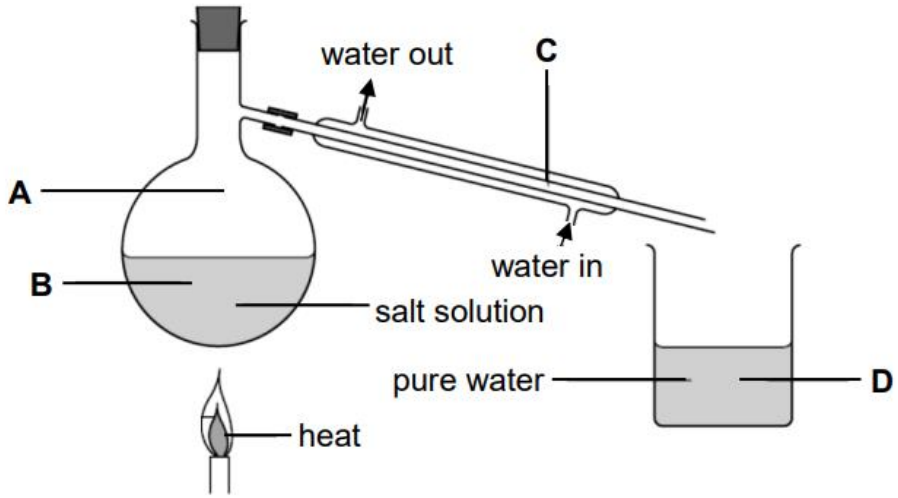
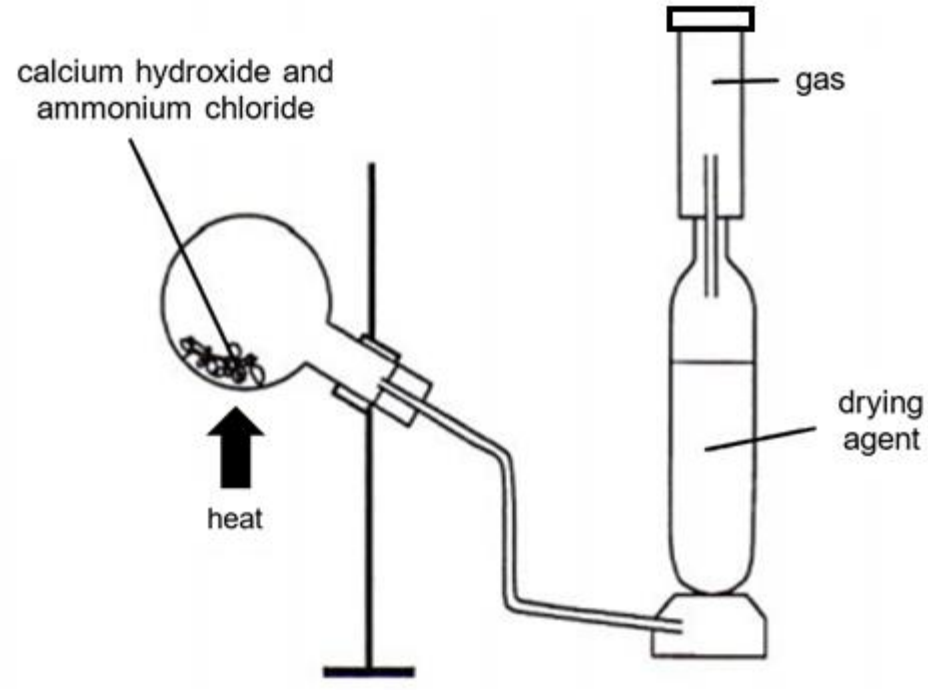
1 The diagram shows how to obtain pure water from salt solution.

Where do water molecules lose energy?



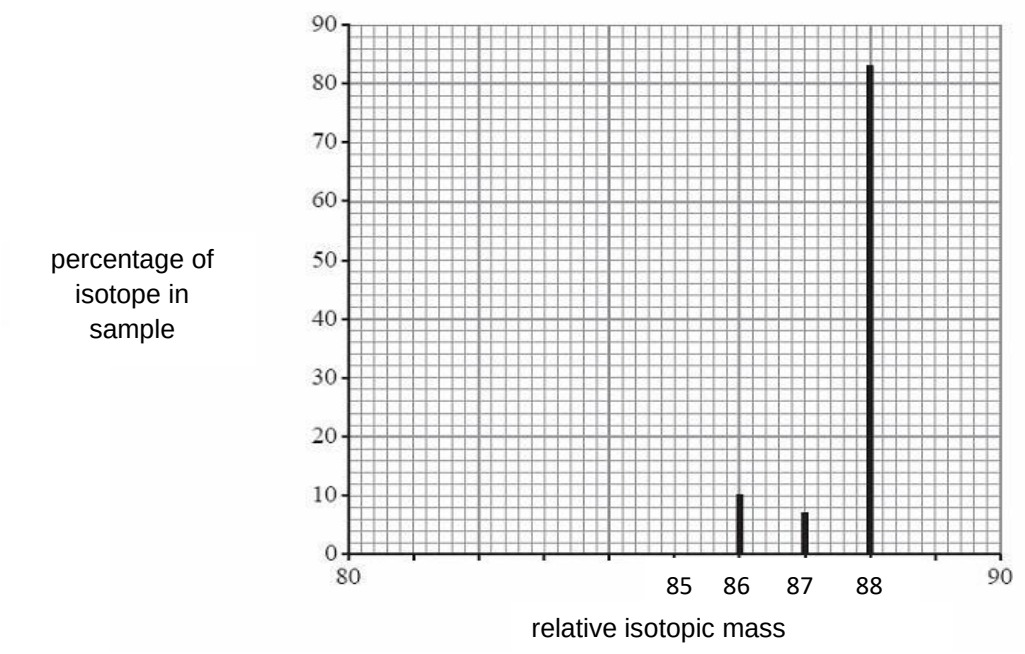
2 A student sets up the following apparatus to collect a gas.



What is the possible identity of the gas and drying agent?

	gas	drying agent
A	hydrogen chloride	calcium oxide
B	hydrogen chloride	concentrated sulfuric acid
C	ammonia	concentrated sulfuric acid
D	ammonia	calcium oxide

3 Strontium is used in fireworks to produce crimson flames. The graph below shows the relative masses of three naturally occurring isotopes of strontium and their percentages in a sample of strontium.



What is the relative atomic mass of naturally occurring strontium?

A 86.5

B 87.4

C 87.7

D 88.0

4 The R_f values for the colours, **E**, **F**, **G** and **H**, in four different solvents are shown in the table.

	solvent			
	water	ethanol	propanone	hexane
E	0.3	0.5	0.6	0.5
F	0.3	0.7	0.9	0.2
G	0.7	0.8	0.3	0.1
H	0.1	0.6	0.6	0.2

Which solvent could be used to separate a mixture of all four colours **E**, **F**, **G** and **H**?

A water

B ethanol

C propanone

D hexane

5 Hydrogen sulfide, H_2S, is a colourless and poisonous gas. The melting point of hydrogen sulfide is −82 °C and the boiling point is −60 °C.

Which statement correctly describes the particles of hydrogen sulfide at −75 °C?

A closely packed, moving freely

B closely packed, vibrating slightly

C far apart, moving freely

D far apart, vibrating slightly

6 An ion contains 8 protons, 8 neutrons and 10 electrons. What is its nucleon number?

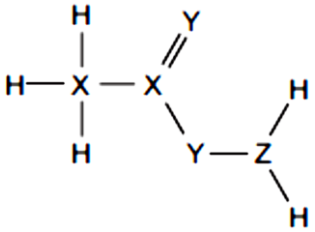
A 8

B 16

C 18

D 26

7 The diagram shows the structure of a covalent compound containing the element hydrogen, H, and the unknown elements X, Y and Z.



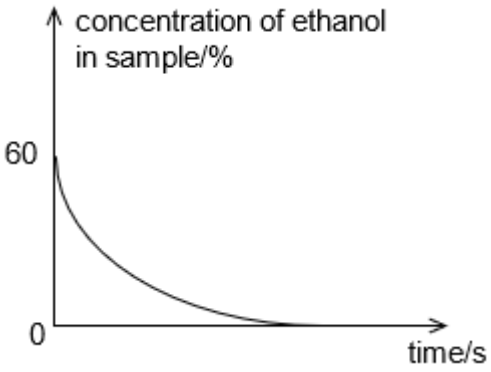
How many outer electrons do each of the three elements, X, Y and Z possess?

	X	Y	Z
A	3	6	5
B	4	2	6
C	4	6	5
D	4	6	3

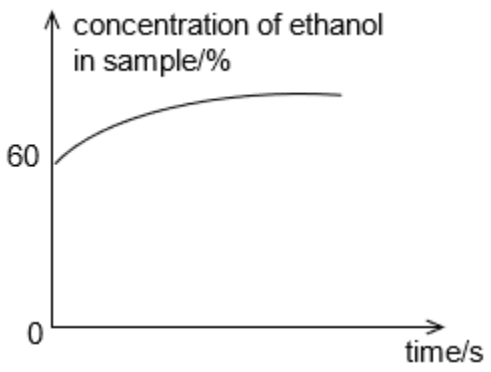
8 Whisky is a beverage composed of mainly water and ethanol. Ethanol boils at 78 °C. A sample of Scotch Whisky that is made up of 40% of ethanol by volume is distilled using fractional distillation.

Which graph shows the change in concentration of ethanol in the sample as the distillation proceeds?

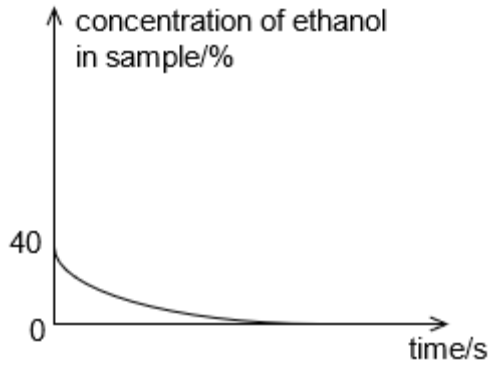
A



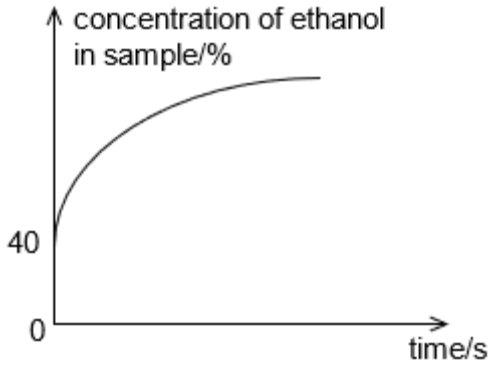
B



C



D



9 Q is an element in the Periodic Table. Which of the following represents an isotope of $^{81}_{35}$Q?

A $^{81}_{37}$Q

B $^{81}_{33}$Q

C $^{79}_{35}$Q

D $^{79}_{33}$Q

10 Which method is most suitable for preparing calcium nitrate crystals?

A Add excess calcium carbonate to nitric acid. Filter and crystallise the filtrate.

B Add equal volumes of aqueous calcium chloride and aqueous sodium nitrate together and filter.

C Add excess nitric acid to calcium oxide. Crystallise the mixture.

D Titrate equal volumes of nitric acid and calcium chloride. Crystallise the mixture.

11 Some properties of substances **J**, **K**, **L** and **M** are given in the table below.

substance	percentage composition by mass	electrical conductivity when solid	effect of heat
J	fixed	yes	solid burns brightly to form an oxide.
K	fixed	no	solid decomposes to form simpler substances.
L	varies	yes	solid melts
M	varies	no	liquid burns to form carbon dioxide and water.

Which classification of the substances as an element, a mixture or a compound is correct?

	element	compound	mixture
A	**K**	**J**	**L**, **M**
B	**J**, **K**	**M**	**L**
C	**J**	**K**, **L**	**M**
D	**J**	**K**	**L**, **M**

12 Which statement(s) is/are true about 1.0 mol/cm^3 of dilute ethanoic acid, 1.0 mol/cm^3 of dilute sulfuric acid and 1.0 mol/cm^3 of dilute hydrochloric acid?

1 All three acids have the same concentration of hydrogen ions.
2 The rate of reaction with magnesium carbonate is the same for hydrochloric acid and sulfuric acid.
3 The rate of reaction with magnesium is fastest for sulfuric acid and slowest for ethanoic acid.
4 Sulfuric acid has twice the concentration of hydrogen ions as compared to hydrochloric acid.

A 1 and 2

B 1, 2 and 3

C 3 only

D 3 and 4

13 Which oxide is insoluble in aqueous sodium hydroxide?

A iron(III) oxide

B carbon dioxide

C lead(II) oxide

D sulfur dioxide

14 512 g of sulfur vapour has the same volume as 64 g of oxygen gas at the same temperature and pressure. What is the formula of a molecule of sulfur?

A S

B S_4

C S_8

D S_{16}

15 Which of the following is the correct ionic equation for the reaction between aqueous sodium carbonate and dilute hydrochloric acid?

A $H^+ + OH^- \rightarrow H_2O$

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

C $2H^+ + Na_2CO_3 \rightarrow H_2O + CO_2 + 2Na^+$

D $2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$

16 0.30 mol of a compound contains 14.4 g of oxygen, 4.8 g of hydrogen and 28.8 g of carbon. What is the empirical formula of the compound?

A C_2H_5O

B C_3H_5O

C $C_8H_{16}O_3$

D $C_{29}H_4O_{14}$

17 Which volume of 0.1 mol/dm^3 sulfuric acid is required to react completely with 20 cm^3 of 0.2 mol/dm^3 lithium hydroxide solution?

A $\frac{20\times0.2}{0.1}$

B $\frac{20\times0.2}{2\times0.1}$

C $\frac{20\times0.1}{0.2}$

D $\frac{20\times0.1}{2\times0.2}$

18 An excess of dilute nitric acid was added separately to the following.

1 4.8 g of magnesium
2 8.4 g of magnesium carbonate
3 4.0 g of magnesium oxide, then warmed

Which of the following options is correct?

A The number of moles of magnesium nitrate formed is the greatest in reaction 1.

B The number of moles of magnesium nitrate formed is the greatest in reaction 2.

C The number of moles of magnesium nitrate formed is the greatest in reaction 3.

D The number of moles of magnesium nitrate formed is the same for all 3 reactions.

19 Which pair of statements describes the differences between the conduction of electricity in the electrolyte and the conduction of electricity in a platinum electrode during electrolysis?

	conduction of electricity in electrolyte	conduction of electricity in platinum electrode
1	current due to movement of ions	current due to movement of ions and electrons
2	charged particles move in opposite directions	charged particles move in a single direction
3	results in a chemical change	does not result in a chemical change

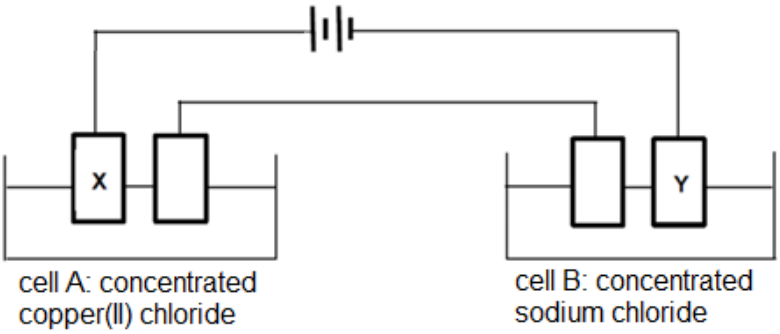
A 2 only

B 1 and 2 only

C 2 and 3 only

D 1, 2 and 3 only

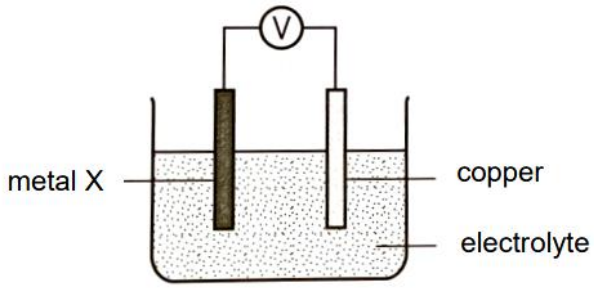
20 A student carried out an experiment involving the electrolysis of concentrated copper(II) chloride in cell A and concentrated sodium chloride in cell B using inert electrodes.



What are the ionic equations that occur at electrode X and Y at the start of the electrolysis?

	electrode X	electrode Y
A	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	$2H^+ + 2e^- \rightarrow H_2$
B	$2Cl^- \rightarrow Cl_2 + 2e^-$	$2H^+ + 2e^- \rightarrow H_2$
C	$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$	$Na^+ + e^- \rightarrow Na$
D	$2Cl^- \rightarrow Cl_2 + 2e^-$	$Na^+ + e^- \rightarrow Na$

21 The diagram below shows a simple cell.



metal X	voltmeter reading when connected to copper/ V
magnesium	3.2
iron	
zinc	2.4
lead	0.8

Study the information given in the table above. What could be the possible voltmeter reading for iron?

A 0.5 V

B 1.7 V

C 2.8 V

D 3.9 V

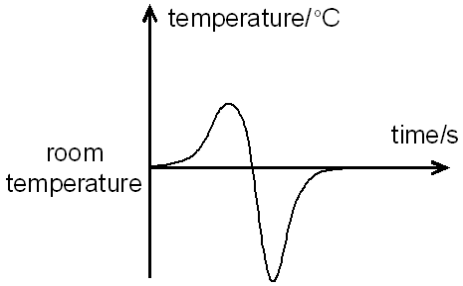
22 In a particular two-step chemical reaction, step 2 occurs immediately after step 1 is complete. X is converted to Y in step 1, while Y is converted to Z in step 2. The enthalpy change of both reactions are also given.

$$X \xrightarrow{\text{step 1}} Y \xrightarrow{\text{step 2}} Z$$

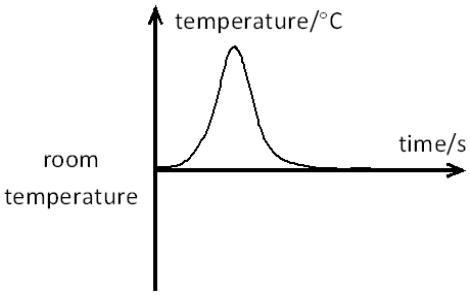
	sign of ΔH	energy change/kJ
step 1	negative	200
step 2	positive	350

Which graph shows the temperature change that will occur for the two-step chemical reaction?

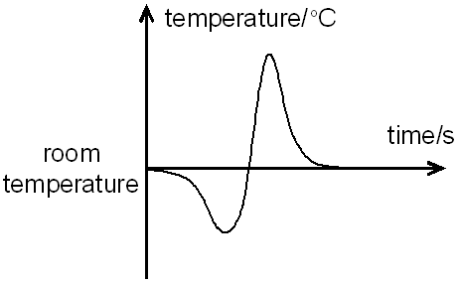
A



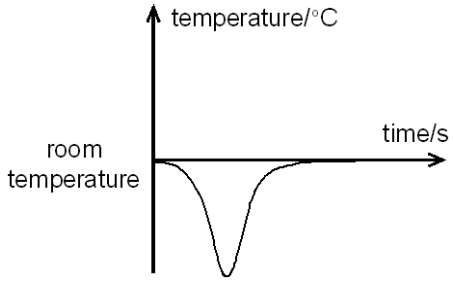
B



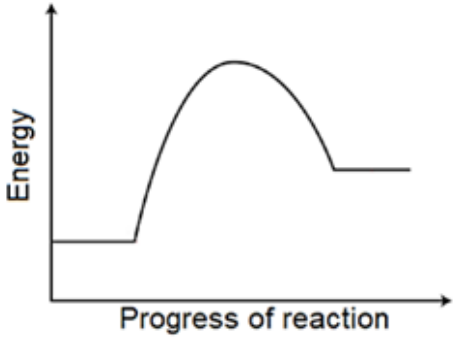
C



D



23 The energy profile diagram of a reaction is given.



Which reaction **cannot** be represented by this diagram?

A C_2H_4 (g) + $3O_2$ (g) → $2CO_2$ (g) + $2H_2O$ (g)

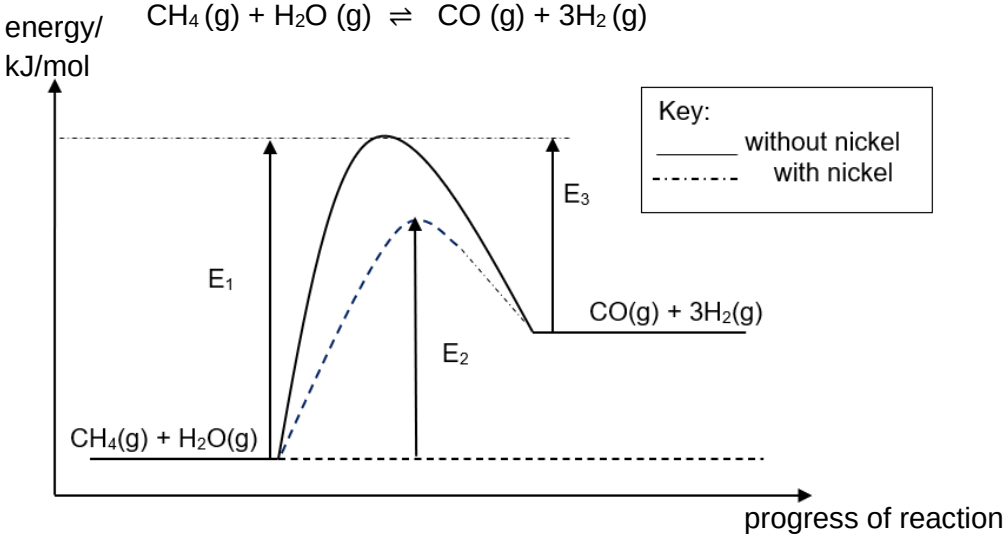
B $6CO_2$ (g) + $6H_2O$ (*l*) → $C_6H_{12}O_6$ (s) + $6O_2$ (g)

C H_2O (g) → 2H (g) + O (g)

D $PbCO_3$ (s) → PbO (s) + CO_2 (g)

24 In the steam reforming reaction, methane reacts with steam to give carbon monoxide and hydrogen.

$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$



The diagram shows the energy profile diagram of the reaction carried out with and without nickel.

Which statement is correct?

A The value of the enthalpy change of the forward reaction is E_1- E_3.

B In the presence of nickel, the activation energy of the backward reaction is E_2.

C Nickel increases the yield of carbon monoxide and hydrogen.

D The enthalpy change of the backward reaction is E_3.

25 Substance X, which is not brown, was bubbled into a solution containing sodium iodide and sodium chloride. The solution turned brown.

Based on this observation, which of the following statements can be deduced about substance X?

1 Substance X is an oxidising agent.
2 Substance X must be bromine gas.
3 The iodide in the solution was reduced to aqueous iodine.

A 1 only

B 1 and 2 only

C 1 and 3 only

D 2 and 3 only

26 A student performs two experiments at room temperature.

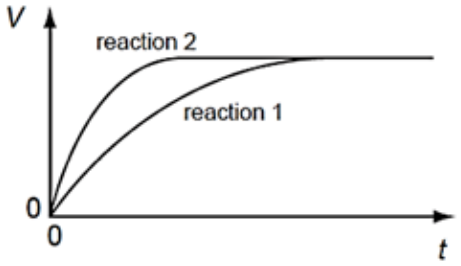
In experiment 1, 10 g of magnesium ribbon was reacted with excess 2.0 mol/dm^3 of dilute hydrochloric acid.

In experiment 2, 5 g of magnesium powder was reacted with excess 2.0 mol/dm^3 of dilute hydrochloric acid.

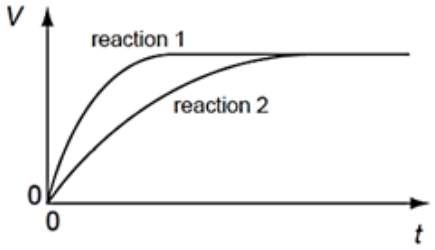
In both experiments, the volume of hydrogen, *V*, was plotted against time, *t*.

Which set of graphs is correct?

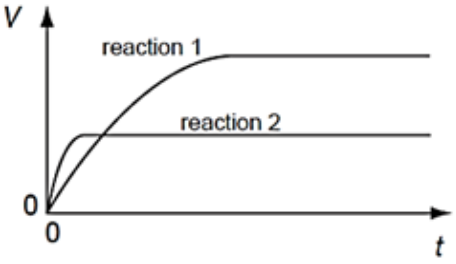
A



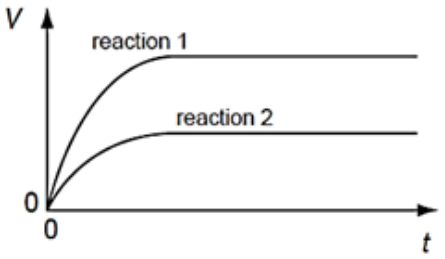
B



C



D



27 Lead reacts with dilute nitric acid at a constant temperature of 30^{o}C.

Which statement about the rate of reaction is correct?

A It decreases then increases as the reaction proceeds.

B It increases as the reaction proceeds.

C It remains the same as the reaction proceeds

D It decreases as the reaction proceeds.

28 Which formula contains nitrogen with an oxidation state of +5?

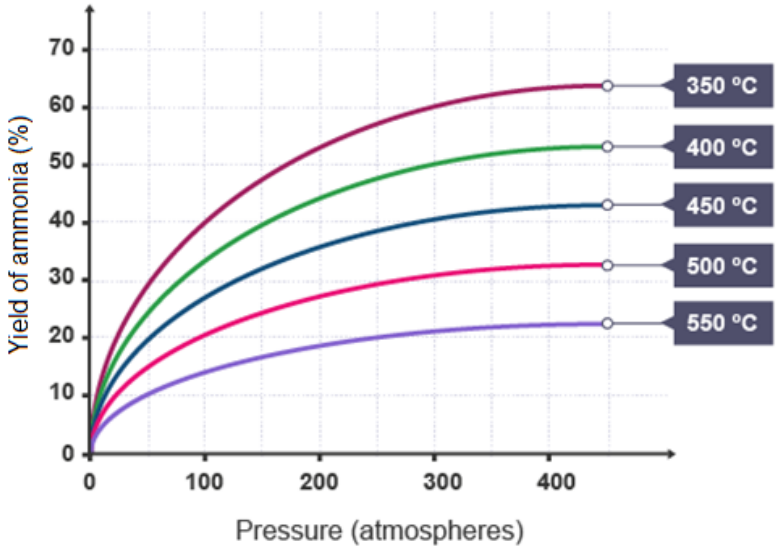
A NO_2

B N_2O_4

C NH_4^+

D HNO_3

29 The Haber process is carried out at 250 atmospheres and 450 °C.



According to the graph, at 450 °C., the yield of ammonia is highest at 450 atm.
What is the reason why the Haber process is carried out at 250 atm instead?

A The rate of reaction would be much slower at 250 atm.

B The high pressure requires very expensive reinforced equipment.

C The high pressure causes a slower rate of reaction.

D A low pressure would cause the gases to leak out.

30 A student has a solution of chloride ions and another solution of sulfate ions. He does not have any aqueous silver nitrate or aqueous barium nitrate with him.

Which of the following options show the correct reagent and its corresponding observation that can help to differentiate the two solutions?

	reagent	observation
A	lead(II) nitrate	white ppt formed in sulfate solution only
B	lead(II) nitrate	white ppt formed in chloride solution only
C	calcium nitrate	white ppt formed in sulfate solution only
D	calcium nitrate	white ppt formed in chloride solution only

31 A newly discovered element, tennessine, is placed in Group VII of the Periodic Table. It has a relative atomic mass of 294. What property is tennessine likely to have?

A It forms a black compound with sodium.

B It reacts with aqueous potassium iodide.

C It is a dark green gas at room temperature.

D It is displaced by fluorine from a compound made from potassium and tennessine.

32 Which pair of compounds shows that transition elements have variable oxidation states?

A Ni_3P and $NiCl_2$

B $CuSO_4$ and $CuCl_2$

C Cr_2O_3 and $CrBr_3$

D $Fe_3(PO_4)_2$ and $FeCl_2$

33 An iron object is galvanised with zinc coating.

Which of the following statements describes what happens to the object and the zinc coating when the surface of the object is scratched?

	iron object	zinc coating
A	starts to rust	remains unchanged
B	starts to rust	continues to corrode
C	remains unchanged	continues to corrode
D	remains unchanged	remains unchanged

34 Some properties of four metals, P, Q, R and S, are shown in the table.

element	observations
P	reacts vigorously with cold water
Q	does not react with water
R	reacts vigorously in hot water
S	reacts slowly in steam

Which of the following shows the arrangement of the reactivity of the metals from the least reactive to the most reactive?

A P > R > S > Q

B Q > S > R > P

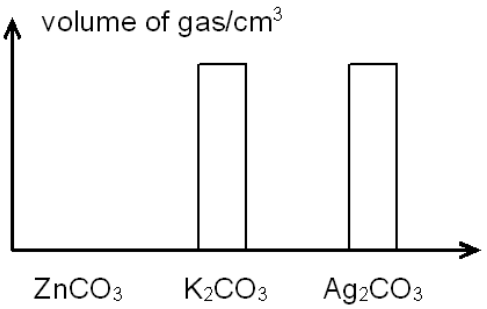
C Q > S > P > R

D S > R > P > Q

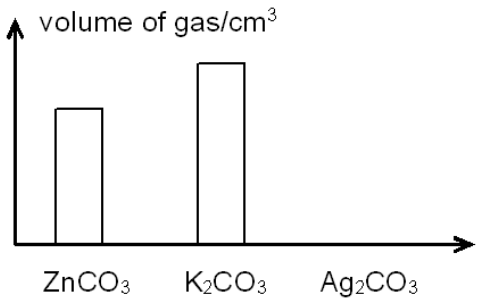
35 Equal moles of carbonates of zinc, potassium and silver were heated strongly.

Which graph best shows the relative volume of gas collected in the first minute of the reaction?

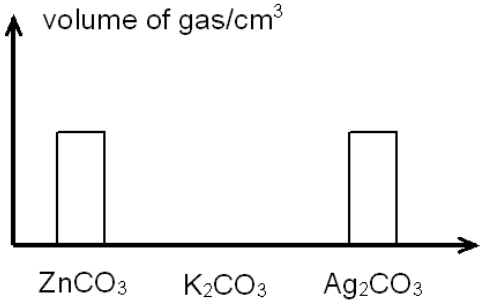
A



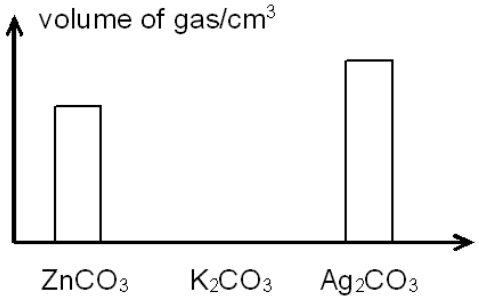
B



C



D



36 Which of the air pollutants is **not** matched correctly to its source?

	air pollutant	source
A	nitrogen dioxide	volcanic activity
B	nitrogen dioxide	internal combustion engines of cars
C	carbon monoxide	incomplete combustion of fossil fuels
D	sulfur dioxide	combustion of fossil fuels

37 Which pollutants can be removed from the car exhaust by a catalytic converter?

1 carbon monoxide
2 oxides of nitrogen
3 unburnt hydrocarbons
4 sulfur dioxide

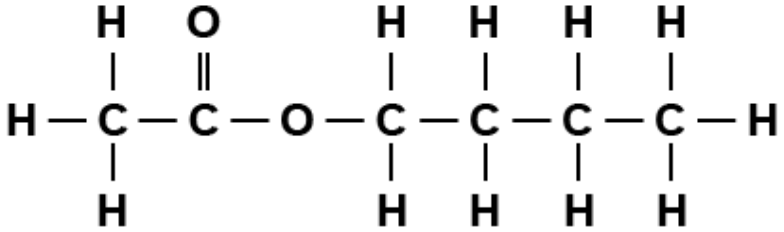
A 1 and 2 only

B 2 and 4 only

C 1, 2 and 3 only

D 1, 2, 3 and 4

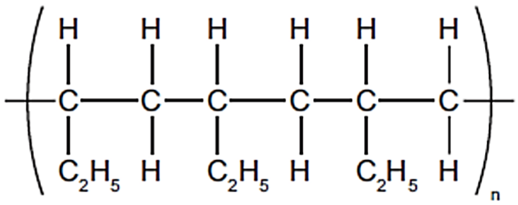
38 A food chemist wants to create the odour of pineapples using the organic compound below.



Which row correctly shows the pair of reactants that would react to form this compound and the name of the compound?

	reactant 1	reactant 2	name of the compound
A	CH_3COOH	$CH_3CH_2CH_2CH_2OH$	ethyl butanoate
B	CH_3COOH	$CH_3CH_2CH_2CH_2OH$	butyl ethanoate
C	CH_3CH_2OH	$CH_3CH_2CH_2COOH$	ethyl butanoate
D	CH_3CH_2OH	$CH_3CH_2CH_2COOH$	butyl ethanoate

39 A section of a polymer chain is shown below.



Which row correctly describes the molecule used to make this polymer, and the type of polymerisation involved?

	molecule	type of polymerisation
A	CH_3-CH=CH-CH_3	addition
B	CH_2=CH-CH_2-CH_3	addition
C	CH_3-CH_2-CH_2-CH=CH_2	condensation
D	CH_3-CH_2-CH=CH_2	condensation

40 When one mole of decane, $C_{10}H_{22}$, is cracked, only three compounds are formed.

What are the compounds and their numbers formed?

A 2 moles of propene, 1 moles of butane, 1 moles of hydrogen

B 2 moles of butene, 1 moles of ethane, 1 moles of hydrogen

C 1 moles of propane, 3 moles of ethene, 1 moles of methane

D 2 moles of propene, 1 moles of ethane, 1 moles of ethene

**End of Paper**