium 157</td><td>65 Tb terbium 159</td><td>66 Dy dysprosium 163</td><td>67 Ho holmium 165</td><td>68 Er erbium 167</td><td>69 Tm thulium 169</td><td>70 Yb ytterbium 173</td><td>71 Lu lutetium 175</td></tr><tr><td>89 Ac actinium –</td><td>90 Th thorium 232</td><td>91 Pa protactinium 231</td><td>92 U uranium 238</td><td>93 Np neptunium –</td><td>94 Pu plutonium –</td><td>95 Am americium –</td><td>96 Cm curium –</td><td>97 Bk berkelium –</td><td>98 Cf californium –</td><td>99 Es einsteinium –</td><td>100 Fm fermium –</td><td>101 Md mendelevium –</td><td>102 No nobelium –</td><td>103 Lr lawrencium –</td></tr></table>																			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 –																						
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 –																																																								

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

europlum

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

–

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.)