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7960164291

CHEMISTRY **0620/33**

Paper 3 Theory (Core) **October/November 2022**

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

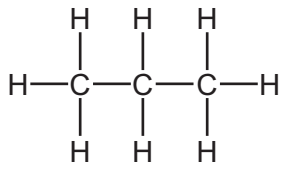
- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Any blank pages are indicated.

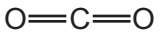
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1 **(a)** The structures of seven compounds or elements, **A**, **B**, **C**, **D**, **E**, **F** and **G**, are shown.

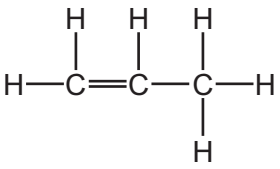
A



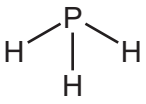
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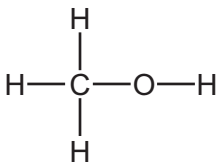
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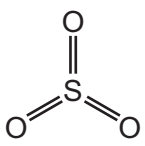
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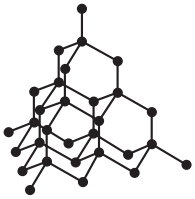
E



F



G



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

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

(i) a compound that contains an atom of an element in Group V of the Periodic Table

..... [1]

(ii) an element

..... [1]

(iii) a substance that is used for cutting tools

..... [1]

(iv) a compound that is a major contributor to climate change

..... [1]

(v) a saturated hydrocarbon.

..... [1]

(b) Describe how aqueous bromine can be used to distinguish between a saturated hydrocarbon and an unsaturated hydrocarbon.

observations with saturated hydrocarbon .....

.....

observations with unsaturated hydrocarbon .....

.....
[2]

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(c) When a hydrocarbon undergoes incomplete combustion, carbon monoxide is formed.

(i) State the meaning of the term *incomplete combustion*.

..... [1]

(ii) Give **one** adverse effect of carbon monoxide on health.

..... [1]

[Total: 9]

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[Turn over

2 **(a)** The table compares the percentage by mass of the elements in the whole Earth and in the oceans.

element	percentage by mass in the whole Earth	percentage by mass in the oceans
calcium	1.1	0.1
chlorine	less than 0.01	1.0
hydrogen	less than 0.01	11.0
iron	34.6	0.0
magnesium	12.7	1.0
oxygen	29.5	85.0
silicon	15.2	0.0
sodium	0.6	1.0
other elements	6.3	
total	100.00	100.00

Answer these questions using only the information in the table.

(i) Deduce the percentage by mass of the other elements in the oceans.

..... [1]

(ii) State which non-metallic element is present in the whole Earth in the greatest percentage by mass.

..... [1]

(iii) Give **two** major differences in the composition of the whole Earth and of the oceans.

1 .....

.....

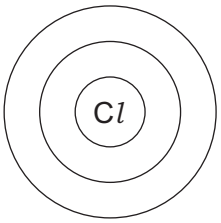
2 .....

.....

[2]

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(b) Complete the diagram to show the electron arrangement in a chlorine atom.



[2]

(c) Iron is extracted from iron(III) oxide in a blast furnace.

(i) Explain why air is blown into the blast furnace.

.....

..... [1]

(ii) In the blast furnace, carbon dioxide reacts with carbon to produce carbon monoxide.

Complete the chemical equation for this reaction.

$$CO_2 + C \rightarrow .....CO$$ [1]

(iii) Carbon monoxide reduces iron(III) oxide to iron.

State the meaning of the term *reduction*.

..... [1]

(iv) When 80 g of iron(III) oxide reacts with excess carbon monoxide, 56 g of iron is produced.

Calculate the minimum mass of iron(III) oxide needed to produce 14 g of iron.

..... g [1]

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[Turn over

(d) Steel is an alloy of iron.

(i) Choose **two** substances from the list that are used in the conversion of iron from the blast furnace into steel.

calcium oxide
carbon dioxide
hydrogen
nitrogen
oxygen
silicon(IV) oxide
sulfur dioxide

1 .....

2 .....
[2]

(ii) State the meaning of the term *alloy*.

.....

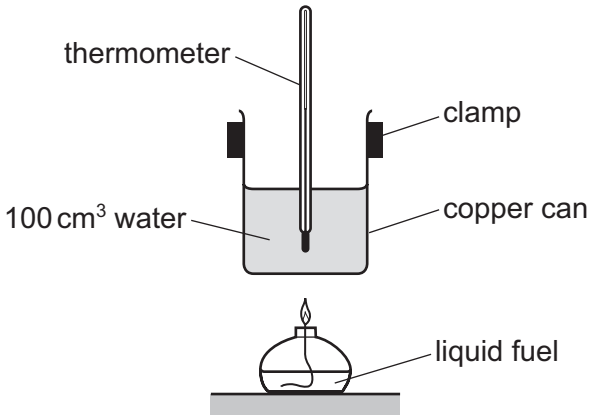
..... [1]

[Total: 13]

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3 This question is about fuels and energy production.

(a) The diagram shows the apparatus used to compare the energy released when 100 cm^3 of water is heated by burning different liquid fuels, **J**, **K**, **L** and **M**.



All conditions are kept the same apart from the type of fuel and mass of fuel burned.

The results are shown.

fuel	mass of fuel burned / g	increase in temperature / °C
J	2	4
K	4	8
L	1	3
M	2	5

Deduce which fuel, **J**, **K**, **L** or **M**, releases the most energy per gram.

..... [1]

(b) The fractional distillation of petroleum produces fractions, such as gasoline and diesel, which are used as fuels.

(i) Name one **other** petroleum fraction that is used as a fuel.

..... [1]

(ii) State the physical property on which the fractional distillation of petroleum depends.

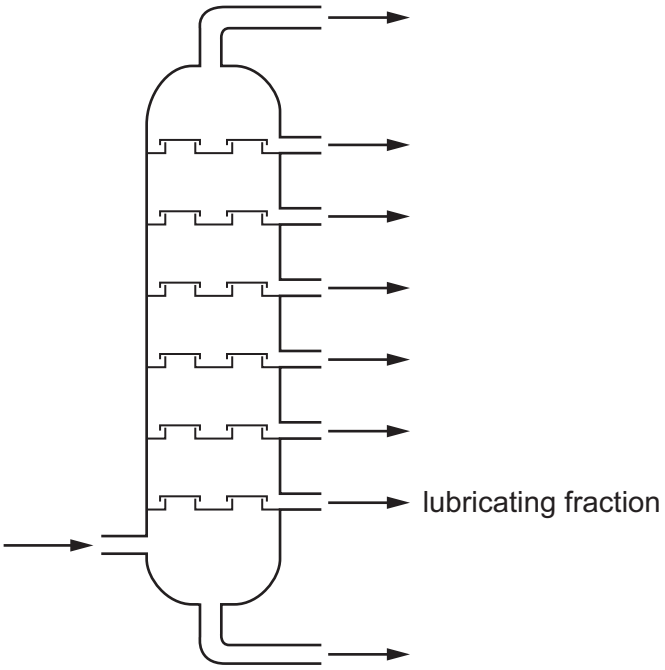
..... [1]

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[Turn over

(iii) Bitumen is a fraction of petroleum.

Write an X **on the diagram** to show where bitumen is obtained.



[1]

(c) (i) Name a radioactive element that is used as a source of energy in nuclear power stations.

..... [1]

(ii) State one **other** industrial use of radioactive isotopes.

..... [1]

[Total: 6]

4 **(a)** The table shows some properties of four Group I elements.

element	melting point / °C	boiling point / °C	hardness / MPa
lithium	181	1342	5.00
sodium	98	.....	0.70
potassium	63	760	0.36
rubidium	39	686	.....

(i) Complete the table by predicting:
- the boiling point of sodium
- the hardness of rubidium. [2]

(ii) Predict the physical state of potassium at 50 °C.
Give a reason for your answer.

.....

..... [2]

(b) When a mixture of sodium and sodium hydroxide is heated, sodium oxide and hydrogen are formed.

(i) Complete the chemical equation for this reaction.

$$.....Na + 2NaOH \rightarrow .....Na_2O + H_2$$ [2]

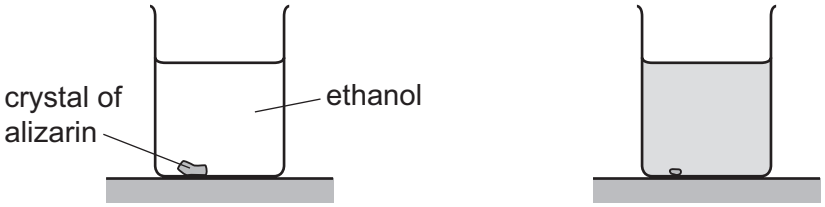
(ii) Describe a test for hydrogen.

test .....

observations .....
[2]

(c) Sodium hydroxide is used to make the red dye alizarin.
Alizarin is soluble in ethanol.

A crystal of alizarin is placed in a beaker of ethanol.
After a few hours, the red colour has spread throughout the beaker.



at the start after a few hours

Explain these observations using the kinetic particle model.

.....

.....

.....

..... [3]

[Total: 11]

5 This question is about compounds of nitrogen and fertilisers.

(a) Ammonium chloride is heated with sodium hydroxide.

$$NH_4Cl + NaOH \rightarrow NH_3 + NaCl + H_2O$$

Choose from the list the word that describes this reaction.

Draw a circle around your answer.

addition **displacement** **oxidation** **reduction** [1]

(b) Ammonia is manufactured from nitrogen and hydrogen.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(i) Give the meaning of the symbol $\rightleftharpoons$.

..... [1]

(ii) The nitrogen for this process is obtained from the air.

State the percentage of nitrogen in clean, dry air.

..... [1]

(c) Fertilisers contain nitrogen.

Name two **other** elements found in most fertilisers that are essential for plant growth.

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

(d) Bacteria in the soil can convert ammonium ions into oxides of nitrogen.

Oxides of nitrogen contribute to acid rain.

(i) Name one **other** pollutant in the air that contributes to acid rain.

..... [1]

(ii) State **one** adverse effect of acid rain on buildings.

..... [1]

[Total: 7]

6 This question is about acids, bases and salts.

(a) Describe the reaction of excess dilute hydrochloric acid with magnesium and with magnesium carbonate. Give the names of the products and any observations.

reaction with magnesium

- products

.....

- observations

.....

.....

reaction with magnesium carbonate

- products

.....

- observations

.....

.....

[4]

(b) (i) Different sized pieces of magnesium react with excess dilute hydrochloric acid. The time taken for each reaction to finish is recorded.

The sizes of the pieces of magnesium are:
- large
- small
- very small.

Equal masses of magnesium are used in each reaction.

All other conditions stay the same.

Complete the table by writing the size of the magnesium pieces in the first column.

size of magnesium pieces	time taken for the reaction to finish / s
	30
	200
	90

[1]

(ii) Describe the effect on the time taken for small pieces of magnesium to react with hydrochloric acid of a lower concentration.

All other conditions stay the same.

..... [1]

(c) (i) Sodium hydroxide is an alkali.

State the colour change when excess aqueous sodium hydroxide is added to a solution of methyl orange in acid.

from ..... to ..... [2]

(ii) Choose the pH value of an alkali.

Draw a circle around your answer.

pH 3 **pH 5** **pH 7** **pH 14** [1]

(d) The salt magnesium chloride can be prepared by reacting hydrochloric acid with magnesium oxide.

(i) The method for preparing pure dry crystals of magnesium chloride is given.

Complete the missing steps 4 and 6.

1 Add excess magnesium oxide to dilute hydrochloric acid.

2 Warm the mixture to complete the reaction.

3 Filter off the excess magnesium oxide and collect the filtrate.

4 .....

5 Remove the crystals.

6 .....

[2]

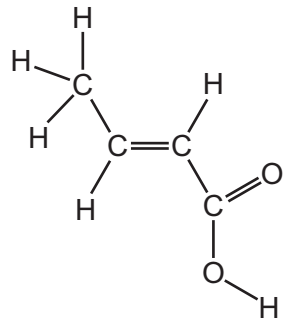
(ii) Magnesium oxide is used as a catalyst in some reactions.

State the purpose of using a catalyst.

..... [1]

[Total: 12]

7 **(a)** The structure of an organic compound, **S**, is shown.



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

(ii) Deduce the formula of compound **S** to show the number of carbon, hydrogen and oxygen atoms.

..... [1]

(iii) Compound **S** is a solid at room temperature.

Use the kinetic particle model to describe the arrangement of the particles in a solid.

..... [1]

(b) Compound **S** reacts with ethanol.

(i) Draw the structure of ethanol to show all of the atoms and all of the bonds.

[1]

(ii) Ethanol can be manufactured by fermentation.

Describe one **other** method of manufacturing ethanol.

.....

..... [2]

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(c) Compound **S** can be polymerised.

(i) State the general name given to the small units that join together to form a polymer.

..... [1]

(ii) Name **one** natural polymer.

..... [1]

(iii) Some plastics are non-biodegradable.

Describe **one** pollution problem caused by non-biodegradable plastics.

..... [1]

[Total: 9]

8 This question is about metals.

(a) (i) Copper is a transition element. Sodium is an element in Group I of the Periodic Table. Copper is harder than sodium.

Give two **other** ways in which the physical properties of copper differ from the physical properties of sodium.

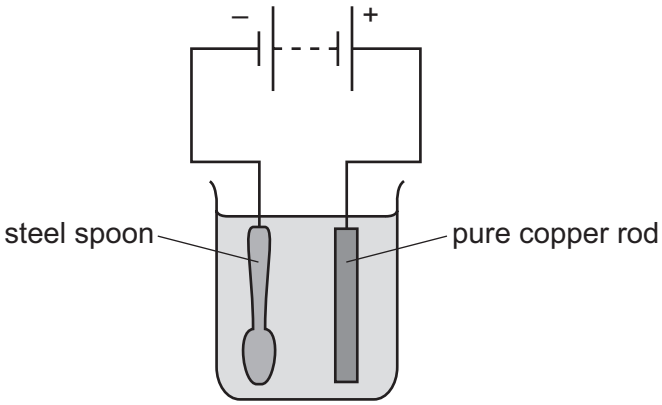
1 .....

2 .....
[2]

(ii) Give **one** use of copper.

..... [1]

(b) The apparatus used to electroplate a steel spoon with copper is shown.



(i) Label the diagram to show:
- the anode
- the electrolyte.

[2]

(ii) Describe the observations made during this electroplating at the:

steel spoon .....

.....

copper rod. .....

.....
[2]

(c) Deduce the number of electrons and neutrons in one atom of the isotope of copper shown.

$^{65}_{29}Cu$

number of electrons .....

number of neutrons .....

[2]

(d) A compound of copper has the formula K_2CuF_4.

Complete the table to calculate the relative molecular mass of K_2CuF_4.

atom	number of atoms	relative atomic mass	
potassium	2	39	$2 \times 39 = 78$
copper		64	
fluorine		19	

relative molecular mass = ... [2]

(e) The table shows the rates of reaction of four metals with steam.

metal	rate of reaction with steam
zinc	reacts quickly
gold	does not react
iron	reacts slowly
lanthanum	reacts very quickly

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

least reactive ⟶ most reactive

[2]

[Total: 13]

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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 –		114 Fl flerovium –		116 Lv livermorium –		

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.).