



Cambridge O Level

CHEMISTRY

3173/12

Paper 1 Multiple Choice

May/June 2021

1 hour

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

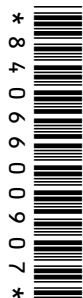
INSTRUCTIONS

- 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.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

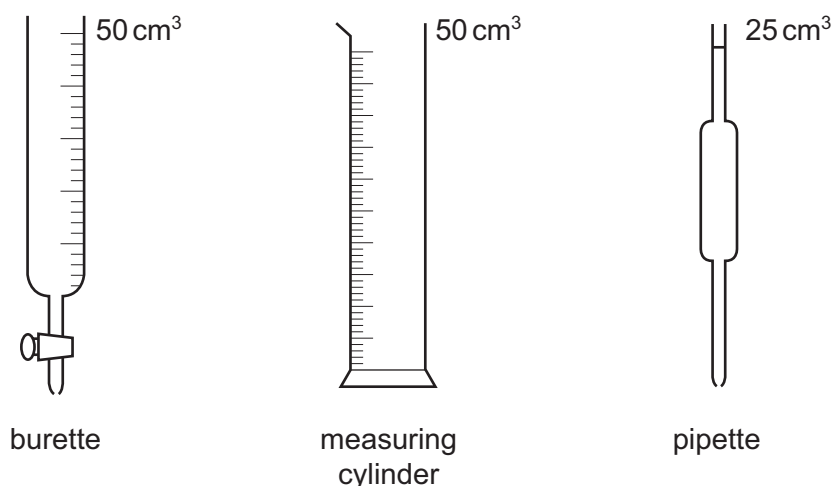
INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark.
- Any rough working should be done on this question paper.
- The Periodic Table is printed in the question paper.

This document has **16** pages.



1 Three pieces of apparatus are shown.



Which pieces of apparatus could be used to measure 23 cm³ of liquid?

- A burette and measuring cylinder only
 - B burette and pipette only
 - C burette, measuring cylinder and pipette
 - D measuring cylinder and pipette only
- 2 Copper(II) nitrate is soluble in water. Copper(II) carbonate is insoluble in water.

A mixture of solid copper(II) nitrate and copper(II) carbonate is added to a beaker of water. It is stirred until no more solid dissolves.

How can separate samples of copper(II) nitrate and copper(II) carbonate be obtained from the resulting mixture?

- A crystallisation followed by distillation
- B evaporation followed by distillation
- C evaporation followed by filtration
- D filtration followed by crystallisation

3 Two compounds, P and Q, are separately dissolved in water and tested as shown.

| test | P | Q |
|--|---|--|
| colour of solution | green | colourless |
| aqueous sodium hydroxide added | green precipitate, soluble in excess, giving a green solution | white precipitate, insoluble in excess |
| aqueous sodium hydroxide and aluminium foil added, then warmed | no gas given off | ammonia given off |
| acidified with nitric acid, then aqueous barium nitrate added | white precipitate | no precipitate |

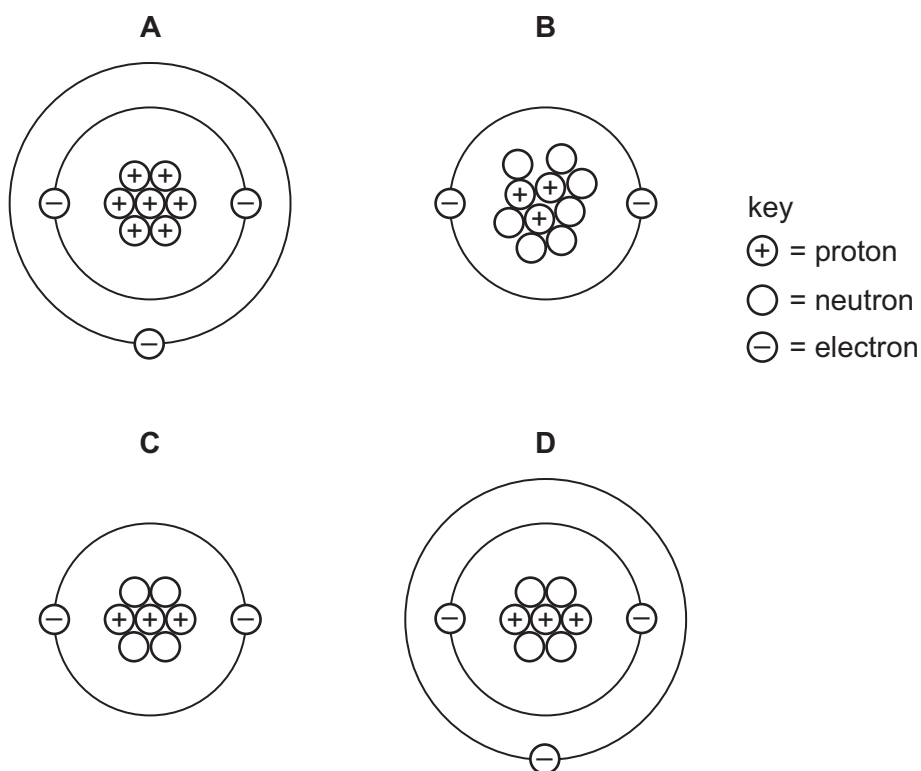
Which ions are present in P and Q?

| | P | Q |
|----------|---|---|
| A | Cr^{3+} and SO_4^{2-} | Zn^{2+} and NO_3^- |
| B | Cr^{3+} and SO_4^{2-} | Ca^{2+} and NO_3^- |
| C | Fe^{2+} and NO_3^- | Ca^{2+} and SO_4^{2-} |
| D | Fe^{2+} and NO_3^- | Zn^{2+} and SO_4^{2-} |

4 Which statement is correct?

- A** When gaseous ammonia becomes liquid ammonia, the change is endothermic.
- B** When liquid ethanol becomes solid ethanol, the change is exothermic.
- C** When liquid water becomes gaseous water, the change is exothermic.
- D** When solid copper becomes liquid copper, the change is exothermic.

5 Which diagram shows the ion ${}^7_3\text{Li}^+$?



6 Three statements about the elements carbon, nitrogen and sulfur are shown.

- 1 They are in groups next to each other in the Periodic Table.
- 2 Their neutron to proton ratios are all two to one.
- 3 They each form an acidic oxide.

Which statements are correct?

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

- 7 The table shows data for some particles. There are gaps represented by W, X, Y and Z.

| particle | proton number | nucleon number | number of neutrons | number of electrons |
|-----------------|---------------|----------------|--------------------|---------------------|
| Ar | 18 | 40 | W | 18 |
| K ⁺ | 19 | 39 | 20 | X |
| Sc | 21 | Y | 24 | 21 |
| S ²⁻ | 16 | 32 | 16 | Z |

Which row shows the correct values for W, X, Y and Z?

| | W | X | Y | Z |
|----------|----|----|----|----|
| A | 20 | 20 | 42 | 14 |
| B | 20 | 20 | 42 | 16 |
| C | 22 | 18 | 45 | 14 |
| D | 22 | 18 | 45 | 18 |

- 8 Hydrogen can form both H⁺ ions and H⁻ ions.

Which statement is correct?

- A** An H⁺ ion has more protons than an H⁻ ion.
B An H⁺ ion has no electrons.
C An H⁻ ion has one more electron than an H⁺ ion.
D An H⁻ ion is formed when a hydrogen atom loses an electron.
- 9 Iodine and sodium chloride are solids at room temperature and pressure.

Which row correctly shows the structure of iodine and the bonding in sodium chloride?

| | structure of iodine | bonding in sodium chloride |
|----------|---------------------|----------------------------|
| A | giant molecular | covalent |
| B | giant molecular | ionic |
| C | simple molecular | covalent |
| D | simple molecular | ionic |

10 It is possible to produce Ar^{2+} ions from argon atoms in a laboratory.

Which statement is correct?

- A Each argon atom gains two electrons and loses the electronic configuration of an inert gas.
- B Each argon atom gains two electrons and obtains the electronic configuration of an inert gas.
- C Each argon atom loses two electrons and loses the electronic configuration of an inert gas.
- D Each argon atom loses two electrons and obtains the electronic configuration of an inert gas.

11 Many elements and compounds contain covalent bonds.

Which statement about covalently bonded elements and compounds is correct?

- A Aqueous solutions of covalent compounds always conduct electricity.
- B Bonding in the nitrogen molecule involves three shared pairs of electrons.
- C Double covalent bonds are present in ethene and in water.
- D The formation of covalent bonds always produces atoms with eight electrons in their outer shells.

12 What is the number of moles of hydrogen atoms in 3.2 g of methane?

- A 0.02 B 0.2 C 0.4 D 0.8

13 What is the ionic equation for the reaction between aqueous silver nitrate and aqueous iron(III) chloride?

- A $\text{Ag}^+(\text{aq}) + \text{Fe}^{3+}(\text{aq}) \rightarrow \text{Ag}(\text{s}) + \text{Fe}^{2+}(\text{aq})$
- B $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{aq})$
- C $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$
- D $\text{Fe}^{3+}(\text{aq}) + 3\text{NO}_3^-(\text{aq}) \rightarrow \text{Fe}(\text{NO}_3)_3(\text{aq})$

14 Calcium carbonate, CaCO_3 , reacts with an acid, HA.

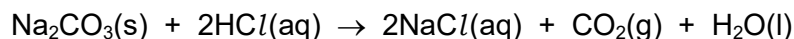


What is the minimum mass of acid required to react completely with 10 g of calcium carbonate?

[M_r : HA, 46; CaCO_3 , 100]

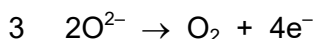
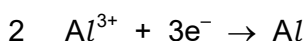
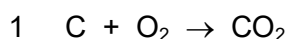
- A 4.6 g B 9.2 g C 10 g D 20 g

- 15 When 1.0 mol/dm^3 hydrochloric acid reacts with excess sodium carbonate, 1.2 dm^3 of carbon dioxide is produced, measured at room temperature and pressure.



Which volume of 1.0 mol/dm^3 hydrochloric acid is used?

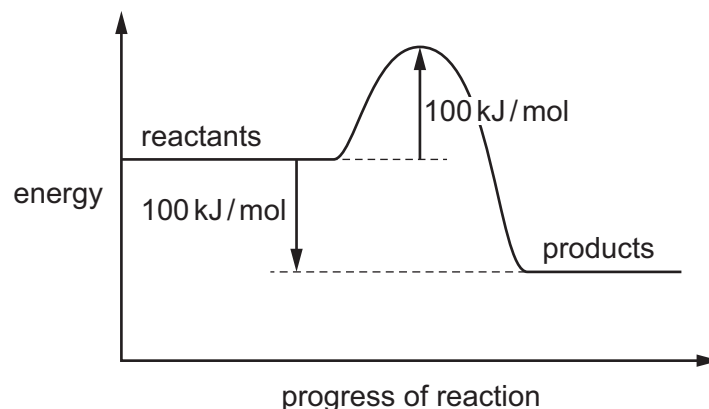
- A** 50 cm^3 **B** 100 cm^3 **C** 200 cm^3 **D** 1000 cm^3
- 16 Which solutions contain the same number of moles of solute?
- 1 10 cm^3 of 0.01 mol/dm^3 copper(II) sulfate
 - 2 100 cm^3 of 0.05 mol/dm^3 sulfuric acid
 - 3 100 cm^3 of 0.001 mol/dm^3 sodium hydroxide
 - 4 50 cm^3 of 1 mol/dm^3 copper(II) sulfate
- A** 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4
- 17 Which statement about the electrolysis of concentrated aqueous sodium chloride is correct?
- A** Chlorine is produced at the cathode.
B Hydrogen is produced at the cathode.
C Oxygen is produced at the cathode.
D Sodium is produced at the cathode.
- 18 The equations for three reactions are shown.



Which reactions occur in the extraction of aluminium from purified aluminium oxide?

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

19 An energy profile diagram is shown.



Which row shows the activation energy of the reverse reaction and the description of the forward reaction?

| | activation energy of the reverse reaction | description of the forward reaction |
|----------|---|---|
| A | +100 kJ/mol | more energy is given out forming bonds in the products than is taken in breaking bonds in the reactants |
| B | +100 kJ/mol | more energy is taken in breaking bonds in the reactants than is given out forming bonds in the products |
| C | +200 kJ/mol | more energy is given out forming bonds in the products than is taken in breaking bonds in the reactants |
| D | +200 kJ/mol | more energy is taken in breaking bonds in the reactants than is given out forming bonds in the products |

20 Petroleum (crude oil) is a mixture of hydrocarbons which can be separated into fractions by fractional distillation.

Which row correctly shows the fractions in order of decreasing boiling point?

| | highest | → | | lowest |
|----------|----------|----------|----------|----------|
| A | diesel | paraffin | naphtha | petrol |
| B | naphtha | petrol | diesel | paraffin |
| C | paraffin | naphtha | petrol | diesel |
| D | petrol | naphtha | paraffin | diesel |

21 The rate of a chemical reaction decreases as the temperature decreases because at a lower temperature:

- 1 a lower proportion of molecules have energy that exceeds the activation energy
- 2 the molecules are further apart
- 3 the frequency of successful collision is less.

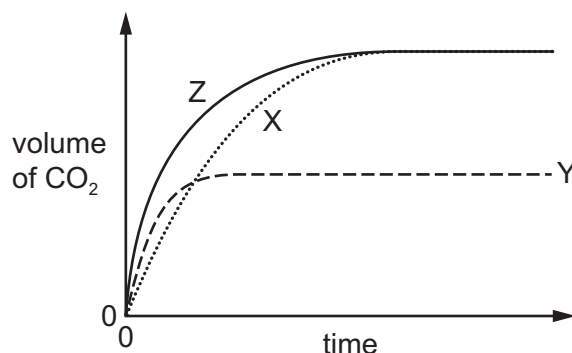
Which reasons correctly explain this decrease?

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

22 The rate of the reaction between a metal carbonate and a dilute acid is followed by measuring the volume of carbon dioxide produced and plotting this against time.

The line labelled X shows the results of an experiment using 50 cm³ of 1.0 mol/dm³ hydrochloric acid and excess metal carbonate.

The experiment is repeated using different conditions and lines Y and Z are drawn to show the volumes of carbon dioxide produced against time.



Which row shows the conditions that could give lines Y and Z?

| | conditions for Y | conditions for Z |
|----------|--|--|
| A | 50 cm ³ of 0.5 mol/dm ³ hydrochloric acid at same temperature. | 25 cm ³ of 2.0 mol/dm ³ hydrochloric acid at same temperature |
| B | 50 cm ³ of 0.5 mol/dm ³ hydrochloric acid at same temperature with a catalyst. | 12.5 cm ³ of 4.0 mol/dm ³ hydrochloric acid at same temperature. |
| C | 50 cm ³ of 1.0 mol/dm ³ hydrochloric acid at a lower temperature. | 50 cm ³ of 1.0 mol/dm ³ hydrochloric acid at a higher temperature. |
| D | 50 cm ³ of 0.5 mol/dm ³ hydrochloric acid at a higher temperature. | 50 cm ³ of 1.0 mol/dm ³ sulfuric acid at same temperature. |

23 In which equation is the underlined substance oxidised?

- A $\text{Cr}_2\text{O}_3 + 2\text{Al} \rightarrow 2\text{Cr} + \text{Al}_2\text{O}_3$
 B $\text{MnO}_2 + 4\text{HCl} \rightarrow \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$
 C $\text{Na}_2\text{SO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{SO}_2$
 D $2\text{NO}_2 \rightarrow 2\text{NO} + \text{O}_2$

24 A compound decolourises acidified potassium manganate(VII).

What could this compound be?

- 1 magnesium chloride, MgCl_2
 2 iron(II) chloride, FeCl_2
 3 ethanol, $\text{C}_2\text{H}_5\text{OH}$

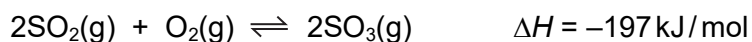
- A 1, 2 and 3 B 1 and 2 only C 2 and 3 only D 3 only

25 If a sample of ammonia is passed over heated iron, two gases, X and Y, are formed. Gas X reacts with oxygen. Gas Y is unreactive.

Which statement is correct?

- A Gas X reacts with oxygen to form water.
 B Gas Y is a compound.
 C The formation of the two gases from ammonia cannot be reversed.
 D There is a triple covalent bond in one molecule of gas X.

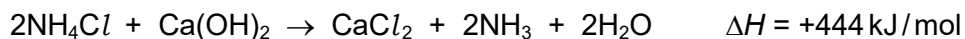
26 The equation shows the reaction for the formation of sulfur trioxide using a catalyst.



Which change in reaction conditions would produce more sulfur trioxide?

- A adding more catalyst
 B decreasing the pressure
 C increasing the temperature
 D removing some sulfur trioxide

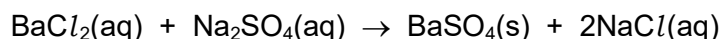
- 27 Ammonia gas is produced by heating a mixture of ammonium chloride and calcium hydroxide.



How can this reaction be described?

- A a decomposition
 - B a redox reaction
 - C an acid-base reaction
 - D an exothermic reaction
- 28 A student prepares a pure sample of barium sulfate.
- The student dissolves 0.1 mol of barium chloride in water, then adds an excess of aqueous sodium sulfate.

The equation for the reaction is shown.



Which statement is correct?

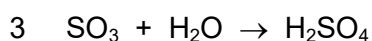
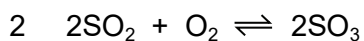
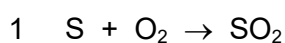
- A 0.1 mol of sodium chloride is produced.
 - B A giant ionic lattice is produced.
 - C After filtering the reaction mixture, barium sulfate is obtained by crystallising the filtrate.
 - D Aqueous sodium sulfate can be used to test for a chloride.
- 29 Which pair of reagents is most suitable for the laboratory preparation of copper(II) chloride?
- A aqueous copper(II) nitrate and aqueous sodium chloride
 - B copper and chlorine
 - C copper and dilute hydrochloric acid
 - D copper(II) oxide and dilute hydrochloric acid

30 Titration and precipitation are two of the methods used in salt preparation.

In which row could the salts be prepared by the method stated?

| | titration | precipitation |
|----------|--------------------|--------------------|
| A | calcium sulfate | lead chloride |
| B | magnesium chloride | iron(II) sulfate |
| C | potassium chloride | silver chloride |
| D | sodium nitrate | copper(II) sulfate |

31 The manufacture of sulfuric acid by the Contact process involves three main reactions.



Which reactions are oxidation processes and which require the use of a catalyst?

| | oxidation process | uses a catalyst |
|----------|-------------------|-----------------|
| A | 1, 2 and 3 | 1 and 2 |
| B | 1, 2 and 3 | 2 only |
| C | 1 and 2 only | 1 and 2 |
| D | 1 and 2 only | 2 only |

32 Some information about elements X and Y is given.

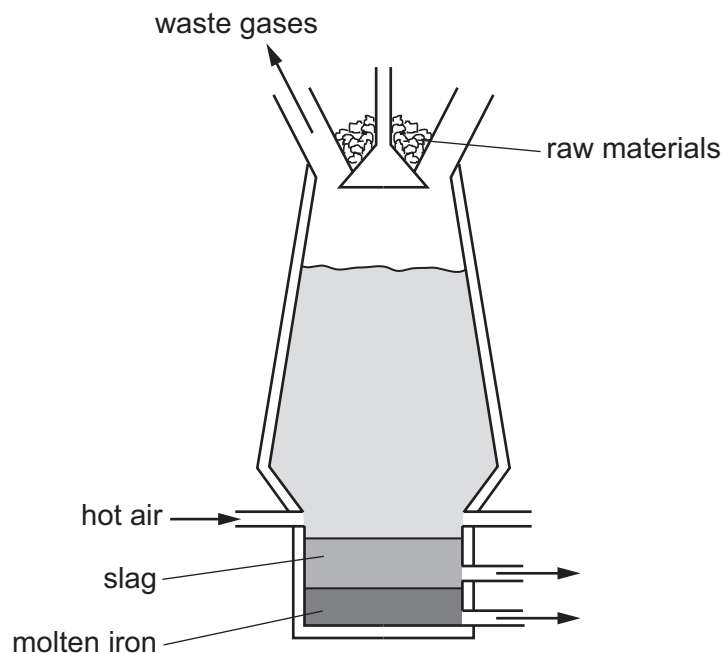
Elements X and Y exist as diatomic molecules.

Element X has a lower boiling point than element Y.

Which row shows possible identities for elements X and Y?

| | X | Y |
|----------|-----------|----------|
| A | bromine | iodine |
| B | bromine | chlorine |
| C | neon | argon |
| D | potassium | sodium |

33 Iron is produced in the blast furnace.



Which statement about this process is correct?

- A Carbon is oxidised to carbon dioxide.
- B Carbon monoxide is produced by the thermal decomposition of calcium carbonate.
- C Haematite is reduced by calcium carbonate.
- D Impurities are removed by hot air.

34 Some pollutants enter the air by natural processes.

Which natural processes release pollutants into the air?

- 1 bacterial decay of vegetable matter
- 2 lightning activity
- 3 volcanoes

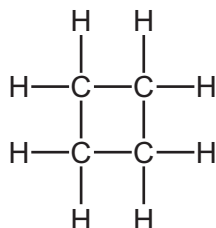
- A 1 and 2 only B 1 and 3 only C 2 and 3 only D 1, 2 and 3

35 Which statement about the pollution and purification of water is correct?

- A Carbon is used to disinfect water for drinking.
- B Desalination produces drinkable water by using fractional distillation.
- C Eutrophication results in water having too little dissolved oxygen.
- D Nitrates from detergents restrict plant growth.

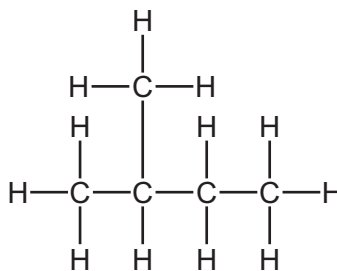
36 The structures and names of four alkanes are given.

1



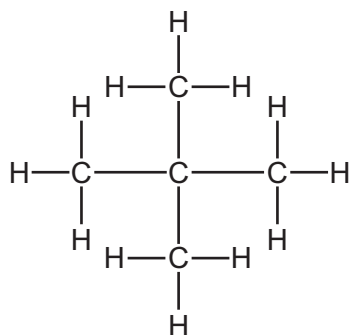
cyclobutane

2



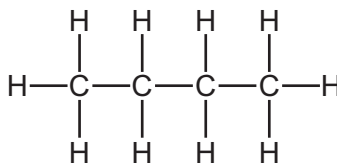
methylbutane

3



dimethylpropane

4



butane

Which two alkanes are isomers of each other?

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

37 A hydrocarbon, C_xH_y , undergoes an addition reaction with chlorine.

A second hydrocarbon, C_pH_q , undergoes a substitution reaction with chlorine.

If $x = 4$ and $p = 6$, what are the values of y and q ?

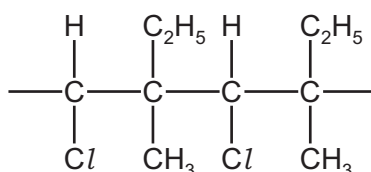
| | y | q |
|----------|-----|-----|
| A | 8 | 16 |
| B | 8 | 14 |
| C | 10 | 12 |
| D | 10 | 14 |

38 An organic compound has an empirical formula C_2H_4O .

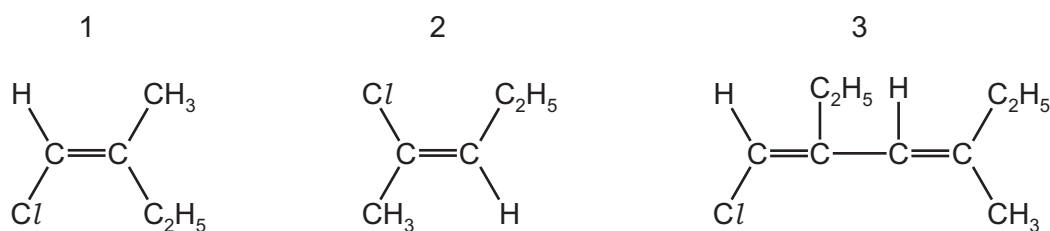
What could the compound be?

- A butanoic acid
- B butanol
- C ethanoic acid
- D ethanol

39 The partial structure of a polymer is shown.



Which monomers could produce this polymer?



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

40 X is a polymer formed by a condensation reaction. X contains nitrogen.

Which statements about X are correct?

- 1 X could also contain oxygen.
- 2 X could be starch.
- 3 X could have the same linkage as proteins.
- 4 X could be formed from one monomer or two different monomers.

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

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The Periodic Table of Elements

| Group | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------------------|-----------------------|---------------------------|------------------------|-----------------------|-----------------------|-----------------------|-------------------------|----------------------|-------------------------|------------------------|---------------------|------------------------|------------------------|-----------------------|-------------|-------------|--------------------------|-----------------------|-----------------------|------------------------|------------------------|------------------------|------------------------|------------------------|----------------------|-----------------------|---------------------|-----------------------|-----------------------|------------------------|---------------------|---------------------|
| I | II | | | | | | | | | | | | | | | | III | IV | V | VI | VII | VIII | | | | | | | | | | |
| 2 | 1 | | | | | | | | | | | | | | | | 5 | 6 | 7 | 8 | 9 | 10 | | | | | | | | | | |
| He helium 4 | H hydrogen 1 | | | | | | | | | | | | | | | | B boron 11 | C carbon 12 | N nitrogen 14 | O oxygen 16 | F fluorine 19 | Ne neon 20 | | | | | | | | | | |
| 11 | 3 | | | | | | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 18 | | | | | | | | | | |
| Na sodium 23 | Li lithium 7 | | | | | | | | | | | | | | | | Al aluminium 27 | Si silicon 28 | P phosphorus 31 | S sulfur 32 | Cl chlorine 35.5 | Ar argon 40 | | | | | | | | | | |
| 19 | 4 | | | | | | | | | | | | | | | | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| K potassium 39 | Be beryllium 9 | | | | | | | | | | | | | | | | 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 |
| 37 | 12 | | | | | | | | | | | | | | | | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 |
| Rb rubidium 85 | Mg magnesium 24 | | | | | | | | | | | | | | | | 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 |
| 55 | 57–71 | | | | | | | | | | | | | | | | 73 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 |
| Cs caesium 133 | lanthanoids | | | | | | | | | | | | | | | | 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 | 89–103 | | | | | | | | | | | | | | | | 105 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 | 113 | 114 | 115 | 116 | 117 | 118 |
| Fr francium — | actinoids | | | | | | | | | | | | | | | | Rf rutherfordium — | Sg seaborgium — | Bh bohrium — | Hs hassium — | Mt meitnerium — | Rg roentgenium — | Cn copernicium — | Flerovium — | Livermorium — | — | — | — | — | — | — | — |
| lanthanoids | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | lanthanoids | | | | | | | | | | | | | | | | |
| La lanthanum 139 | Ce cerium 140 | Pr praseodymium 141 | Nd neodymium 144 | Pm promethium — | Sm samarium 150 | Eu europium 152 | Gd gadolinium 157 | Tb terbium 159 | Dy dysprosium 163 | Ho holmium 165 | Er erbium 167 | Tm thulium 169 | Yb ytterbium 173 | Lu lutetium 175 | lanthanoids | | | | | | | | | | | | | | | | | |
| actinoids | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 | 101 | 102 | 103 | actinoids | | | | | | | | | | | | | | | | |
| Ac actinium — | Th thorium 232 | Pa protactinium 231 | U uranium 238 | Np neptunium — | Pu plutonium — | Am americium — | Cm curium — | Bk berkelium — | Cf californium — | Es einsteinium — | Fm fermium — | Md mendelevium — | No nobelium — | Lr lawrencium — | actinoids | | | | | | | | | | | | | | | | | |

Key

 atomic number
 atomic symbol
 name
 relative atomic mass
The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).