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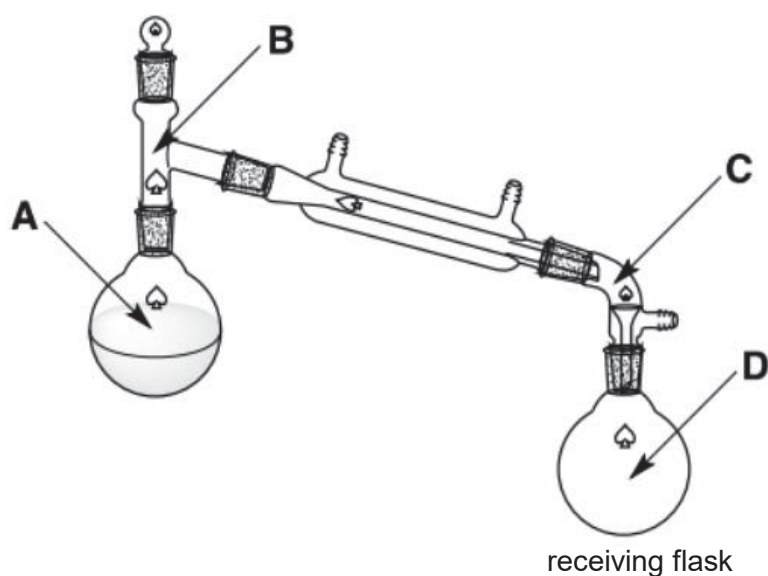
- 1 20.0 cm³ of 0.50 mol/dm³ dilute hydrochloric acid was added to three samples of 25.0 cm³ aqueous sodium carbonate of different concentrations to compare the rate of carbon dioxide production.

Which apparatus is **not** required to carry out the above experiment?

- A burette
- B filter funnel
- C gas syringe
- D stopwatch

- 2 A student is distilling a mixture of saltwater to obtain pure water.

Which point of the experimental set-up will have temperature of 100 °C when the first drop of distillate is collected in the receiving flask?



- 3 Ink X melts at 10 °C and boils at 90 °C. It does not dissolve in water and also does not react with water.

Which method is most suitable for separating X from a mixture of substance X and water?

- A chromatography
- B distillation
- C filtration
- D separating funnel

- 4 Aqueous sodium hydroxide was added to a mixture of an aqueous solution of Z. On warming, ammonia gas evolved. When aluminium foil is added to the reaction mixture and warmed, more ammonia gas was given off.

What could chemical Z be?

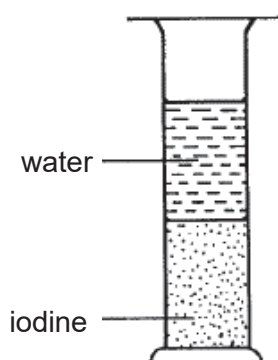
- A aluminium nitrate
- B aluminium sulfate
- C ammonium nitrate
- D ammonium sulfate

- 5 Aqueous ammonia has a pH of 11.

Which of the following is true of the resulting mixture after the addition of excess aqueous aluminium nitrate?

	observations	pH
A	colourless solution	decreases
B	colourless solution	increases
C	white precipitate	decreases
D	white precipitate	increases

- 6 An experiment was set up as shown below.

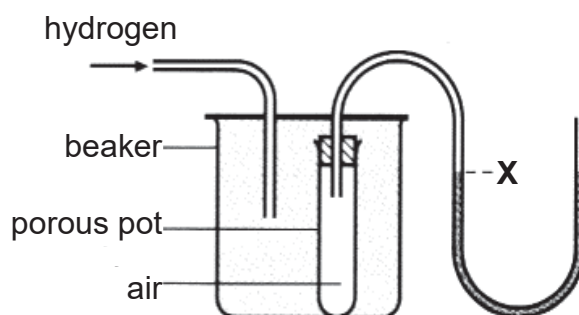


It was observed that after leaving it for several days, the liquid in the jar had the same colour throughout.

What was the cause of this observation?

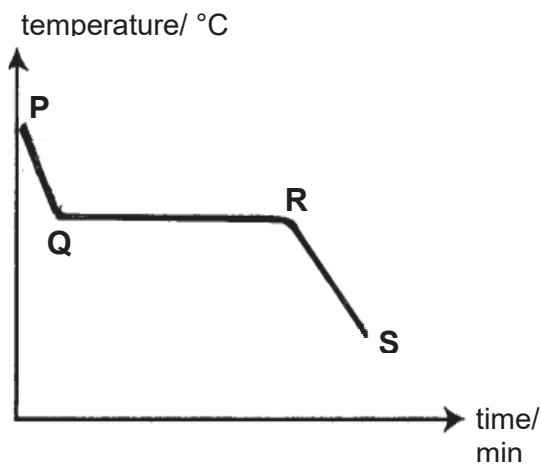
- A The movement of iodine and water molecules.
- B The movement of iodine molecules.
- C The movement of iodide ions and iodine atoms.
- D The movement iodide ions and water molecules.

- 7 The apparatus can be used to show the diffusion of gases. Air is present in the porous pot. The beaker is filled with hydrogen. Assume all gases are at the same temperature and pressure.



What would happen to the water level at X over time?

- A** The water level at X will remain unchanged.
B The water level at X will rise and then return to its original position.
C The water level at X will drop and then return to its original position.
D The water level at X will drop and remains there.
- 8 A sample of solid Y is heated until it is completely melted. The graph shows how its temperature varies with time as molten Y is cooled.



Which of the following statements are true about the particles in Y?

- 1 They are closer to each other at stage RS than at stage PQ.
 - 2 The forces of attraction are stronger at stage P than at stage S.
 - 3 The arrangement is more orderly at stage RS than at stage PQ.
 - 4 Their total energy content at stage QR is lower than at stage RS.
- A** 1 and 3 are correct
B 1 and 4 are correct
C 2 and 3 are correct
D 2 and 4 are correct

- 9 A student gave four statements about elements, compounds and mixtures to show his understanding.

Statement 1: Elements and compounds have fixed melting points.

Statement 2: The properties of a compound are similar to that of its elements.

Statement 3: A mixture can be separated into its components by physical means.

Statement 4: Elements can exist either in the form of atoms or molecules.

Which of the statements are correct?

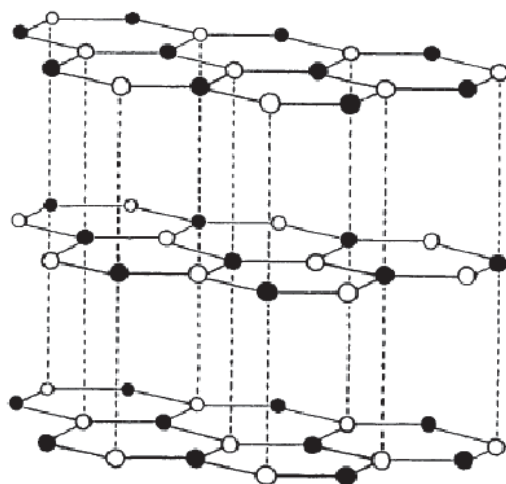
- A** Statements 1 & 2 only
B Statements 1, 2 and 3 only
C Statements 1, 3 and 4 only
D Statements 2, 3 and 4 only
- 10 Which statement on the number of electrons is true?
- A** Ne has more electrons than F^-
B F^- has more electrons than Na^+
C Cu^{2+} has more electrons than Cu^+
D Na has more electrons than Na^+
- 11 Which definition of isotopes is correct?
- A** Isotopes are atoms of the same element with different numbers of electrons.
B Isotopes are atoms of the same element with different numbers of neutrons.
C Isotopes are atoms with the same number of neutrons and different numbers of protons.
D Isotopes are atoms with the same physical properties and different chemical properties.
- 12 Compound L contains two elements, metal M and non-metal, N.

L consists of a lattice of positive and negative ions. Each positive ion is surrounded by four anions and each negative ion is surrounded by two cations.

What ions are present in compound L and what is its formula?

	ions present	formula
A	$M^{2+}N^-$	MN_2
B	M^+N^{2-}	M_2N
C	N^+M^{2-}	N_2M
D	$N^{2+}M^-$	NM_2

- 13 The diagram shows the structure of boron nitride.



Key:

- boron
○ nitrogen

Which property is boron nitride expected to have?

- A** It is soluble in water.
B It has low melting point.
C It is soft and can act as lubricant.
D It does not conduct electricity in solid state but conducts electricity in molten state.
- 14 Which of the following has a mass equal to the mass of one mole of H_2O ?
- A** 0.5 mole of O_2
B one mole of steam
C one molecule of water
D two moles of H_2 and one mole of O_2

- 15 An acid, W, contains the elements carbon, hydrogen and oxygen. The composition by mass of each element is shown.

element in W	percentage composition by mass (%)
carbon	35.8
hydrogen	4.5
oxygen	59.7

What is the empirical formula of W?

- A CH₂O
B C₂H₃O₃
C C₄H₆O₅
D C₈H₁₂O₁₀
- 16 A piece of chalk has a mass of 23.0 g. Chalk is impure calcium carbonate. When analysed, the piece of chalk is found to contain 0.226 moles of pure calcium carbonate.

What is the percentage purity of the piece of chalk?

- A 0.983%
B 1.70%
C 77.0%
D 98.3%
- 17 1.0 mole of Cu₃FeS₃ and 1.0 mole of O₂ are allowed to react according to the equation.



Which of the following is true?

- A 0.286 mole of Cu₃FeS₃ remains unreacted
B 0.714 mole of Cu₃FeS₃ remains unreacted
C 5.0 moles of O₂ remains unreacted
D all reactants are used up at the end of reaction

- 18 Which of the following will be observed when concentrated sodium bromide is electrolysed using inert electrodes?
- A a layer of bromine deposit on the positive electrode
 - B a gas evolved at the positive electrode
 - C a gas evolved from one electrode and a brown liquid at the other electrode
 - D a gas evolved at both electrodes

- 19 What happens when molten lead(II) chloride is electrolysed?

- A chloride ions gain electrons at the positive electrode
- B chloride ions lose electrons at the negative electrode
- C lead(II) ions gain electrons at the negative electrode
- D lead(II) ions lose electrons at the positive electrode

- 20 During electrolysis of molten silver bromide using graphite electrodes, 0.5 mol of electrons was passed through the electrolytic cell.

What will be the mass of the products formed at the positive electrode?

	mass at positive electrode/g
A	27
B	40
C	54
D	80

- 21 In which instance is there no change in the concentration of solution during electrolysis?

- A concentrated sodium chloride solution between carbon electrodes
- B concentrated sodium chloride solution between platinum electrodes
- C copper(II) sulfate solution between carbon electrodes
- D copper(II) sulfate solution between copper electrodes

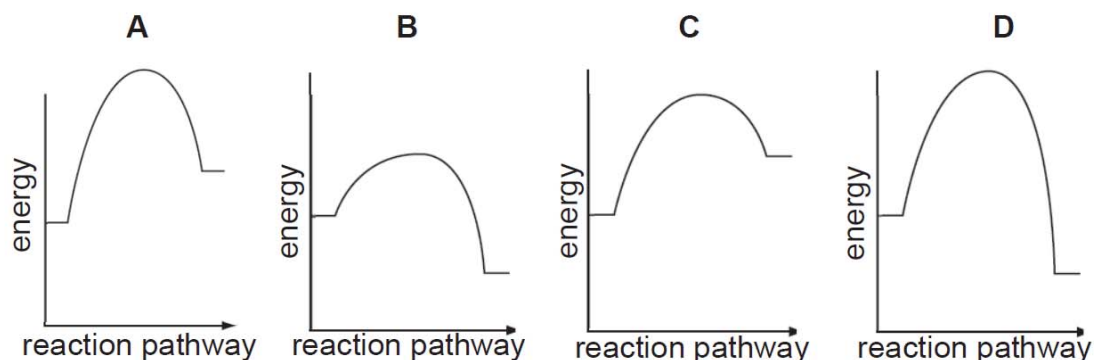
- 22 The table compares the strengths of bonds present in substances, P_2 , Q_2 and PQ_3 that are involved in the reaction shown below.



Which comparison of the strengths of the bonds will result in the most endothermic reaction?

	bonds in P_2	bonds in Q_2	bonds in PQ_3
A	strong	strong	weak
B	strong	weak	weak
C	weak	strong	strong
D	weak	weak	strong

- 23 The reaction profiles of four chemical reactions are given. Which one represents that of the slowest exothermic reaction?



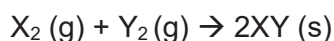
- 24 A sample of hydrogen peroxide is decomposed by a metal oxide catalyst.



What will increase if the experiment is repeated using a more effective catalyst?

- A** The amount of hydrogen peroxide left over at the end of the reaction.
- B** The initial gradient of a graph of total volume of gas produced against time.
- C** The time needed to produce a particular volume of gas.
- D** The total volume of gas produced at the end of the reaction.

- 25 X and Y are two elements which react to form the compound XY according to the equation below.



Which of the following are true?

- 1 Increasing the pressure has no effect on the total mass of XY obtained.
- 2 Every collision between X_2 and Y_2 molecules will result in a reaction to form XY.
- 3 A small fall in temperature will lead to a much higher frequency of collision of X_2 and Y_2 .
- 4 Increasing the pressure of X_2 alone has an effect on the reaction rate.

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

- 26 Which of the following reactions is **not** a redox reaction?

- A $2Fe + 3Cl_2 \longrightarrow 2FeCl_2$
 B $2FeCl_2 + Cl_2 \longrightarrow 2FeCl_3$
 C $Fe + 2FeCl_3 \longrightarrow 3FeCl_2$
 D $Fe_2O_3 + 6HCl \longrightarrow 2FeCl_3 + 3H_2O$

- 27 Small portions of potassium iodide (KI) and acidified potassium manganate(VII) were added separately to four solutions.

The observed colour changes are given in the table below.

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 solution(s) contain(s) an oxidizing agent?

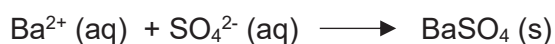
- A solution 2 only
 B solutions 1 and 2
 C solutions 1 and 3
 D solutions 2 and 4

- 28 The table contains data about two acids.

acid	concentration (mol/dm ³)	pH
hydrochloric acid	0.1	1.0
ethanoic acid	0.1	3.7

Why are the pH values of the two acids different?

- A Ethanoic acid contains carbon, hydrogen and oxygen.
 - B Ethanoic acid partially ionizes in water.
 - C Hydrochloric acid comprises smaller molecules.
 - D Hydrochloric acid releases fewer H⁺ ions in water.
- 29 The ionic equation for a reaction is shown below:



Which of the following conditions will allow this reaction to take place readily?

- A Barium nitrate is added to sodium sulfate.
 - B Barium carbonate is added to sulfuric acid.
 - C Barium nitrate is added to lead(II) sulfate.
 - D Barium chloride is added to lead(II) sulfate.
- 30 A solution of salt X gives an insoluble hydroxide Y on reacting with aqueous NaOH.

Y dissolves in excess aqueous NaOH to give solution Z. On adding aqueous HCl to Z, the precipitate Y reappears but dissolves in excess aqueous HCl.

What type of hydroxide is hydroxide Y?

- A acidic
- B amphoteric
- C basic
- D neutral

31 Element X reacts with oxygen to form Z.

Z changes the colour of damp litmus paper from blue to red.

What is element X?

- A argon
- B nitrogen
- C oxygen
- D sodium

32 Which statement about halogens is correct?

- A Their melting points increase on descending the group.
- B Their reactivities increase on descending the group.
- C They form covalent compounds with alkali metals.
- D They conduct electricity in all physical states.

33 Elements P, Q and R are all in the same period of the Periodic Table.

P is very unreactive and does not form compounds with other elements.

Solid Q does not conduct electricity.

R forms an oxide that is an ionic compound.

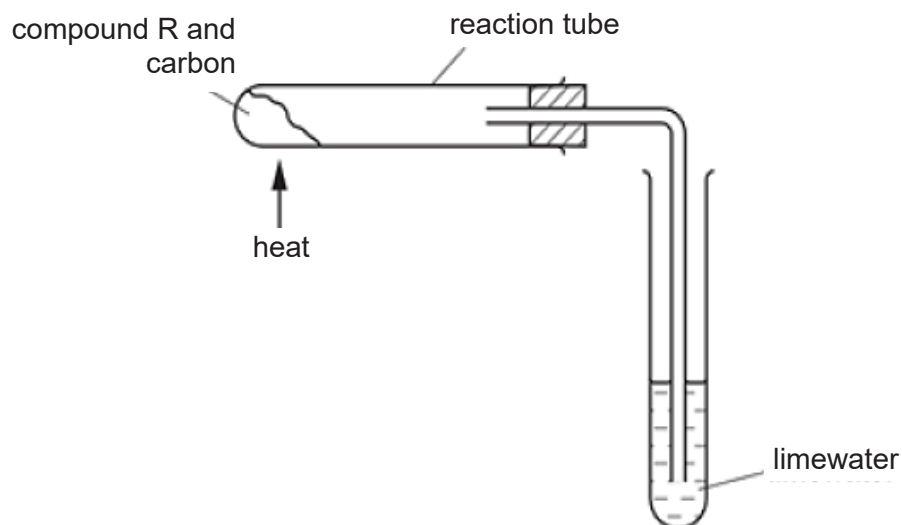
In which order do the elements appear in the Periodic Table?

- A P → Q → R
- B P → R → Q
- C R → P → Q
- D R → Q → P

34 Which of the following statements best explains why a higher temperature is not optimal for the Haber process?

- A Higher temperature would make it more difficult to separate ammonia gas from the reactants.
- B Higher temperature causes the formation of ammonia to be too fast.
- C Higher temperature causes reaction between ammonia and the reactants.
- D Higher temperature causes more ammonia gas to decompose back to nitrogen and hydrogen.

- 35 Compound R is heated with carbon using the apparatus shown below.



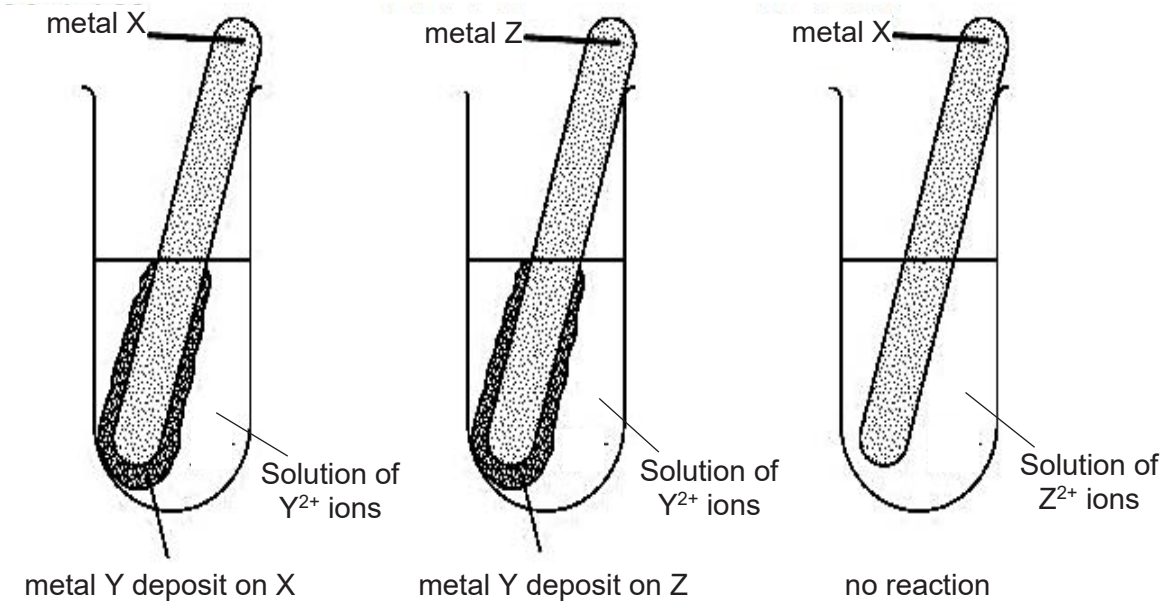
A reddish brown solid is formed in the reaction tube and the limewater turns cloudy.

What is compound R?

- A aluminum oxide
 - B calcium oxide
 - C copper(II) oxide
 - D iron(III) oxide
- 36 Which statement about the production of iron from iron(III) oxide in a blast furnace is **not** correct?
- A Calcium silicate is formed by the reaction of limestone with sand.
 - B Carbon dioxide reacts with coke to form carbon monoxide.
 - C The iron(III) oxide is reduced by carbon monoxide.
 - D Molten iron formed is denser than molten slag.

- 37 A student performed three tests to investigate the relative reactivity of metals X, Y and Z. In each test a metal strip was placed in a solution containing ions of a different metal.

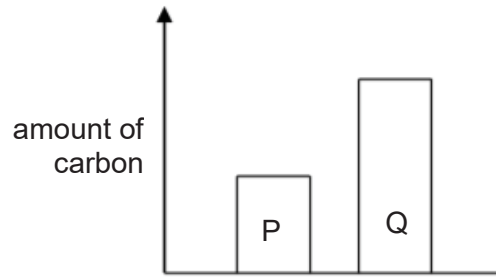
The results are shown in the diagrams.



What is the order of reactivity, from the most reactive to the least reactive, of the three metals?

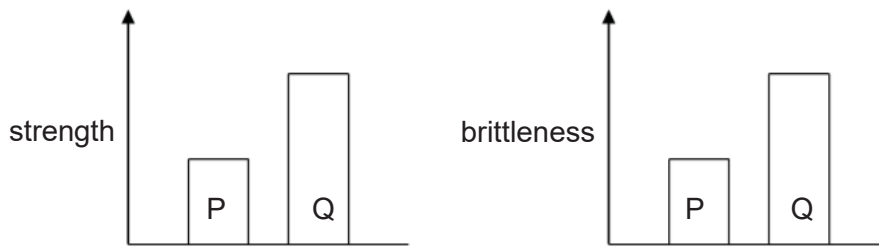
	most reactive	→	least reactive
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	X	Y

38 The diagram compares the amount of carbon in two steels, P and Q.

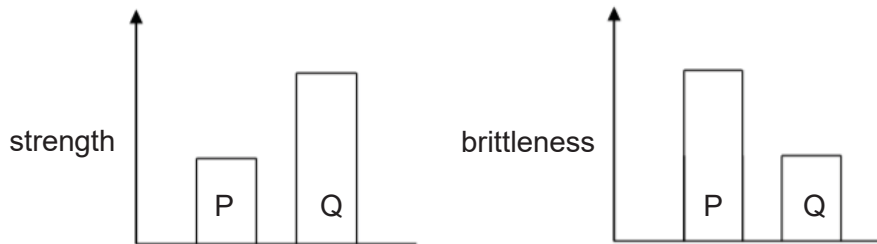


Which two diagrams correctly compare the strength and brittleness of P and Q?

A



B



C



D



- 39** Which air pollutants can be removed by factories using moist calcium carbonate in scrubbers attached to chimney stacks?
- A** NO, NO₂, SO₂
B CO, NO₂, SO₂
C HCl, NO, CH₄
D HCl, NO₂, SO₂
- 40** Car manufacturers are exploring the use of 'lean burn' internal combustion engines. 'Lean burn' engines operate at a lower temperature and a higher percentage of air is mixed with petrol during combustion.

	percentage of gas in exhaust gases emitted	
	carbon monoxide	nitrogen dioxide
internal combustion engines		
without 'lean burn'	0.2%	0.3%
with 'lean burn'	less than 0.1%	0.1%

What is the reason for the change in percentage of carbon monoxide present in the exhaust gases when 'lean burn' engines are used?

- A** Lower temperature reduces the production of carbon monoxide in the internal combustion engines.
B Higher percentage of air causes more nitrogen dioxide to react with carbon monoxide.
C Higher percentage of air mixed with petrol results in a decrease in incomplete combustion of petrol.
D Lower temperature increases the reaction between nitrogen dioxide and carbon monoxide.

END OF PAPER

The Periodic Table of Elements

Group																																																																																																							
I	II																III	IV	V	VI	VII	0																																																																																	
3 Li lithium 7	4 Be beryllium 9	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> Key proton (atomic) number atomic symbol name relative atomic mass </div>																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 Lv livermorium -	116 Og oganeson -	117 Ts tennessine -	118 Uue unbinilium -

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
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 -

actinoids

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

Section A

Answer **all** questions in this section in the spaces provided.
The total mark for this section is 50.

A1 Helium and neon are chemically similar.

Complete the diagrams of atoms of helium and neon to show:

- the names and numbers of each particle in the nucleus
- the arrangement of the electrons

Helium nucleus contains

.....

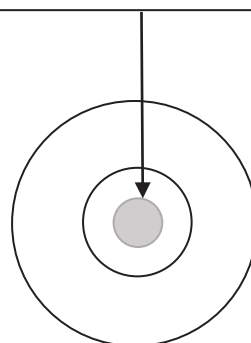
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Neon nucleus contains

.....

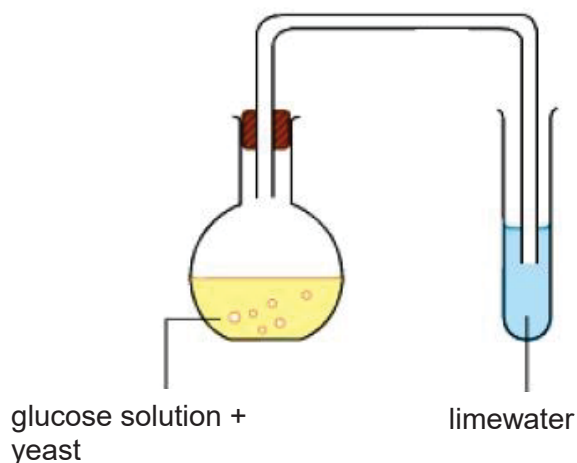
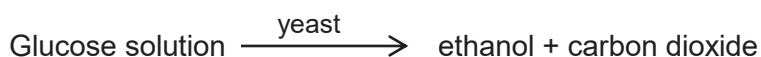
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[2]

[Total: 2]

- A2** Fermentation is a chemical process where yeast is used to produce ethanol from glucose solution. The reaction can be summarised by the equation as shown.



- (a) Using a chemical equation, describe the expected observation in the test tube with limewater during the reaction.

.....

.....

.....

.....

[2]

- (b) The fermentation of glucose produces only a dilute solution of ethanol of up to 15%.

Given that ethanol is soluble in water and has a boiling point of 78 °C, describe the process by which pure ethanol can be extracted from the mixture of glucose solution and yeast.

.....

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.....

.....

[3]

[Total: 5]

A4 Oxides of nitrogen in the upper atmosphere cause damage to the ozone layer. Engines of jet aircrafts at their cruising altitudes are a source of oxides of nitrogen.

(a) (i) Explain how oxides of nitrogen are formed in the engines of a jet aircraft.

.....
.....
..... [2]

(ii) State how oxides of nitrogen can be formed in nature.

..... [1]

(b) An oxide of nitrogen can dissolve in rainwater to form acid rain.

(i) Give the chemical name and formula of the acid produced.

..... [1]

(ii) Acid rain will react with limestone in the soil to produce a calcium salt that is needed by plants for healthy growth.

Give the chemical equation for the reaction between the acid and limestone.
Include state symbols.

..... [2]

(iii) Describe one other effect that acid rain has on the environment.

.....
..... [1]

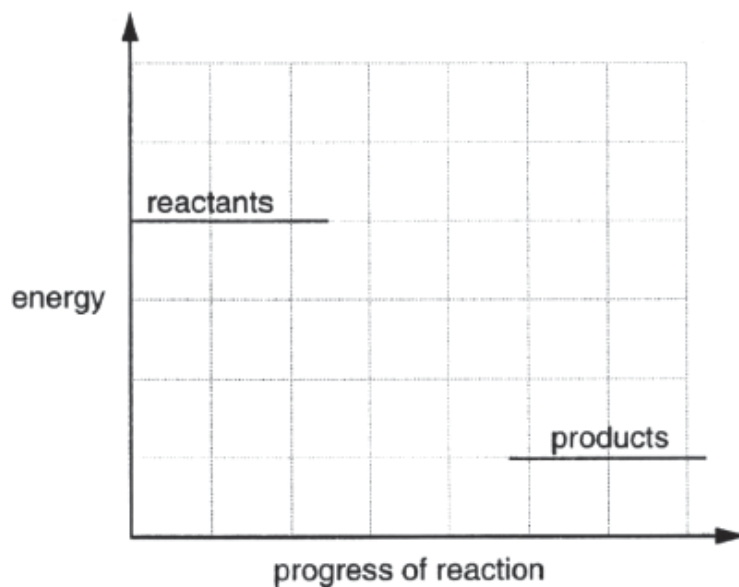
[Total: 7]

A5 Octane, C_8H_{18} is found in petrol that is used as fuel for motor vehicles. The chemical equation for the combustion of octane and the enthalpy change is given below.



The reaction produces 10900 kJ of energy per 1 mole of octane.

(a) The diagram shows the energy levels of the reactants and products for this reaction.



Complete the diagram by

- drawing the reaction pathway for the reaction,
- showing the energy change for the reaction, ΔH .

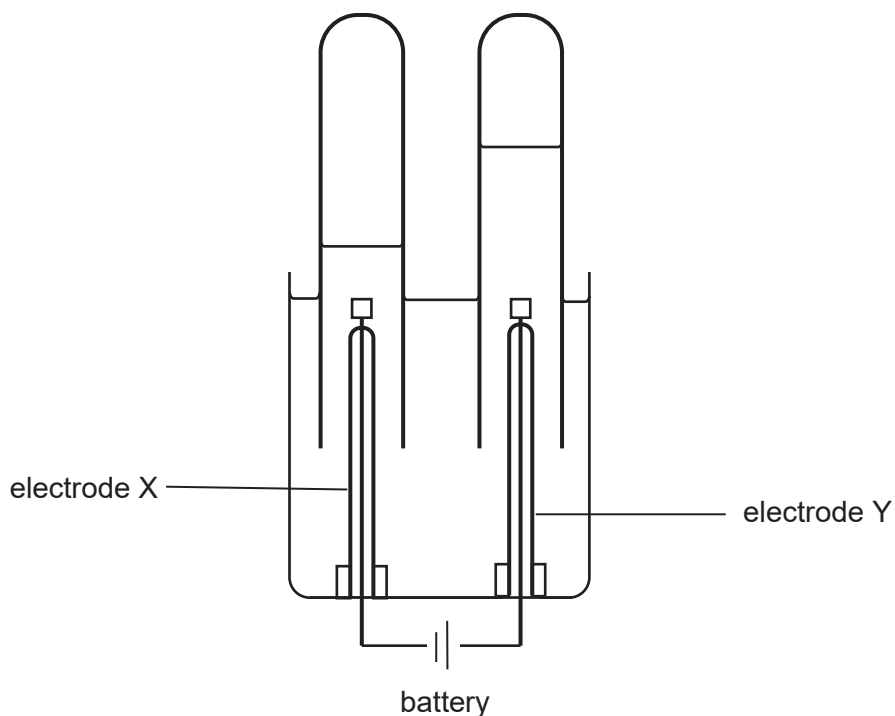
[2]

(b) Calculate the energy released when 48 dm^3 of carbon dioxide is produced in the combustion of octane, C_8H_{18} .

energy released = kJ [2]

[Total: 4]

- A7** The diagram below shows an apparatus in which electrolysis of dilute sodium sulfate containing litmus solution was carried out.



- (a) (i) Complete the table below.

electrode	name of gas	name of the electrode at which gas is produced (cathode/anode)
X		
Y		

[2]

- (ii) Write the ionic equations for the reactions that occur at electrodes X and Y.

electrode X -

electrode Y -

[2]

- (b) Describe what will be observed at electrode X during electrolysis.

.....

.....

[2]

[Total: 6]

A8 The table below shows some information of various metals.

metal	abundance in Earth's crust (%)	approximate cost (\$/kg)	relative electrical conductivity
aluminium	7.5	1.45	0.382
copper	0.007	1.65	0.593
iron	5	0.23	0.100
silver	0.0000075	3909	0.620
tin	0.005	16.5	0.088

(a) Silver and copper are the two metals that have high electrical conductivity.

Using data from the table, suggest reasons why silver is not widely used as an electrical conductor.

.....

[1]

(b) (i) Explain why food cans made of steel are usually coated with a non-reactive metal like tin.

.....

[2]

(ii) State one disadvantage of using tin as a coating for food cans.

.....

[1]

- (c) The table below lists the energy required to extract and recycle two types of metals.

	cost per kg/\$	energy required to extract 1 kg of metal from metal ore/ kWh	energy required to recycle 1 kg of metal / kWh
iron	0.23	6.9	4.2
aluminium	1.45	95.0	4.8

- (i) Suggest why it is more important to recycle aluminum as compared to iron.

.....

[1]

- (ii) Suggest why aluminum is more expensive than iron.

.....

[2]

- (iii) Suggest one reason why recycling metals uses lesser energy than extraction from metal ores.

.....

[1]

- (iv) Recycling is essential to ensure that we do not run out of certain metals.

Give one other reason why recycling metals is important.

.....

[1]

[Total: 9]

- A9** A student added calcium carbonate to an excess of 1.0 mol/dm^3 hydrochloric acid at room temperature.

As the reaction proceeded, she measured the volume of carbon dioxide released and plotted a graph as shown in Fig. 9.1.

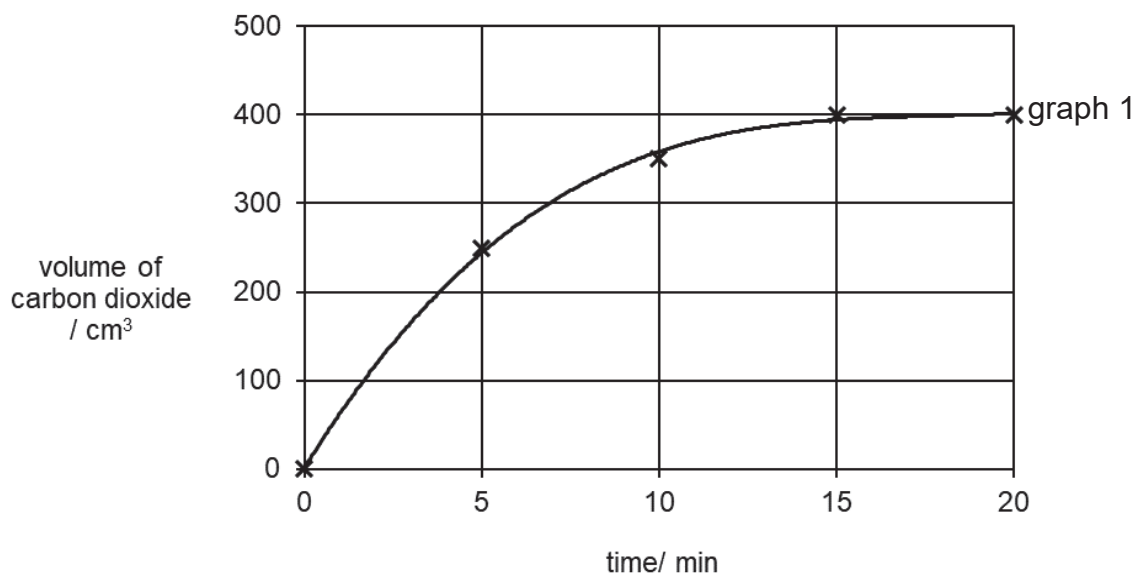


Fig 9.1

- (a) (i)** Describe how the speed of the above reaction changes with time.

.....

.....

.....

.....

[2]

- (ii)** Using particle collision theory, explain why the speed of the reaction changes as described in **(a)(i)**.

.....

.....

.....

.....

.....

.....

[3]

(b) The student repeated the experiment using 0.75 mol/dm^3 hydrochloric acid.

(i) On Fig. 9.1, sketch a graph to represent this new experiment.
Label this graph as graph 2.

[1]

(ii) Explain the difference in the shapes of both graphs.

.....

.....

[2]

[Total: 8]

Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B10 Read the information about the chlorides of the elements in Period 3 of the Periodic Table.

The formulae and physical properties of the chlorides change across Period 3.

The chlorides behave differently when they are added to water. Some of the chlorides dissolve in water to form a solution. Some hydrolyse when they are added to water. This means that they react chemically with water to produce new products.

name	formula	melting point/ °C	boiling point/ °C	effect of adding chloride to water
sodium chloride	NaCl	801	1413	Dissolves readily
magnesium chloride	MgCl_2	714	1412	Dissolves readily
silicon tetrachloride	SiCl_4	-70	58	Hydrolyse to produce fumes of HCl
phosphorus trichloride	PCl_3	-112	76	Hydrolyse to produce fumes of HCl
disulfur chloride	S_2Cl_2	-80	136	Hydrolyse to produce fumes of HCl

The chlorides have different formulae and the ratio of the element to chlorine changes across Period 3. Some examples are shown in the table below.

formula of chloride	ratio of element to chlorine
NaCl	1:1
MgCl_2	1:2
AlCl_3	1:3

(a) (i) State one difference in physical property between metallic and non-metallic chlorides.

.....
 [1]

(ii) Give reasons, in terms of bonding, to account for the difference in this physical property between metallic and non-metallic chlorides.

.....

 [3]

(b) Draw a 'dot-and-cross' diagram to illustrate the bonding in one of the non-metallic chlorides listed above. You only need to show the valence electrons.

[2]

(c) Explain, in terms of structure, the difference in electrical conductivity of molten magnesium chloride and liquid disulfur chloride.

.....
.....
.....
.....

[2]

(d) Describe the pattern for the ratio of each element to chlorine across Period 3. Include the ratios in your answer.

.....
.....
.....
.....

[2]

(e) When disulfur dichloride reacts with water, it gives a yellow precipitate and a solution containing hydrochloric acid and another acid.

Suggest a test to determine whether the other acid is sulfuric acid.

.....
.....
.....
.....

[2]

[Total: 12]

- B11** A student investigated the reaction between 0.120 g of magnesium with excess dilute hydrochloric acid.

The results of the experiments are shown in the table below.

experiment	concentration of acid in mol/dm ³	temperature / °C		form of magnesium	time for the magnesium to dissolve / s
		before	after		
1	1.0	20	32	ribbon	100
2	1.0	20	32	small pieces	55
3	2.0	20	32	powder	10
4	2.0	40	50	ribbon	10

- (a) (i)** Give the chemical equation for the reaction.

..... [1]

- (ii)** Calculate the maximum volume of hydrogen gas produced in experiment 2.

volume of hydrogen gas = dm³ [2]

- (b)** Explain how the total volume of hydrogen evolved in **(a)(ii)** would be affected if experiment 2 was performed with a mixture of aqueous copper(II) sulfate and hydrochloric acid.

.....

 [3]

(c) Suggest why experiment 4 is faster than experiment 1.

.....
.....

[1]

(d) The student noticed that bubbling only started a few seconds after the magnesium ribbon touched the acid.

Suggest a reason why this is so.

.....
.....

[1]

[Total: 8]

(c) Student A suggested that substance **G** is mercury.

Do you agree with Student A? Explain your answer

.....
.....
.....
.....

[2]

[Total: 10]

OR

B12 The radii of atoms and ions can be measured.

The tables show some information about atomic radii and ionic radii of some Group I and Group VII elements.

element	number of shells of electrons in atom	atomic radius /pm	number of shells of electrons in +1 ion	ionic radius /pm
lithium	2	152		68
sodium	3	185		98
potassium	4	227		133

element	number of shells of electrons in atom	atomic radius /pm	number of shells of electrons in -1 ion	ionic radius /pm
fluorine	2	71		133
chlorine	3	99		181
bromine	4	115		196

(1 000 000 000 000 pm = 1m)

(a) Complete the tables to show the number of shells of electrons in the **ions** of Group I and Group VII elements

[2]

(b) Describe the trend in atomic radii for Group I and use the data to explain this trend.

.....

[2]

(c) Strontium is in Group II.

Predict the ionic radius of strontium. Explain your reasoning.

Prediction pm

Reasoning

[3]

(d) The transition elements are in a block in the centre of the Periodic Table.

Transition elements act as catalysts to increase the rate of industrial processes.

(i) State **two** characteristics of transition elements other than acting as catalysts.

.....
.....
.....
..... [2]

(ii) Catalysts like transition elements are expensive to buy but reduce costs in the long run.

Suggest one reason why catalysts reduce costs in the long run.

.....
..... [1]

[Total: 10]

END OF PAPER

The Periodic Table of Elements

Group																																																																																																							
I	II	III										IV	V	VI	VII	0																																																																																							
3 Li lithium 7	4 Be beryllium 9	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> 1 H hydrogen 1 </div> <div style="border: 1px solid black; padding: 5px;"> proton (atomic) number atomic symbol name relative atomic mass </div> </div>																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 actinoids	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 Lv livermorium -	116 Ts tennessine -	117 Uu unbinilium -	118 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
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 -

actinoids

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

