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CHEMISTRY

0620/32

Paper 3 Theory (Core)

May/June 2021

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

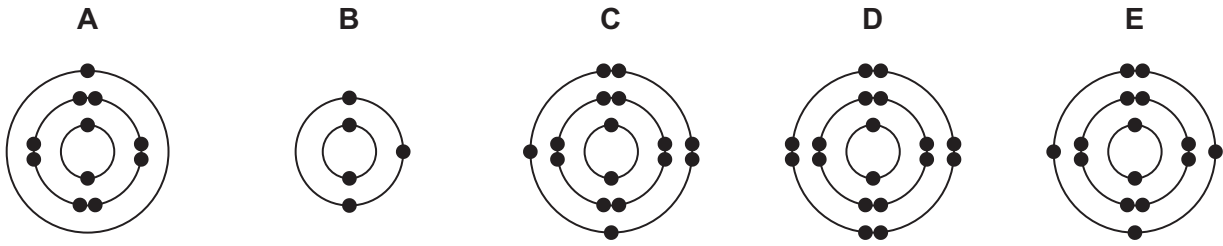
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction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

INFORMATION

- 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 (a) The electronic structures of five atoms, **A**, **B**, **C**, **D** and **E**, are shown.



Answer the following questions about these electronic structures.
Each electronic structure may be used once, more than once or not at all.

State which electronic structure, **A**, **B**, **C**, **D** or **E**, represents:

(i) an atom in Group III of the Periodic Table

..... [1]

(ii) an atom of a noble gas

..... [1]

(iii) an atom that forms a stable ion with a single positive charge

..... [1]

(iv) an atom that contains only two shells of electrons

..... [1]

(v) an atom with a proton number of 16.

..... [1]

(b) Complete the table to show the number of electrons, neutrons and protons in the silicon atom and sodium ion shown.

	number of electrons	number of neutrons	number of protons
$^{30}_{14}\text{Si}$	14		
$^{23}_{11}\text{Na}^+$		12	

[3]

[Total: 8]

2 The table shows the masses of some of the ions in 1000 cm³ of fruit juice.

name of ion	formula of ion	mass of ion in 1000 cm ³ of fruit juice / mg
ammonium	NH ₄ ⁺	15
	Ca ²⁺	71
chloride	Cl ⁻	135
magnesium	Mg ²⁺	160
nitrate	NO ₃ ⁻	2
phosphate	PO ₄ ³⁻	63
potassium	K ⁺	184
sodium	Na ⁺	3
	SO ₄ ²⁻	85

(a) Answer these questions using only the information in the table.

(i) State which positive ion has the lowest mass in 1000 cm³ of fruit juice.

..... [1]

(ii) Give the formulae of the ions in calcium sulfate.

..... and [1]

(iii) Calculate the mass of magnesium ions in 250 cm³ of fruit juice.

mass = mg [1]

(b) Describe a test for calcium ions.

test

observations

[2]

(c) Ammonium ions, NH₄⁺, are present in most fertilisers. Ammonium ions contain nitrogen.

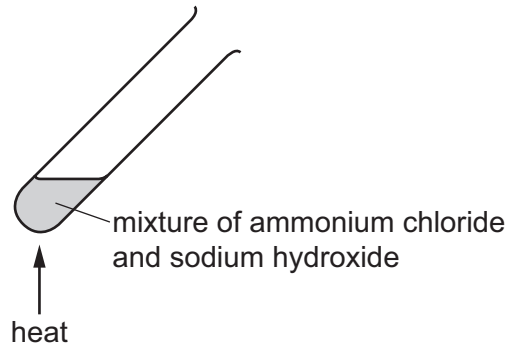
Name two **other** elements present in most fertilisers.

1

2

[2]

- (d) A student heated a mixture of ammonium chloride and sodium hydroxide in a test-tube.



Pungent-smelling ammonia gas is given off.

Describe one **other** observation that can be made.

..... [1]

- (e) Ammonia reacts with chlorine.

Complete the equation for this reaction.



- (f) A small beaker of aqueous ammonia is placed at the front of a classroom.

At first, the students at the back of the class do not smell the ammonia gas.
After a short time, the students at the back of the class smell the ammonia.

Explain these observations using the kinetic particle model.

.....

 [3]

[Total: 13]

3 The table shows some properties of four halogens.

element	melting point /°C	boiling point /°C	density of liquid at boiling point in g/cm ³	colour
chlorine	-101	-35	1.56	light green
bromine	-7		3.12	red-brown
iodine	114	184		dark grey
astatine	302	337	6.35	black

(a) (i) Complete the table by predicting:

- the boiling point of bromine
- the density of liquid iodine at its boiling point.

[2]

(ii) Describe the trend in the depth of colour of the halogens down the group.

..... [1]

(iii) Deduce the state of chlorine at -50°C.
Explain your answer.

.....

 [2]

(b) The halogens have molecules that are diatomic.

Explain the meaning of the term *diatomic*.

..... [1]

(c) Astatine is a radioactive element. One isotope of astatine has a nucleon number of 209.

(i) Define *nucleon number*.

..... [1]

(ii) State **one** medical use of radioactive isotopes.

..... [1]

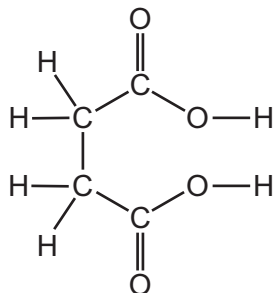
(iii) The isotope ²³⁵U is also radioactive.

State the major use of this isotope of uranium.

..... [1]

[Total: 9]

4 The structure of succinic acid is shown.



(a) (i) On the structure draw a circle around one carboxylic acid functional group. [1]

(ii) Deduce the formula of succinic acid to show the number of carbon, hydrogen and oxygen atoms.

..... [1]

(b) When succinic acid is heated it undergoes sublimation.

State the meaning of the term *sublimation*.

.....
 [1]

(c) Succinic acid is heated with compound F.

Compound F has the formula HOCH₂CH₂OH.

(i) State the name of the –OH functional group in compound F.

..... [1]

(ii) A polymer is formed when succinic acid is heated with compound F.

Choose **one** word from the list that best describes the small molecules that react together to form a polymer.

Draw a circle around the correct answer.

bases **ceramics** **monomers** **plastics** [1]

(d) Ethanoic acid is also a carboxylic acid.

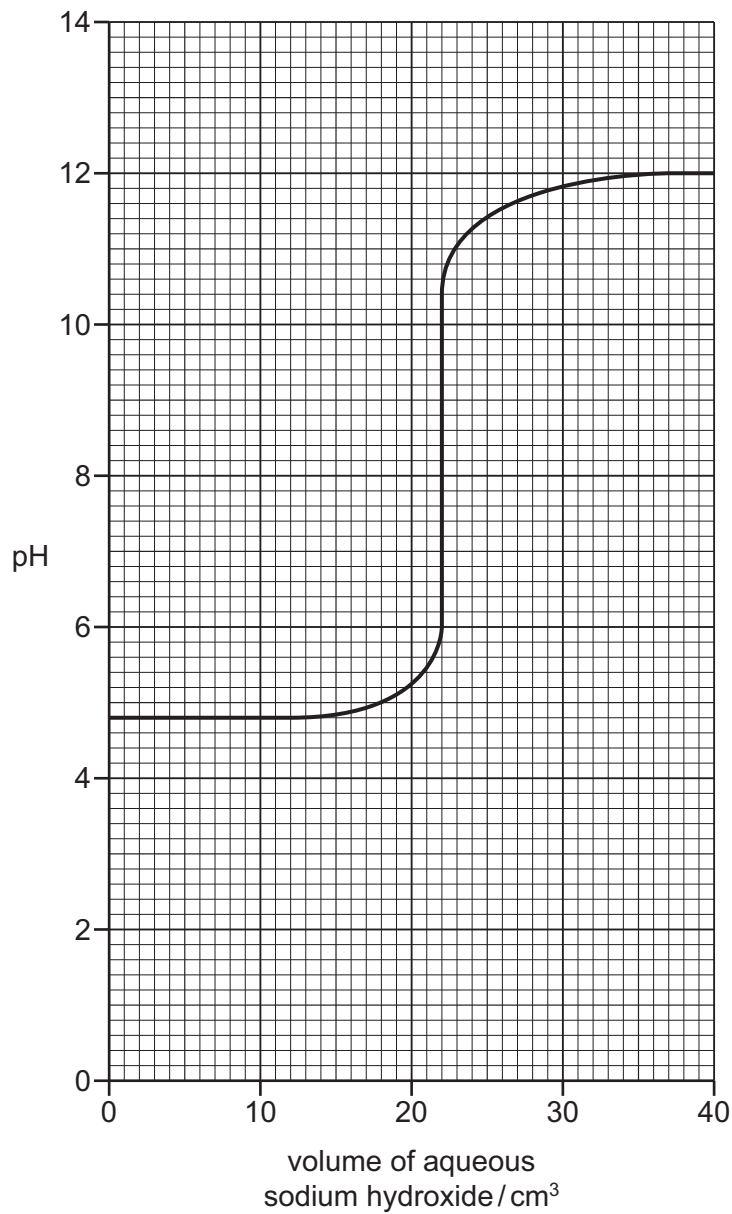
Describe the observations made when ethanoic acid reacts with:

blue litmus paper

calcium carbonate.

[2]

- (e) A student's graph of how the pH changes when aqueous sodium hydroxide is added slowly to dilute ethanoic acid is shown.



- (i) Deduce the pH of the dilute ethanoic acid before the addition of aqueous sodium hydroxide.

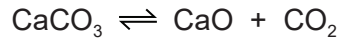
pH = [1]

- (ii) Deduce the volume of aqueous sodium hydroxide added when the pH is neutral.

..... cm³ [1]

[Total: 9]

- 5 (a) Calcium carbonate is heated in a closed container.



- (i) State the name of a rock which is mainly calcium carbonate.

..... [1]

- (ii) State the meaning of the symbol \rightleftharpoons .

..... [1]

- (iii) CaO is lime. Lime is used for neutralising acidic industrial waste.

Give one **other** use of lime.

..... [1]

- (iv) Describe a test for carbon dioxide.

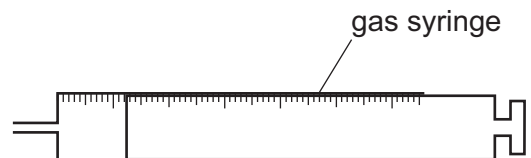
test

observations [2]

- (b) Carbon dioxide is produced when dilute hydrochloric acid reacts with calcium carbonate.



- (i) Complete the diagram to show the apparatus used to investigate the volume of carbon dioxide produced during this reaction.



[2]

(ii) Describe the effect of each of the following on the rate of reaction of dilute hydrochloric acid with calcium carbonate.

- The temperature is decreased.

All other conditions stay the same.

.....

- Calcium carbonate powder is used instead of large pieces of calcium carbonate.

All other conditions stay the same.

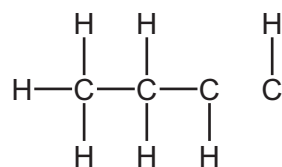
.....

[2]

(c) Carbon dioxide is also formed when the hydrocarbon C_4H_8 is completely combusted.

(i) The hydrocarbon C_4H_8 is an alkene.

Complete the structure of this alkene by adding the missing bonds and atom.



[2]

(ii) The incomplete combustion of C_4H_8 produces carbon monoxide.

State the meaning of the term *incomplete combustion*.

.....

..... [1]

[Total: 12]

6 This question is about air and gases.

(a) (i) State the percentage of oxygen in clean, dry air.

..... % [1]

(ii) Name **two** other elements in clean, dry air.

..... and [2]

(b) Lead and sulfur dioxide are pollutants of air.

For each of these pollutants state the source of the pollutant and an adverse effect of the pollutant.

source of lead

adverse effect

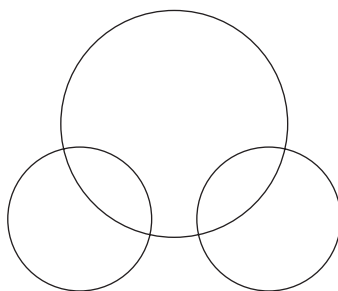
source of sulfur dioxide

adverse effect

[4]

(c) Water is present in the atmosphere.

(i) Complete the dot-and-cross diagram to show the electron arrangement in a molecule of water.



[2]

(ii) Anhydrous copper(II) sulfate is used to test for water.

State the colour change in this test.

from to [2]

[Total: 11]

- 7 (a) Dilute sulfuric acid is electrolysed using carbon electrodes.

State the products of this electrolysis at:

the negative electrode

the positive electrode.

[2]

- (b) Graphite is a form of carbon. Graphite has a giant structure with covalent bonds.

- (i) State the meaning of the term *covalent bond*.

.....

..... [2]

- (ii) Graphite is a solid.

Describe the arrangement and motion of the particles in a solid.

arrangement

.....

motion

.....

[2]

- (c) Graphite is one form of solid carbon.

Name one **other** form of solid carbon.

..... [1]

[Total: 7]

8 This question is about elements in the Periodic Table.

(a) The table shows some properties of five elements, **P**, **Q**, **R**, **S** and **T**.

element	melting point / °C	density in g/cm ³	electrical conductivity of the solid	atomic radius / nm
P	63	0.86	very good	0.235
Q	-7	3.12	does not conduct	0.114
R	839	1.54	very good	0.174
S	1495	8.9	very good	0.126
T	-157	0.0035	does not conduct	0.110

Use only the elements shown in the table to answer this question.

State which two of the elements, **P**, **Q**, **R**, **S** and **T**, are covalent molecules.

Give **two** reasons for your answer.

elements and

reason 1

reason 2

[3]

(b) Describe how the metallic character of the elements depends on their position in the Periodic Table.

.....

..... [1]

(c) Potassium is an element in Group I of the Periodic Table. Cobalt is a transition element.

Cobalt has a higher density than potassium.

Give **two** other ways in which the properties of transition elements differ from the properties of Group I elements.

1

2

[2]

(d) State whether potassium oxide is a basic oxide or an acidic oxide.

Give a reason for your answer.

..... [1]

(e) The table compares the ease of reduction of four metal oxides when heated with carbon.

metal oxide	details of reduction
chromium(III) oxide	reduced at 1200 °C
manganese(IV) oxide	reduced at 1400 °C
potassium oxide	not reduced at 1400 °C
zinc oxide	reduced at 850 °C

Put the four metals in order of their reactivity.
Put the least reactive metal first.

least reactive $\xrightarrow{\hspace{15em}}$ most reactive

[2]

(f) Describe how aqueous sodium hydroxide is used to test for chromium(III) ions, Cr^{3+} .

.....

.....

..... [2]

[Total: 11]

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