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0620/41

October/November 2022

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].
- The Periodic Table is printed in the question paper.

This document has **16** pages. Any blank pages are indicated.

1 The names of the elements of Period 2 of the Periodic Table are shown.

lithium beryllium boron carbon nitrogen oxygen fluorine neon

Answer the following questions about these elements.

Each element may be used once, more than once or not at all.

Identify the element which:

(a) is a product of photosynthesis

..... [1]

(b) has an oxide found in clean, dry air

..... [1]

(c) forms a basic oxide with the formula X_2O

..... [1]

(d) is a main component of fertilisers used to improve crop growth

..... [1]

(e) has the highest rate of diffusion at room temperature

..... [1]

(f) produces a red flame in a flame test

..... [1]

(g) has only 5 electrons in each of its atoms

..... [1]

(h) has an oxide responsible for acid rain.

..... [1]

[Total: 8]

2 Potassium is a Group I element.

(a) Name and describe the bonding in potassium.

name

description

.....

.....

.....

[4]

(b) Potassium combines with sulfur to form an ionic compound, potassium sulfide, K_2S .

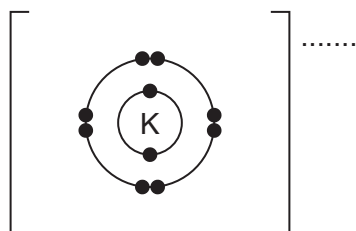
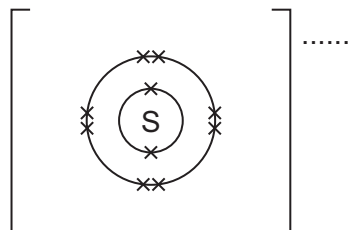
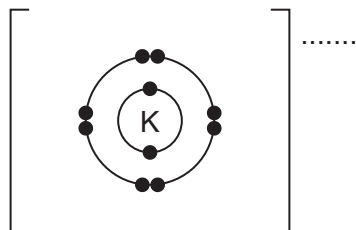
(i) Give **two** physical properties of ionic compounds.

1

2

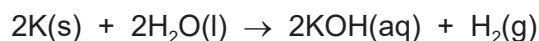
[2]

(ii) Complete the dot-and-cross diagram to show the electron arrangement and charges of the ions in potassium sulfide.



[3]

- (c) When potassium is added to water, it reacts vigorously and a coloured flame is seen. The equation for the reaction is shown.



- (i) State the colour of the flame seen.

..... [1]

- (ii) The solution formed is potassium hydroxide, a strong alkali.

State the formula of the ion responsible for alkalinity in a solution.

..... [1]

- (iii) State the colour of litmus in a strong alkali.

..... [1]

- (iv) Calculate the volume, in cm^3 , of hydrogen gas formed when 2.34 g of potassium is added to excess water at room temperature and pressure.

Use the following steps.

- Calculate the number of moles of potassium added.

= mol

- Determine the number of moles of hydrogen gas formed.

= mol

- Calculate the volume of hydrogen gas formed.

volume = cm^3
[3]

(d) Aqueous potassium hydroxide reacts with a dilute acid to produce aqueous potassium chloride, KCl(aq) , which is a salt.

(i) Name the dilute acid used.

..... [1]

(ii) State the type of reaction taking place.

..... [1]

(iii) Name the experimental technique used when salts are made by reacting a dilute acid with an aqueous alkali.

..... [1]

(e) When aqueous silver nitrate, $\text{AgNO}_3\text{(aq)}$, is added to aqueous potassium chloride, a precipitate is formed.

(i) State the colour of the precipitate formed.

..... [1]

(ii) Name the precipitate formed.

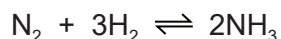
..... [1]

(iii) Write the ionic equation for the reaction. Include state symbols.

..... [3]

[Total: 23]

- 3 Ammonia is made in an industrial process starting with nitrogen. The equation for the reaction is shown.



- (a) Name the industrial process used to make ammonia.

..... [1]

- (b) State the raw material from which nitrogen is obtained.

..... [1]

- (c) State what is meant by the symbol $\rightleftharpoons$.

..... [1]

- (d) State the temperature and pressure used in this industrial process.

temperature = °C

pressure = atm
[2]

- (e) Name the catalyst used in this industrial process.

..... [1]

- (f) The forward reaction is exothermic.

State the effect, if any, on the position of the equilibrium when the following changes are made.
Explain your answers.

temperature is reduced

.....
.....

pressure is reduced

.....
.....

[4]

- (g) Explain, in terms of particles, what happens to the rate of reaction when the temperature is reduced.

.....

.....

.....

.....

..... [3]

- (h) Give the formula of the compound formed when sulfuric acid reacts with ammonia.

..... [1]

[Total: 14]

4 A student prepares calcium nitrate, $\text{Ca}(\text{NO}_3)_2$, by adding calcium carbonate to dilute nitric acid.

(a) Write the chemical equation for this reaction.

..... [2]

(b) Describe **two** observations during this reaction.

1

2 [2]

(c) The student continues to add calcium carbonate until it is in excess. The student then removes the excess calcium carbonate by filtration and collects the aqueous calcium nitrate.

State the general term given to a solution collected from filtration.

..... [1]

(d) The student gently heats the aqueous calcium nitrate until the solution is saturated.

(i) Suggest what is meant by the term *saturated solution*.

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

(ii) Describe how crystals are produced from a hot saturated solution.

..... [1]

- (e) Calcium nitrate crystals are hydrated and have the formula $\text{Ca}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ where x is a whole number of molecules of water.

The student heats the crystals to remove the molecules of water.



- (i) State the term used to describe the calcium nitrate after the molecules of water have been removed.

..... [1]

- (ii) The student heats a sample of $\text{Ca}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$ and forms 2.46g of $\text{Ca}(\text{NO}_3)_2$ and 0.0600 moles of H_2O .

Determine the value of x . Use the following steps.

- Calculate the M_r of $\text{Ca}(\text{NO}_3)_2$.

$M_r =$

- Determine the number of moles of $\text{Ca}(\text{NO}_3)_2$ formed.

moles of $\text{Ca}(\text{NO}_3)_2$ formed =

- Determine the value of x in $\text{Ca}(\text{NO}_3)_2 \cdot x\text{H}_2\text{O}$.

$x =$
[3]

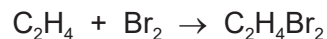
- (f) Nitrates decompose on heating.

Write the chemical equation for the reaction when solid sodium nitrate is heated.

..... [2]

[Total: 14]

- 5 Ethene is an alkene which reacts with bromine as shown in the equation.



- (a) Write the general formula of alkenes.

..... [1]

- (b) Describe the colour change seen when ethene is bubbled through aqueous bromine.

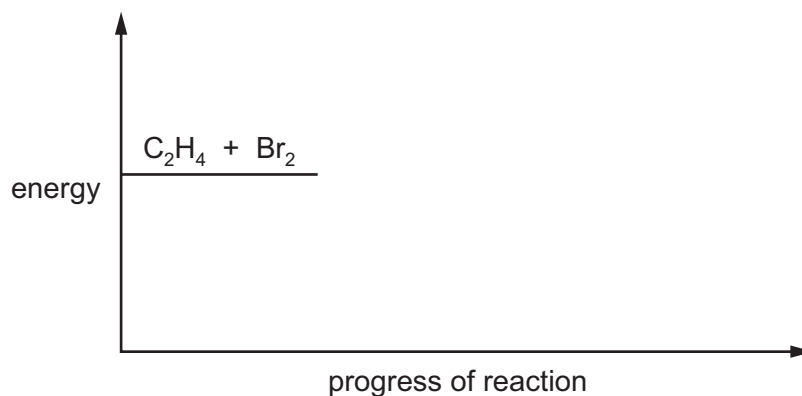
from to [1]

- (c) In this reaction only one product is formed from two reactants.

Name this type of organic reaction.

..... [1]

- (d) Part of the energy profile diagram of this reaction is shown.



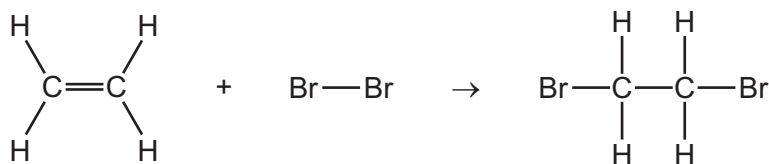
- (i) The reaction is exothermic.

Complete the energy profile diagram for this reaction.
Include:

- the position of the products
- an arrow to show the activation energy, labelled as A
- an arrow to show the energy change for the reaction.

[3]

(ii) The chemical equation for the reaction can be represented as shown.



Some bond energies are given.

bond	bond energy /kJ mol
C–H	410
C=C	610
Br–Br	190
C–C	350
C–Br	290

Use the bond energies in the table to calculate the energy change in this reaction.

Use the following steps.

- Calculate the energy needed to break bonds.

energy = kJ

- Calculate the energy released in making bonds.

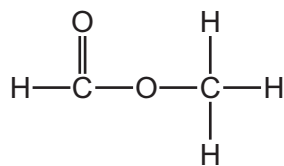
energy = kJ

- Determine the energy change in this reaction.

energy change in this reaction = kJ/mol
[3]

[Total: 9]

6 Ester **Y** has the structure shown.



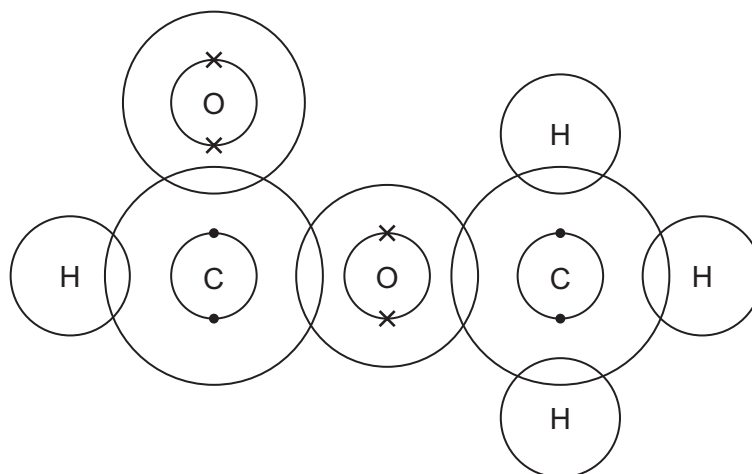
(a) (i) Name ester **Y**.

..... [1]

(ii) Deduce the empirical formula of ester **Y**.

..... [1]

(b) Complete the dot-and-cross diagram to show the arrangement of electrons in a molecule of ester **Y**.



[3]

(c) Ester **Y** can be made by reacting two organic compounds together.

Name the compounds and draw their structures.

Show all of the atoms and all of the bonds.

name

structure

name

structure

[4]

(d) (i) Describe what is meant by the term *structural isomer*.

.....

..... [2]

(ii) Name a carboxylic acid which is a structural isomer of ester **Y**.

..... [1]

[Total: 12]

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The Periodic Table of Elements

Group																			
I	II											III	IV	V	VI	VII	VIII		
		1Hhydrogen1																	
		Key atomic number atomic symbol name relative atomic mass																	
3Li lithium 7	4Be beryllium 9													5B boron 11	6C carbon 12	7N nitrogen 14	8O oxygen 16	9F fluorine 19	10Ne neon 20
11Na sodium 23	12Mg magnesium 24													13Al aluminium 27	14Si silicon 28	15P phosphorus 31	16S sulfur 32	17Cl chlorine 35.5	18Ar argon 40
19K potassium 39	20Ca calcium 40	21Sc scandium 45	22Ti titanium 48	23V vanadium 51	24Cr chromium 52	25Mn manganese 55	26Fe iron 56	27Co cobalt 59	28Ni nickel 59	29Cu copper 64	30Zn zinc 65	31Ga gallium 70	32Ge germanium 73	33As arsenic 75	34Se selenium 79	35Br bromine 80	36Kr krypton 84		
37Rb rubidium 85	38Sr strontium 88	39Y yttrium 89	40Zr zirconium 91	41Nb niobium 93	42Mo molybdenum 96	43Tc technetium —	44Ru ruthenium 101	45Rh rhodium 103	46Pd palladium 106	47Ag silver 108	48Cd cadmium 112	49In indium 115	50Sn tin 119	51Sb antimony 122	52Te tellurium 128	53I iodine 127	54Xe xenon 131		
55Cs caesium 133	56Ba barium 137	57–71 lanthanoids		72Hf hafnium 178	73Ta tantalum 181	74W tungsten 184	75Re rhenium 186	76Os osmium 190	77Ir iridium 192	78Pt platinum 195	79Au gold 197	80Hg mercury 201	81Tl thallium 204	82Pb lead 207	83Bi bismuth 209	84Po polonium —	85At astatine —	86Rn radon —	
87Fr francium —	88Ra radium —	89–103 actinoids		104Rf rutherfordium —	105Db dubnium —	106Sg seaborgium —	107Bh bohrium —	108Hs hassium —	109Mt meitnerium —	110Ds darmstadtium —	111Rg roentgenium —	112Cn copernicium —	114Fl flerovium —		116Lv livermorium —				