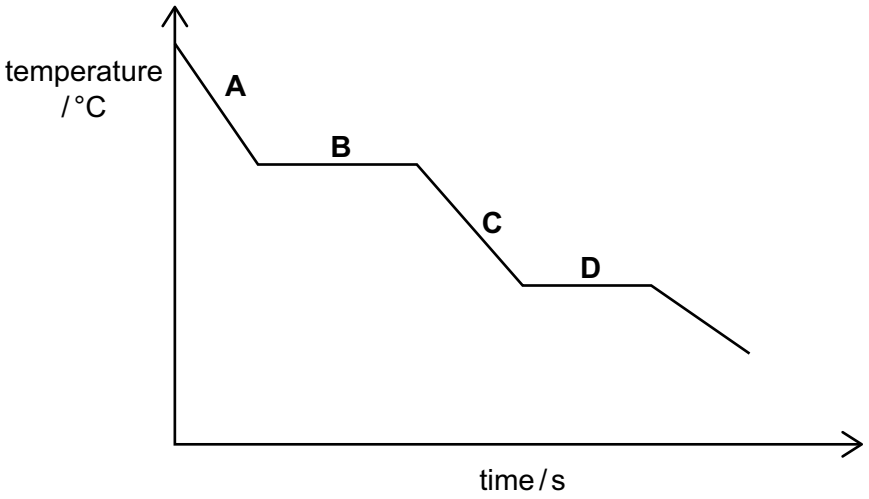
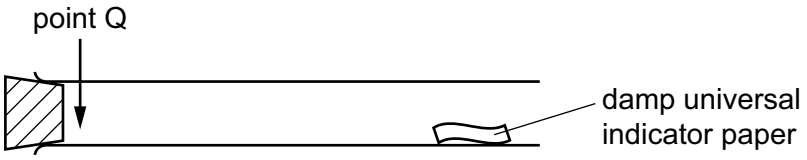
1 A gaseous substance is slowly cooled and the temperature recorded every second.

The results are shown on the graph.



At which point is the substance a solid?

2 A gas is released at point Q, in the apparatus shown.



Which gas changes the colour of the damp universal indicator paper most quickly?

	gas	relative molecular mass
A	ammonia	17
B	carbon dioxide	44
C	chlorine	71
D	hydrogen	2

3 Which statement describes the bonding in sodium chloride?

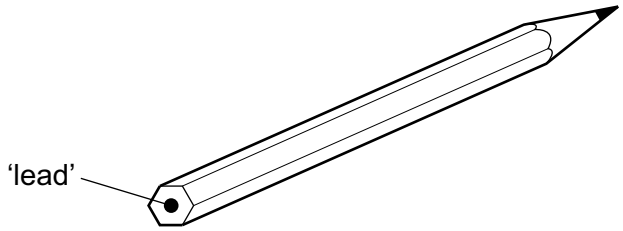
A A shared pair of electrons between two atoms leading to a noble gas configuration.

B A strong force of attraction between oppositely charged ions.

C A strong force of attraction between two molecules.

D A weak force of attraction between oppositely charged ions.

4 The 'lead' in a pencil is made of a mixture of graphite and clay.



When the percentage of graphite is increased, the pencil moves across the paper more easily.

Which statement explains this observation?

A Graphite has a high melting point.

B Graphite is a form of carbon.

C Graphite is a lubricant.

D Graphite is a non-metal.

5 Which statement about metals is **not** correct?

A They conduct electricity because delocalised electrons can move throughout the metal.

B They consist of layers of atoms that can slide over each other.

C They have a giant lattice of oppositely charged ions in a 'sea' of delocalised electrons.

D They have a giant lattice of positive ions in a 'sea' of delocalised electrons.

6 Aqueous iron(III) sulfate and aqueous sodium hydroxide react to give a precipitate of iron(III) hydroxide and a solution of sodium sulfate.

What is the balanced symbol equation for this reaction?

A $Fe_2(SO_4)_3(aq) + 2NaOH(aq) \rightarrow Fe(OH)_3(s) + Na_2SO_4(aq)$

B $Fe_2(SO_4)_3(aq) + 3NaOH(aq) \rightarrow Fe(OH)_3(s) + 3Na_2SO_4(aq)$

C $Fe_2(SO_4)_3(aq) + 6NaOH(aq) \rightarrow 2Fe(OH)_3(s) + 3Na_2SO_4(aq)$

D $2Fe_2(SO_4)_3(aq) + 6NaOH(aq) \rightarrow 4Fe(OH)_3(s) + 6Na_2SO_4(aq)$

7 Which information is needed to calculate the relative atomic mass of an element?

A The total number of protons and neutrons in the most abundant isotope.

B The nucleon numbers and the total number of isotopes.

C The mass number and abundance of each of its isotopes.

D The atomic number and abundance of each of its isotopes.

8 The equation for the reaction between sodium carbonate and excess dilute hydrochloric acid is shown.

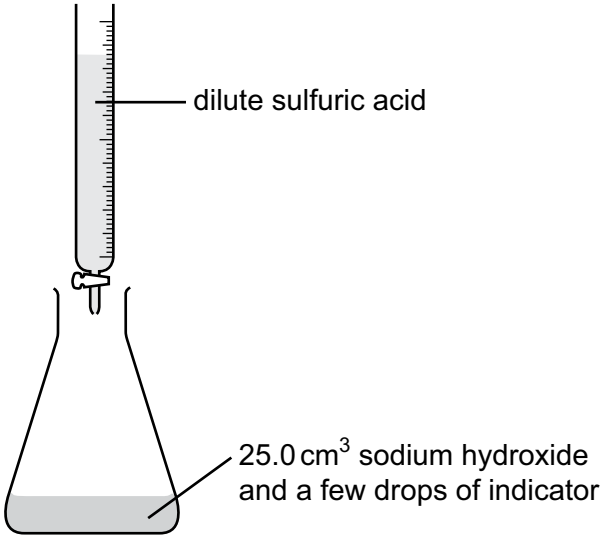
$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

When 26.5 g of sodium carbonate reacts with excess dilute hydrochloric acid, what is the maximum volume of carbon dioxide produced?

A $6\,dm^3$ **B** $12\,dm^3$ **C** $18\,dm^3$ **D** $24\,dm^3$

9 A volumetric pipette is used to measure $25.0\,cm^3$ of $2.0\,mol/dm^3$ aqueous sodium hydroxide into a conical flask.

A burette is filled with dilute sulfuric acid.



The equation for the reaction is shown.

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

The reaction requires $50.0\,cm^3$ of dilute sulfuric acid to reach the end-point.

What is the concentration of the dilute sulfuric acid in mol/dm^3?

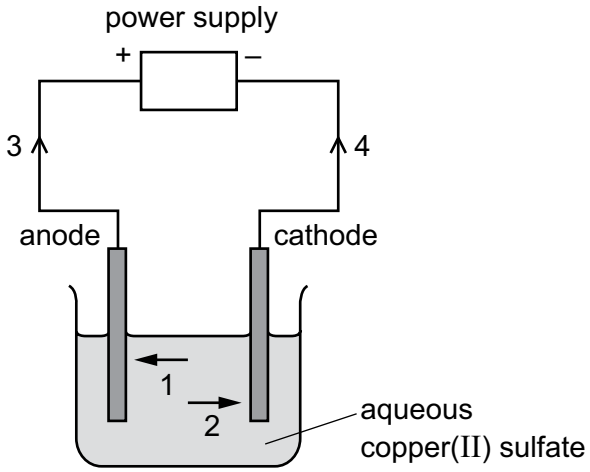
A $0.50\,mol/dm^3$

B $1.0\,mol/dm^3$

C $2.0\,mol/dm^3$

D $4.0\,mol/dm^3$

10 The diagram shows a circuit used to electrolyse aqueous copper(II) sulfate.



Which arrows indicate the movement of the copper ions in the electrolyte and of the electrons in the external circuit?

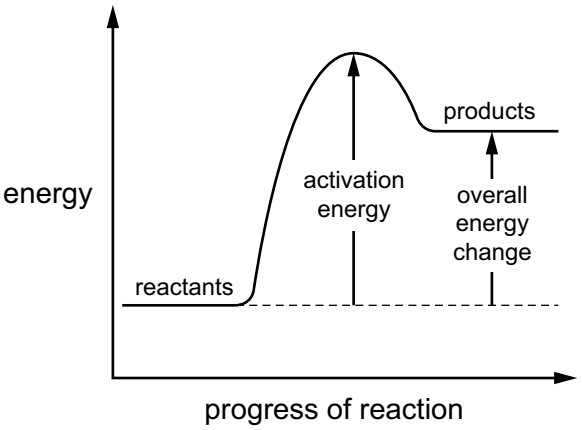
	copper ions	electrons
A	1	3
B	1	4
C	2	3
D	2	4

11 Which row shows the waste products released from the exhaust of a vehicle powered using a hydrogen–oxygen fuel cell?

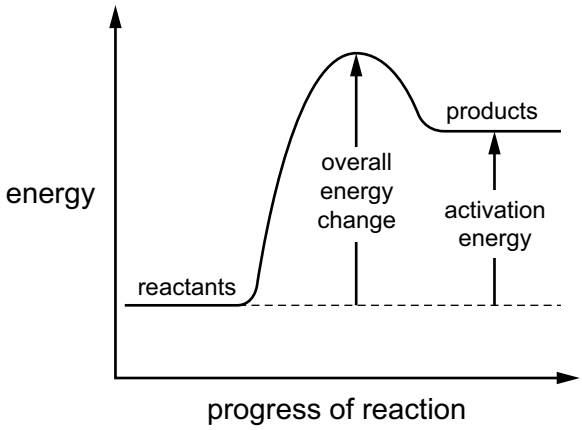
	carbon dioxide	oxides of nitrogen	water
A	✓	✓	✓
B	×	✓	✓
C	✓	×	×
D	×	×	✓

12 Which diagram is a correctly labelled reaction pathway diagram for an endothermic reaction?

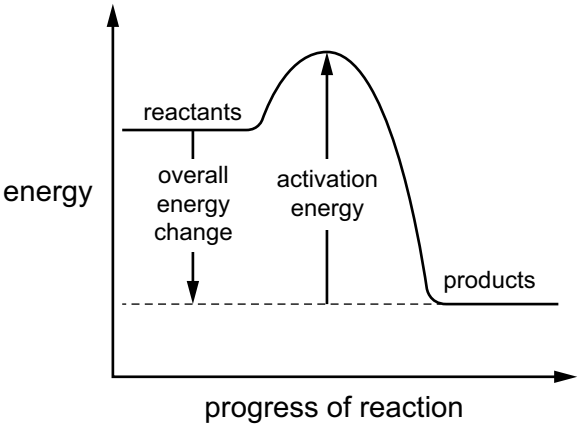
A



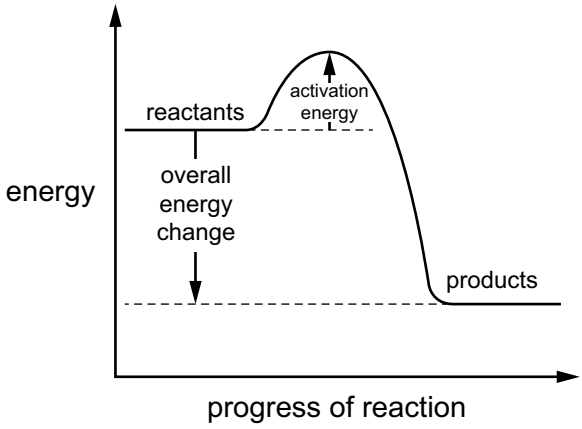
B



C



D



13 Which changes are physical changes?

1 melting ice to form water

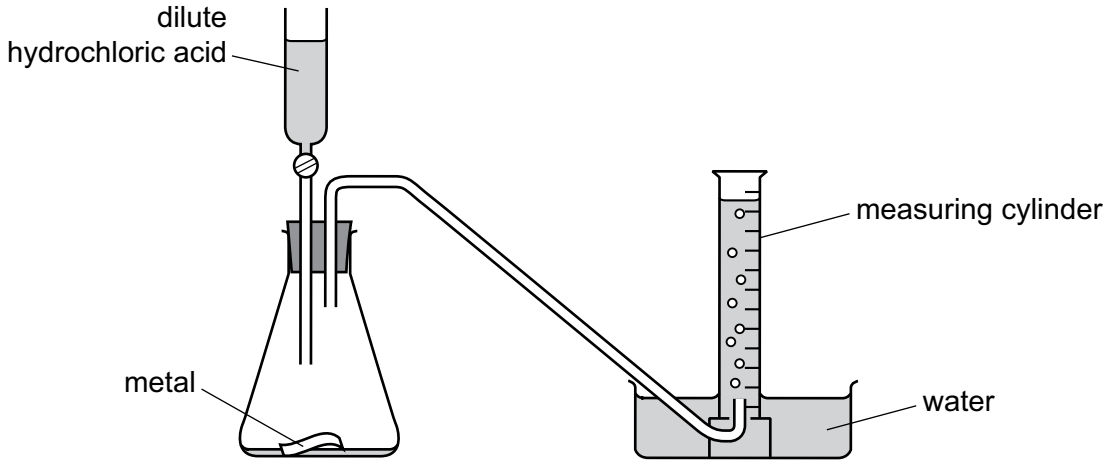
2 burning hydrogen to form water

3 adding sodium to water

4 boiling water to form steam

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

14 The diagram shows an experiment to measure the rate of a chemical reaction.



Which change decreases the rate of reaction?

A adding water to the flask

B heating the flask during the reaction

C using more concentrated acid

D using powdered metal

15 Which row describes the effect of increasing concentration and increasing temperature on the collisions between reacting particles?

	increasing concentration	increasing temperature
A	more collisions per second only	more collisions per second only
B	more collisions per second only	more collisions per second and more collisions with sufficient energy to react
C	more collisions per second and more collisions with sufficient energy to react	more collisions per second only
D	more collisions per second and more collisions with sufficient energy to react	more collisions per second and more collisions with sufficient energy to react

16 Methanol is prepared by the reversible reaction shown.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

The forward reaction is exothermic.

Which conditions produce the highest equilibrium yield of methanol?

	temperature	pressure
A	high	high
B	high	low
C	low	high
D	low	low

17 When chlorine gas dissolves in water a reaction occurs.

$$Cl_2 + H_2O \rightarrow HCl + HClO$$

Which row of the table identifies the oxidation number for chlorine in the chlorine-containing species?

	Cl_2	HCl	$HClO$
A	−1	−1	−1
B	0	−1	−1
C	−1	+1	+1
D	0	−1	+1

18 Four different solutions, J, K, L and M, are tested with universal indicator.

solution	J	K	L	M
colour with universal indicator	green	red	purple	orange

Which solutions are acidic?

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

19 Which solution has the lowest pH?

A $0.1\,mol/dm^3$ ammonia solution

B $0.1\,mol/dm^3$ ethanoic acid

C $0.1 mol/dm^3$ hydrochloric acid

D $0.1\,mol/dm^3$ lithium hydroxide

20 Magnesium, calcium, strontium and barium are Group II elements.

Group II elements follow the same trends in reactivity as Group I elements.

Which statements about Group II elements are correct?

1 Calcium reacts faster than magnesium with water.

2 Barium reacts less vigorously than magnesium with dilute acid.

3 Strontium oxidises in air more slowly than barium.

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

21 Chlorine, bromine and iodine are elements in Group VII of the Periodic Table.

Which statement about these elements is correct?

A The colour gets lighter down the group.

B The density decreases down the group.

C They are all gases at room temperature and pressure.

D They are all non-metals.

22 Which row describes the properties of a typical transition element?

	melting point	variable oxidation number	can act as a catalyst
A	high	no	no
B	high	yes	yes
C	low	no	yes
D	low	yes	no

23 Which statement about the noble gases is correct?

A Noble gases are diatomic molecules.

B Noble gases are reactive gases.

C Noble gases have full outer electron shells.

D The noble gases are found on the left-hand side of the Periodic Table.

24 What is a property of **all** metals?

A conducts electricity

B hard

C low melting point

D reacts with water

25 Which statement explains why aluminium is used in the manufacture of aircraft?

A It conducts heat well.

B It has a low density.

C It is a good insulator.

D It is easy to recycle.

26 The section of the reactivity series shown includes a newly discovered metal, symbol X.

Ca
Mg
Fe
X
H
Cu

The only oxide of X has the formula XO.

Which equation shows a reaction which occurs?

A $Cu(s) + X^{2+}(aq) \rightarrow Cu^{2+}(aq) + X(s)$

B $2X(s) + Cu^{2+}(aq) \rightarrow 2X^{+}(aq) + Cu(s)$

C $X(s) + Fe_2O_3(s) \rightarrow 2Fe(s) + 3XO(s)$

D $X(s) + 2HCl(aq) \rightarrow XCl_2(aq) + H_2(g)$

27 Which metal compound produces a gas that turns limewater milky when it is heated with a Bunsen burner?

A copper(II) carbonate

B magnesium nitrate

C sodium sulfate

D zinc nitrate

28 Which statement about the extraction of iron in a blast furnace is correct?

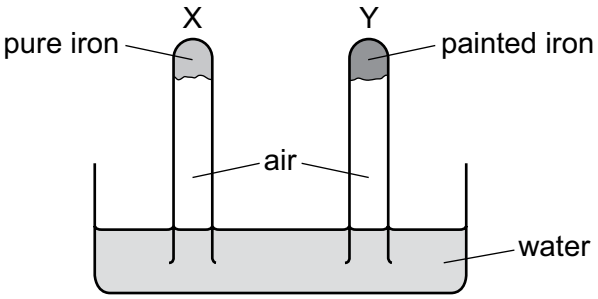
A Calcium oxide reacts with basic impurities.

B Carbon is burnt to provide heat.

C Iron(III) oxide is reduced to iron by carbon dioxide.

D The raw materials are bauxite, limestone and coke.

29 An experiment to investigate the effect of painting iron is shown.



The experiment is left for seven days.

What happens to the water level in test-tubes X and Y?

	test-tube X	test-tube Y
A	falls	rises
B	no change	no change
C	rises	falls
D	rises	no change

30 Bauxite contains aluminium oxide.

Aluminium is extracted from aluminium oxide by electrolysis.

Which statement is a reason for why cryolite is added to the electrolytic cell used to extract aluminium?

A Cryolite decreases the rate at which aluminium ions are discharged.

B Cryolite lowers the melting point of the electrolyte mixture.

C Cryolite prevents the carbon anodes being burned away.

D Cryolite removes impurities from the bauxite.

31 Oxides of nitrogen are formed in car engines and are a source of air pollution.

To decrease this pollution, catalytic converters are fitted to car exhausts.

What happens to the oxides of nitrogen in the catalytic converter?

A combustion

B cracking

C oxidation

D reduction

32 Ammonia is manufactured by the Haber Process.

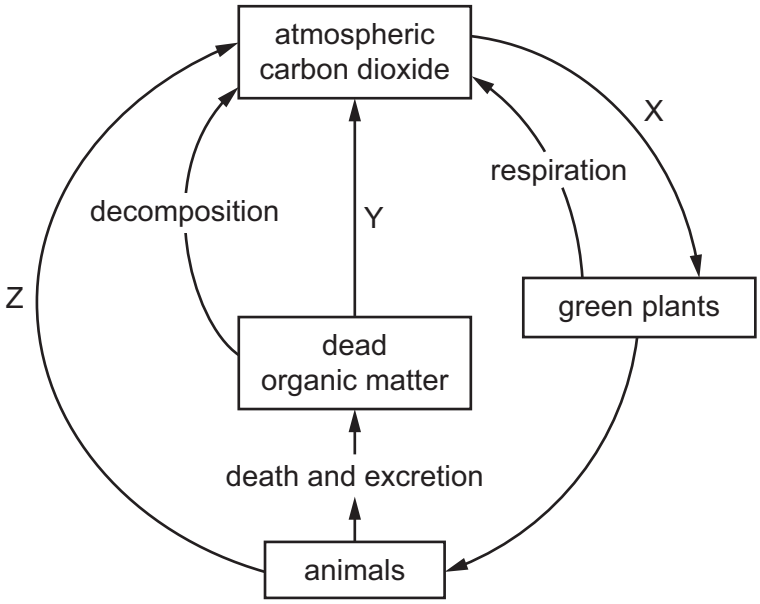
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

The forward reaction is exothermic.

Which conditions maximise the yield of ammonia?

	pressure	temperature
A	high	high
B	high	low
C	low	high
D	low	low

33 The carbon cycle is shown.



Which row describes processes X, Y and Z?

	X	Y	Z
A	respiration	combustion	photosynthesis
B	respiration	photosynthesis	combustion
C	photosynthesis	combustion	respiration
D	photosynthesis	respiration	combustion

34 Which row shows the conditions used in the Contact process?

	temperature / °C	pressure / atm	catalyst
A	25	2	iron
B	25	200	iron
C	450	2	vanadium(V) oxide
D	450	200	vanadium(V) oxide

35 Which statement about elements in Group I and Group VII of the Periodic Table is correct

? **A** Bromine reacts with potassium chloride to produce chlorine.

B Iodine is a monatomic non-metal.

C Lithium has a higher melting point than potassium.

D Sodium is more reactive with water than potassium.

36 Which statement about elements in Group VIII of the Periodic Table is correct?

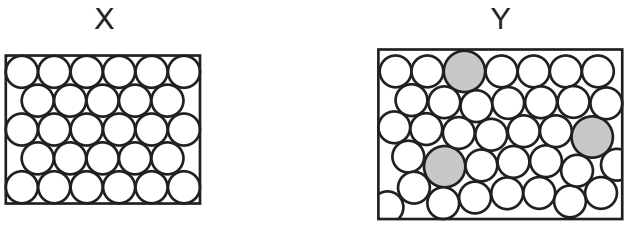
A They all have a full outer shell of electrons.

B They all react with Group I elements to form ionic compounds.

C They are all diatomic molecules.

D They are all liquids at room temperature.

37 The diagrams show the structure of two substances used to make electrical conductors.



Which statement correctly describes X and Y?

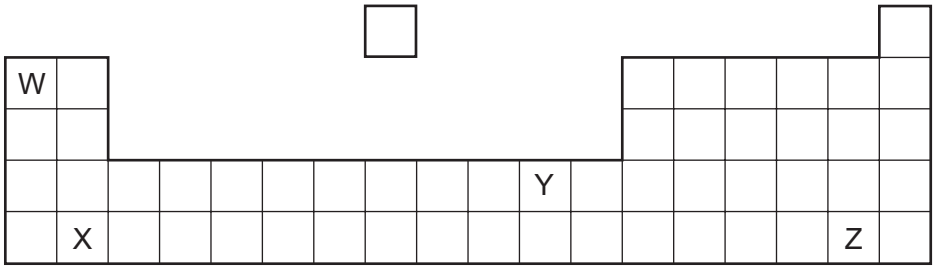
A X is a pure metal and Y is a compound.

B X is a pure metal and Y is an alloy.

C X is a solid and Y is a liquid.

D X is harder and stronger than Y.

38 The positions of elements W, X, Y and Z in the Periodic Table are shown.



Which elements form basic oxides?

A W, X and Y **B** W and X only **C** Y only **D** Z only

39 Ethanoic acid is a weak acid.

Hydrochloric acid is a strong acid.

Which statements are correct?

1 Ethanoic acid molecules are partially dissociated into ions.

2 1.0 mol / dm^3 ethanoic acid has a higher pH than 1.0 mol / dm^3 hydrochloric acid.

3 Ethanoic acid is always more dilute than hydrochloric acid.

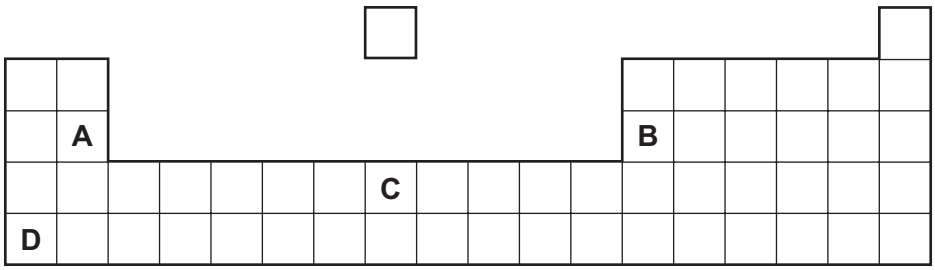
4 Ethanoic acid is a proton acceptor.

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

40 The properties of an element are shown.

electrical conductivity	density	reaction with water
high	low	reacts violently with cold water

Which element has these properties?



The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							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	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

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.).