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Class:

**WOODLANDS SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024**

Level: Secondary 4 Express

Marks: 40

Subject: Pure Chemistry

Day: Tuesday

Paper: 6092/01

Date: 20 August 2024

Duration: 1 hour

Time: 1030 – 1130 hours

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.

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.

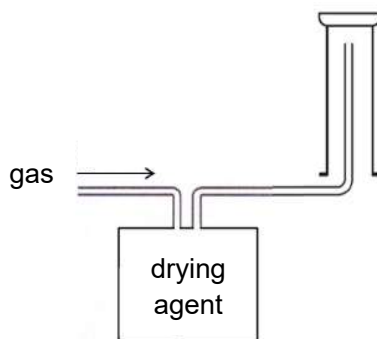
Any rough working should be done in this booklet.

A copy of the Periodic Table is printed on page 20.

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

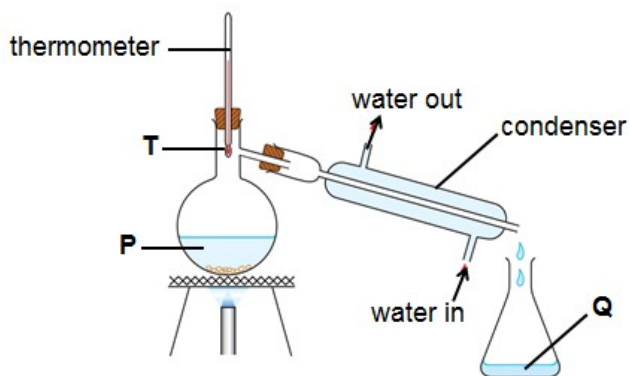
FOR EXAMINER'S USE**Total****/40****DO NOT TURN THE PAGE UNTIL YOU ARE TOLD TO DO SO.**This document consists of **19** printed pages and 1 blank page.

- 1 Which row shows the correct drying agent and the corresponding gas that can be collected by upward delivery into a gas jar as shown in the set-up below?



	drying agent	gas collected
A	anhydrous calcium oxide	carbon dioxide
B	anhydrous calcium oxide	ammonia
C	concentrated sulfuric acid	sulfur dioxide
D	concentrated sulfuric acid	chlorine

- 2 The diagram below shows the apparatus used to obtain pure water from aqueous iron(II) sulfate.



Which statement about the separation process is true?

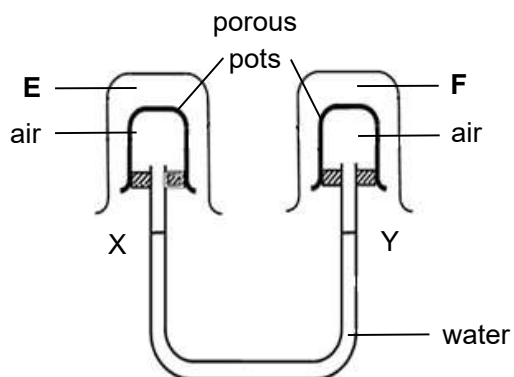
- A** Liquid **Q** is pale green in colour.
- B** Liquid **P** becomes lighter in colour.
- C** The temperature at **T** steadily rises as liquid **Q** is being collected.
- D** The concentration of iron(II) sulfate in liquid **P** increases as liquid **Q** is being collected.

- 3 A mixture of propane, butane, hydrogen sulfide and carbon dioxide at $-30\text{ }^{\circ}\text{C}$ is allowed to cool down gradually to $-200\text{ }^{\circ}\text{C}$.

compound	melting point / $^{\circ}\text{C}$	boiling point / $^{\circ}\text{C}$
propane	-188	-42
butane	-135	-1
hydrogen sulfide	-85	-51
carbon dioxide	-78	-78

Which compound can be solidified first?

- A** butane
B carbon dioxide
C hydrogen sulfide
D propane
- 4 The apparatus shown is set up using different gases in the beakers.



Which gases, when placed into **E** and **F** respectively, will cause the water level at X to fall initially?

	E	F
A	oxygen	helium
B	oxygen	nitrogen
C	helium	oxygen
D	nitrogen	helium

- 5 Two substances **P** and **Q** are heating and its changes on heating are recorded below.

substance P
P , a brown liquid, which separates into a few liquids with different boiling points using fractional distillation.

substance Q
Q , a colourless liquid, breaks down into hydrogen gas and oxygen gas using electricity.

Which classification is correct?

	P	Q
A	compound	element
B	element	mixture
C	mixture	compound
D	mixture	mixture

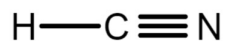
- 6 The table shows details of the particles present in an atom of potassium and in ions of potassium and phosphorous.

formula	atomic number	nucleon number	number of neutrons	number of electrons
K	19	39	W	19
K ⁺	19	39	20	X
P ³⁻	15	Y	16	Z

What are the values of **W**, **X**, **Y** and **Z**?

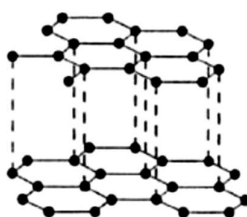
	W	X	Y	Z
A	19	20	28	12
B	19	19	34	18
C	20	18	31	18
D	20	20	28	12

- 7 How many electrons are **not** used in bonding in the molecule below?

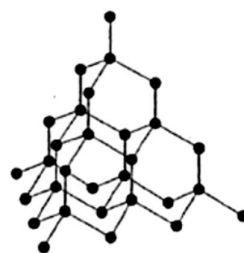


- A 4
B 5
C 6
D 8

- 8 The diagrams show the structures of two forms of carbon.



S



T

Which set of data is correct for these two structures?

	conducts electricity	very hard material	can be used as a lubricant
A	S	S	T
B	S	T	S
C	T	S	T
D	T	T	S

- 9 Two statements about the structure and properties of metals are given.

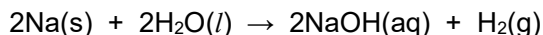
statement 1: Metals are malleable and have high melting points.

statement 2: Metals have mobile electrons in their structure.

Which statement is correct?

- A Both statements are correct and statement 2 explains statement 1.
B Both statements are correct but statement 2 does not explain statement 1.
C Statement 1 is correct but statement 2 is incorrect.
D Statement 2 is correct but statement 1 is incorrect.

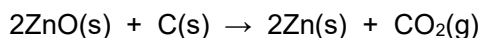
- 10 The equation for the reaction between sodium and water is shown.



What volume of hydrogen is produced when 2.30 g of sodium reacts completely with water?

- A 1.2 dm³
- B 2.4 dm³
- C 4.8 dm³
- D 9.6 dm³

- 11 Zinc can be extracted from its compound zinc oxide by heating with carbon.



81.0 g of impure zinc oxide is used to produce 52.0 g of zinc.

What is the percentage purity of the zinc oxide used?

- A 16.0 %
- B 20.0 %
- C 64.2 %
- D 80.0 %

- 12 Which statement about acids and bases is correct?

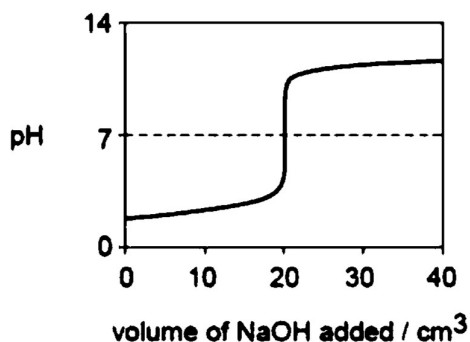
- A All strong acids react with carbonates but all weak acids do not.
- B The oxides of Group 1 metals are amphoteric.
- C The pH of 1.0 mol/dm³ ethanoic acid, CH₃COOH, is higher than the pH of 1.0 mol/dm³ sulfuric acid, H₂SO₄.
- D The pH of 1.0 mol/dm³ nitric acid, HNO₃, is lower than the pH of 1.0 mol/dm³ hydrochloric acid, HCl.

- 13 When a piece of barium is put into sulfuric acid, there is a vigorous reaction but the reaction stops after a short while.

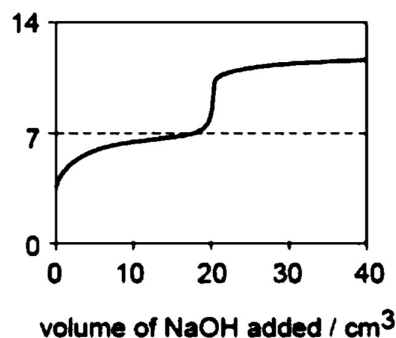
What is the explanation for this observation?

- A An insoluble layer of barium sulfate is formed on barium which prevents further reaction.
- B Barium has a layer of barium oxide which prevents further reaction with sulfuric acid.
- C Barium is placed below hydrogen in the reactivity series for metals.
- D Barium metal is highly resistant to corrosion.

- 14 A titration was conducted by adding aqueous sodium hydroxide from a burette to hydrochloric acid in a conical flask. The pH of the solution in the flask was recorded during the titration and **Graph 1** was obtained.



Graph 1



Graph 2

The table below shows some indicators that could be used to identify the endpoint of titrations.

indicator	acidic colour	range of colour change	alkaline colour
methyl orange	red	3.1 – 4.4	yellow
methyl red	red	4.4 – 6.2	yellow
bromothymol blue	yellow	6.0 – 7.6	blue
cresolphthalein	colourless	8.1 – 9.7	red
alizarin yellow	yellow	10.1 – 12.0	red

For the first titration, the appropriate indicator could be methyl red, bromothymol blue or cresolphthalein.

Which indicator is appropriate for the second titration?

- A methyl orange
 - B methyl red
 - C cresolphthalein
 - D alizarin yellow
- 15 Which reagent could be used to distinguish dilute nitric acid and dilute hydrochloric acid?
- A Aqueous ammonia
 - B Aqueous barium chloride
 - C Aqueous silver nitrate
 - D Aqueous sodium carbonate

- 16** The results of three tests on a solution of compound **X** are shown in the table.

test	results
aqueous sodium hydroxide added	white precipitate formed, soluble in excess
aqueous ammonia added	white precipitate formed, insoluble in excess
acidified silver nitrate added	white precipitate formed

What is compound **X**?

- A** aluminium chloride
B aluminium iodide
C zinc chloride
D zinc iodide
- 17** Which statements are correct in the Haber process to manufacture ammonia?
- The catalyst used is a transition metal.
 - Unreacted nitrogen and hydrogen are circulated back into the system.
 - Both reactants are obtained from the fractional distillation of liquefied air.
 - The reaction is never complete and the yield is only about 10% to 15%.
- A** 1, 2 and 3
B 1, 2 and 4
C 2, 3 and 4
D 1, 2, 3 and 4
- 18** Equations for reactions of iron and iron compounds are shown.

- $\text{Fe} + \text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2$
- $2\text{FeCl}_2 + \text{Cl}_2 \rightarrow 2\text{FeCl}_3$
- $\text{FeSO}_4 + \text{Mg} \rightarrow \text{Fe} + \text{MgSO}_4$
- $\text{FeSO}_4 + 2\text{NaOH} \rightarrow \text{Fe(OH)}_2 + \text{Na}_2\text{SO}_4$

How many of these are redox reactions?

- A** 1
B 2
C 3
D 4

- 19 In which substance does the nitrogen atom have the same oxidation state as the nitrogen atom in HNO_2 ?

A NF_3
 B NH_4^+
 C NO
 D NO_2^+

- 20 Aqueous copper(II) sulfate is electrolysed using carbon electrodes.

What happens to the electrolyte?

A It becomes more acidic.
 B It becomes more alkaline.
 C It turns deeper blue.
 D It remains unchanged.

- 21 Concentrated aqueous sodium chloride is electrolysed using inert electrodes.

Which row shows what happens in this electrolysis and why it happens?

	change occurring	explanation
A	Oxygen is discharged at the anode.	OH^- ions lose electrons more readily than Cl^- ions.
B	During electrolysis, the pH of the electrolyte increases.	The concentration of OH^- is higher than the concentration of H^+ in the electrolyte.
C	Solid sodium is produced.	Na^+ ions are present in aqueous solution.
D	The products stay the same if the aqueous sodium chloride is replaced by molten sodium chloride.	Na^+ and Cl^- are present in both molten and aqueous sodium chloride.

- 22 Sodium, potassium and rubidium are in Group 1 of the Periodic Table.

Chlorine, bromine and iodine are in Group 17.

Which statement is correct?

- A Bromine displaces chlorine from an aqueous solution of sodium chloride.
- B Iodine is discharged at the negative electrode when concentrated aqueous potassium iodide is electrolysed.
- C Rubidium has a greater tendency to form positive ions than potassium.
- D Sodium and potassium both react with water but the reaction is more violent with sodium.

- 23 **P**, **Q**, **R** and **S** are elements in period 3 of the Periodic Table. The descriptions of these elements are given below.

- The oxide of **P** is soluble in water to give a solution with pH less than 7.
- The oxide of **Q** has a giant covalent structure.
- Element **R** is a metal which floats on water.
- Element **S** is used to fill light bulbs.

Which of the following arranges the four elements in order of **increasing** proton number?

- A **R, Q, P, S**
- B **R, P, Q, S**
- C **S, Q, P, R**
- D **S, P, Q, R**

- 24 The equations for some of the reactions of metals **Q**, **R** and **T** are shown.

- $2\text{QNO}_3(\text{aq}) + \text{Cu}(\text{s}) \rightarrow 2\text{Q}(\text{s}) + \text{Cu}(\text{NO}_3)_2(\text{aq})$
- $\text{R}(\text{s}) + \text{TSO}_4(\text{aq}) \rightarrow \text{T}(\text{s}) + \text{RSO}_4(\text{aq})$
- $\text{T}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{TSO}_4(\text{aq}) + \text{H}_2(\text{g})$

Using the equations, what is the order of reactivity of **Q**, **R** and **T**?

	most reactive		least reactive
A	Q	T	R
B	R	Q	T
C	R	T	Q
D	T	R	Q

- 25** Metal **X** is an unreactive metal.

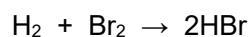
Metal **Y** reacts rapidly when exposed to air.

Metal **Z** can be used for the sacrificial protection of underwater pipes.

Which row is correct?

	obtained by electrolysis	obtained by reduction using carbon	can be found as the metal
A	X	Y	Z
B	Z	X	Y
C	Y	Z	X
D	X	Z	Y

- 26** Hydrogen and bromine react to form hydrogen bromide



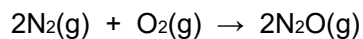
Bond energy data is given in the table.

bond	bond energy in kJ/mol
H–H	436
Br–Br	193
H–Br	366

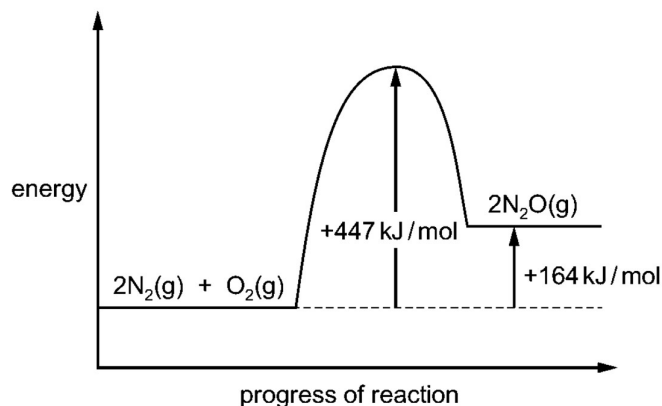
What is the enthalpy change, ΔH , for this reaction?

- A** –263 kJ/mol
- B** –103 kJ/mol
- C** +103 kJ/mol
- D** +263 kJ/mol

- 27 Under certain conditions, nitrogen reacts with oxygen to form N_2O .



The reaction pathway diagram is shown.



What is the activation energy of the reverse reaction?

- A -447 kJ/mol
 B -283 kJ/mol
 C $+141.5 \text{ kJ/mol}$
 D $+283 \text{ kJ/mol}$
- 28 Gold is used as a catalyst in some chemical reactions. Some statements about the use of gold as a catalyst are given.
- Gold increases the yield of the reaction.
 - Gold is chemically unchanged at the end of the reaction.
 - Gold provides an alternative pathway with a lower activation energy.
 - Gold speeds up the rate of the reaction.

How many statement(s) is/are correct?

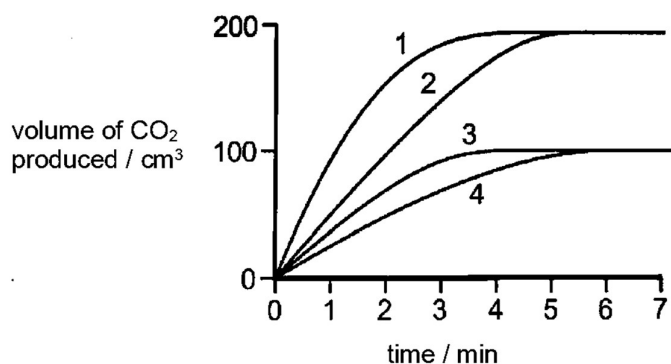
- A 1
 B 2
 C 3
 D 4

- 29** In four separate experiments, 1, 2, 3 and 4, dilute nitric acid was added to excess marble chips and the volume of carbon dioxide produced was measured.

In all four experiments, the same volume of dilute nitric acid was used.

The concentration of the acid, or temperature, or both concentration and temperature of the acid, were changed.

The results of the experiments are shown on the graph.



Which statement is correct?

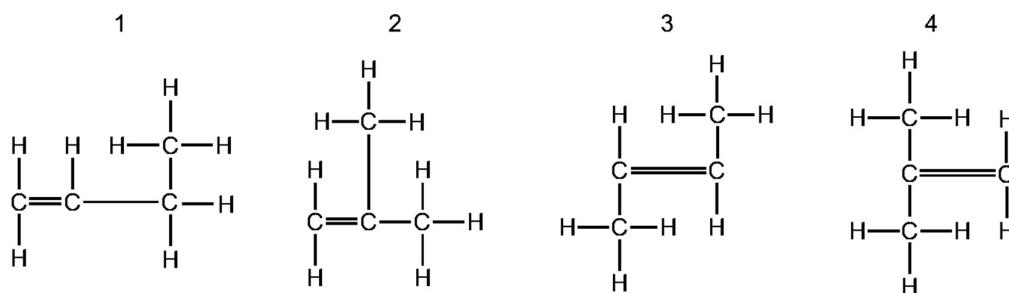
- A** A lower concentration of acid was used in experiment 3 than in experiment 1.
 - B** Experiment 4 was faster than experiment 3.
 - C** Powdered marble chips were used in experiment 2.
 - D** The temperature of the acid was the same in experiments 1 and 2.
- 30** Which statements are true for homologous series?
- 1 Each series contains saturated compounds.
 - 2 The compounds in each series are unreactive.
 - 3 Each series has a general formula.
 - 4 Each series has a gradation in physical properties.
- A** 1, 2, 3 and 4
 - B** 1, 2, and 3 only
 - C** 1 and 4 only
 - D** 3 and 4 only

- 31** Octane is an alkane with eight carbon atoms per molecule.

What is the molecular formula of octane, and how does its boiling point compare with that of butane?

	molecular formula of octane	boiling point of octane
A	C_8H_{16}	higher than butane
B	C_8H_{16}	lower than butane
C	C_8H_{18}	lower than butane
D	C_8H_{18}	higher than butane

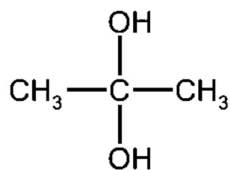
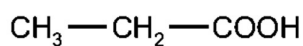
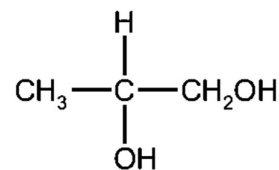
- 32** The diagrams show four structures of C_4H_8 .



Which structures represent the same molecule?

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

- 33 The structures of three compounds, **W**, **X** and **Y**, are shown.

**W****X****Y**

Which statements about these three compounds are correct?

- 1 **W** and **Y** are both alcohols and **X** is a carboxylic acid.
- 2 **W**, **X** and **Y** have the same functional group.
- 3 **W** and **Y** are structural isomers of each other.

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

- 34 A student investigated the reaction of different vegetable oils with hydrogen. 200 cm³ of hydrogen was passed through 2 g samples of vegetable oils containing a suitable catalyst.

The volume of hydrogen remaining after each reaction was recorded.

vegetable oil	volume of hydrogen remaining / cm ³
J	0
K	165
L	187
M	200

Which vegetable oil(s) is/are unsaturated?

- A** **J** only
B **K** and **L** only
C **J**, **K** and **L** only
D **M** only

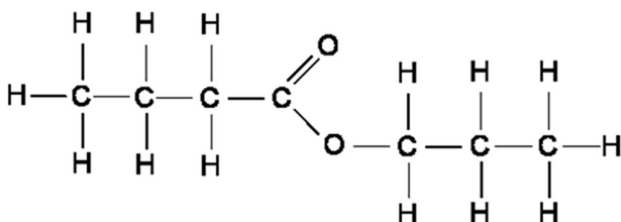
- 35 Eleostearic acid is a fatty acid present in bitter gourd oil.

It has a molecular formula of $C_{17}H_{29}COOH$.

How many carbon-carbon double bonds are present in one molecule of the acid?

- A 2
B 3
C 4
D 5

- 36 The diagram shows the structure of an ester.

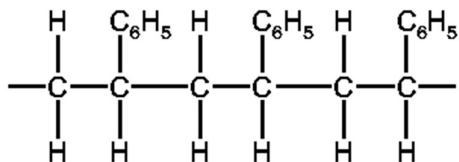


What are the reagents required to produce the ester above?

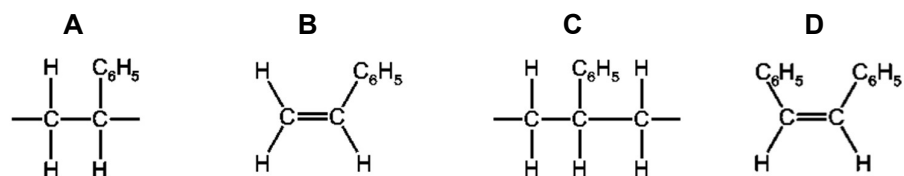
- A butanoic acid and butanol
B butanoic acid and propanol
C propanoic acid and butanol
D propanoic acid and propanol

- 37 Poly(styrene) is an addition polymer.

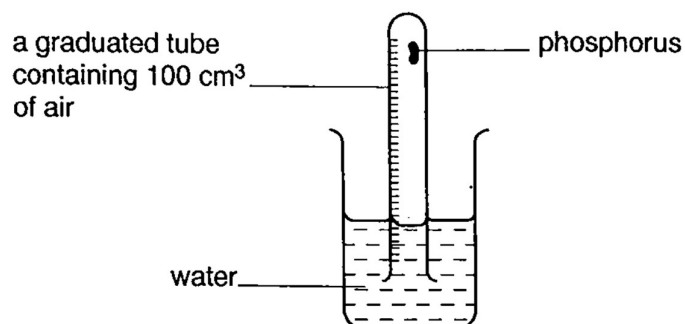
The partial structure of poly(styrene) is shown.



What is the formula of the monomer from which poly(styrene) is made?

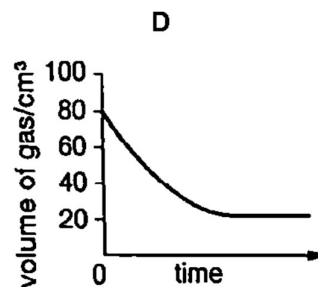
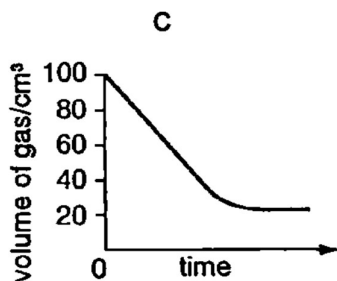
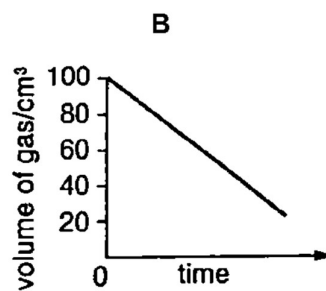
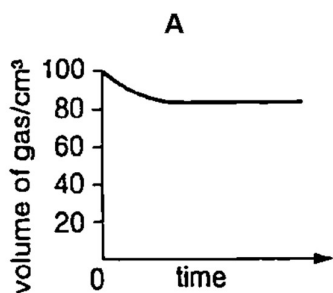


- 38 The diagram shows an apparatus used to measure the percentage composition of the atmosphere. Phosphorus reacts with oxygen in the air to form phosphorus(V) oxide that dissolves in water.



The initial volume of the air in the tube is 100 cm³.

Which graph shows how the volume of gas remaining in the apparatus changes?



39 Which statements about air pollutants are correct?

- 1 Carbon monoxide is responsible for the production of acid rain.
- 2 Oxides of nitrogen are produced in car exhausts.
- 3 Sulfur dioxide can be produced by the combustion of coal.
- 4 Methane is produced from the incomplete combustion of fossil fuels.

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

40 Three statements about the carbon cycle are given.

- 1 The carbon cycle regulates the amount of carbon dioxide in the atmosphere.
- 2 During photosynthesis, carbon dioxide is produced.
- 3 Combustion of hydrocarbons requires oxygen.

Which statements are correct?

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

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The Periodic Table of Elements

Group																															
1	2	1 H hydrogen 1														13	14	15	16	17	18										
		Key																													
3	4	proton (atomic) number atomic symbol relative atomic mass																5	6	7	8	9	10	11	12	13	14	15	16	17	18
Li lithium 7	Be beryllium 9																	B boron 11	C carbon 12	N nitrogen 14	O oxygen 16	F fluorine 19	Ne neon 20								
11	12																	13	14	15	16	17	18					10			
Na sodium 23	Mg magnesium 24																	Al aluminium 27	Si silicon 28	P phosphorus 31	S sulfur 32	Cl chlorine 35.5	Ar argon 40					4			
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36					36									
K potassium 39	Ca calcium 40	Sc scandium 45	Ti titanium 48	V vanadium 51	Cr chromium 52	Mn manganese 55	Fe iron 56	Co cobalt 59	Ni nickel 59	Cu copper 64	Zn zinc 65	Ga gallium 70	Ge germanium 73	As arsenic 75	Se selenium 79	Br bromine 80	Kr krypton 84					84									
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54					54									
Rb rubidium 85	Sr strontium 88	Y yttrium 89	Zr zirconium 91	Nb niobium 93	Mo molybdenum 96	Tc technetium —	Ru ruthenium 101	Rh rhodium 103	Pd palladium 106	Ag silver 108	Cd cadmium 112	In indium 115	Sn tin 119	Sb antimony 122	Te tellurium 128	I iodine 127	Xe xenon 131					131									
55	56	57–71 lanthanoids		72	73	74	75	76	77	78	79	80	81	82	83	84	85	86					86								
Cs caesium 133	Ba barium 137			Hf hafnium 178	Ta tantalum 181	W tungsten 184	Re rhenium 186	Os osmium 190	Ir iridium 192	Pt platinum 195	Au gold 197	Hg mercury 201	Tl thallium 204	Pb lead 207	Bi bismuth 209	Po polonium —	At astatine —	Rn radon —					—								
87	88	89–103 actinoids		104	105	106	107	108	109	110	111	112	113	114	115	116	117	118					118								
Fr francium —	Ra radium —			Rf rutherfordium —	Db dubnium —	Sg seaborgium —	Bh bohrium —	Hs hassium —	Mt meitnerium —	Ds darmstadtium —	Rg roentgenium —	Cn copernicium —	Nh nihonium —	Fl flerovium —	Mc moscovium —	Lv livermorium —	Ts tennessine —	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, $L = 6.02 \times 10^{23} \text{ mol}^{-1}$.