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CHEMISTRY **0620/32**

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.

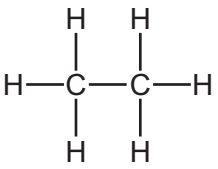
This document has **20** pages. Any blank pages are indicated.

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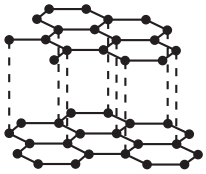
[Turn over

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

A

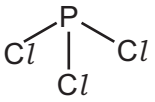


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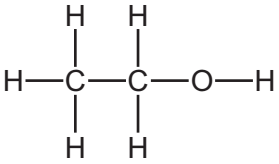


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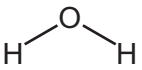
D



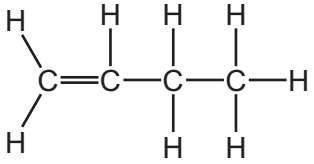
E



F



G



(a) 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 atoms of a Group VII element

..... [1]

(ii) an element with a giant covalent structure

..... [1]

(iii) a compound that turns anhydrous copper(II) sulfate blue

..... [1]

(iv) an element that conducts electricity

..... [1]

(v) an unsaturated hydrocarbon.

..... [1]

(b) Describe a test for an unsaturated hydrocarbon.

test .....

observations .....
[2]

(c) Name the **two** products formed when compound **A** undergoes complete combustion.

1 .....

2 .....
[2]

[Total: 9]

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2 **(a)** The table compares the percentage by mass of the elements in the Earth's crust and in the Moon's crust.

element	percentage by mass in the Earth's crust	percentage by mass in the Moon's crust
aluminium	8.20	7.50
calcium	3.60	7.50
iron	5.00	13.50
magnesium	2.00	5.50
oxygen	46.60	40.00
silicon	29.50	19.50
titanium	0.55	3.00
other elements	4.55	
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 Moon's crust.

..... [1]

(ii) State which element is present in the Earth's crust in the greatest percentage by mass.

..... [1]

(iii) Give **two** major differences in the composition of the Earth's crust and in the Moon's crust.

1 .....

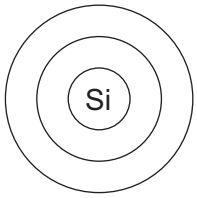
.....

2 .....

.....

[2]

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



[2]

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[Turn over

(c) Iron reacts with oxygen to form an oxide of iron with the formula Fe_3O_4.

(i) Complete the chemical equation for this reaction.

$$.....Fe + ...O_2 \rightarrow Fe_3O_4$$ [2]

(ii) Complete these sentences about the extraction of iron from iron ore in a blast furnace using words from the list.

air **decomposed** **dioxide** **hydrogen** **iron**

monoxide **oxidised** **reduced** **slag**

The raw materials put into the blast furnace are iron ore, limestone and ..... .

Carbon monoxide reacts with iron(III) oxide to produce iron. In this reaction iron(III) oxide is

..... .

Limestone decomposes to produce calcium oxide and carbon ..... .

Calcium oxide reacts with impurities in the iron ore to form ..... .

[4]

(d) Iron is converted to steel using oxygen and one other type of compound.

(i) Explain how the oxygen removes the carbon.

..... [1]

(ii) Choose from the list the name of the other type of compound used to convert iron into steel.

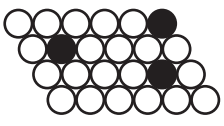
acidic oxide
alcohol
basic oxide
hydrocarbon

..... [1]

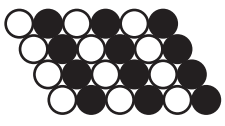
(iii) Steel is an alloy.

Choose the diagram, **J**, **K**, **L** or **M**, which best represents an alloy.

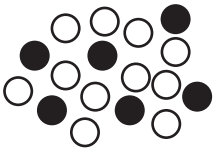
J



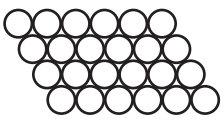
K



L



M



..... [1]

[Total: 15]

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3 This question is about fuels and energy production.

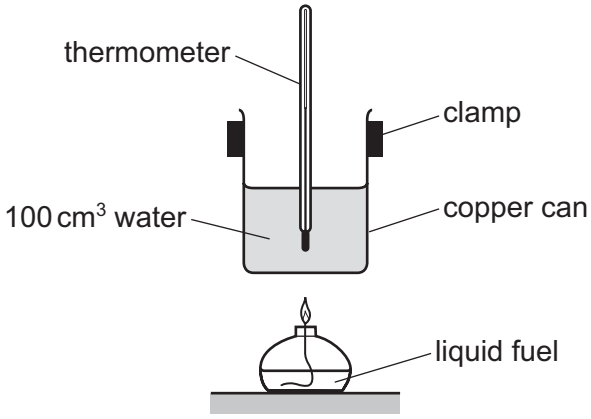
(a) Chemical reactions can be endothermic or exothermic.

State the meaning of the term *endothermic*.

.....

..... [1]

(b) The diagram shows the apparatus used to compare the energy released when 100 cm^3 of water is heated by burning different liquid fuels, **P**, **Q**, **R** and **S**.



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
P	3	6
Q	2	8
R	1	3
S	3	9

Deduce which fuel, **P**, **Q**, **R** or **S**, releases the least energy per gram.

..... [1]

(c) Name a gas that is used as a fuel.

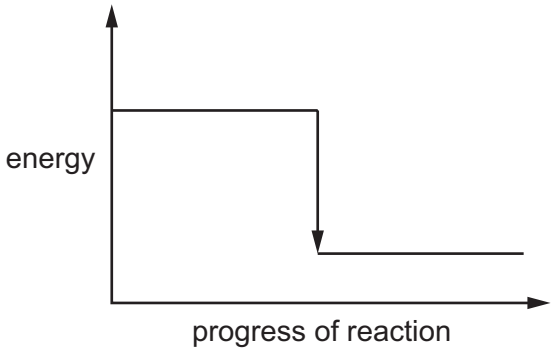
..... [1]

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(d) An energy level diagram for the burning of a fuel is shown.



Complete the diagram using these words:

- products
- reactants.

[1]

(e) The radioactive isotope ^{235}U is used as a source of energy.

State one **other** use of radioactive isotopes.

..... [1]

[Total: 5]

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4 This question is about halogens.

(a) The table shows some properties of four halogens.

halogen	melting point in °C	boiling point in °C	density at room temperature and pressure in g/cm^3
chlorine	–101	–35	0.003
bromine	–7	59	3.12
iodine	114	184	.....
astatine	302	.....	6.35

(i) Complete the table by predicting:
- the density of iodine at room temperature and pressure
- the boiling point of astatine.

[2]

(ii) Predict the physical state of bromine at 20 °C.
Give a reason for your answer.

.....

..... [2]

(b) Bromine reacts with sulfur dioxide and water.

(i) Complete the chemical equation for this reaction.

$$Br_2 + SO_2 + ...H_2O \rightarrow H_2SO_4 + ...HBr$$ [2]

(ii) In this reaction both oxidation and reduction take place.

State the meaning of the term *reduction*.

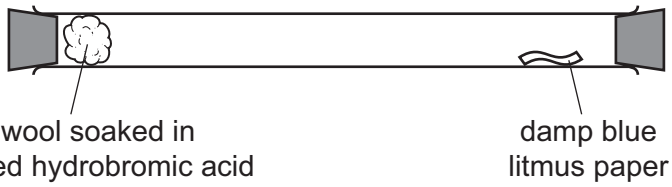
..... [1]

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(c) Concentrated aqueous hydrobromic acid releases fumes of acidic hydrogen bromide gas.

A long glass tube is set up as shown.



At first the blue litmus paper does not turn red.
After a short time the blue litmus paper turns red.

Explain these observations using the kinetic particle model.

.....

.....

.....

..... [3]

[Total: 10]

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5 This question is about air and fertilisers.

(a) Air contains nitrogen, oxygen, noble gases and carbon dioxide.

State the percentage of nitrogen in clean, dry air.

..... [1]

(b) Polluted air contains oxides of nitrogen.

(i) Give **one** source of oxides of nitrogen in the air.

..... [1]

(ii) State **one** adverse effect of oxides of nitrogen on health.

..... [1]

(c) Many fertilisers contain nitrogen and potassium.

(i) Name one **other** element found in most fertilisers.

..... [1]

(ii) Explain why farmers use fertilisers on fields where crops are to be grown.

..... [1]

(iii) Describe a test for potassium ions.

test .....

observations .....
[2]

[Total: 7]

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[Turn over

6 This question is about acids, bases and salts.

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

reaction with magnesium carbonate

- products

.....

- observations

.....

.....

reaction with magnesium oxide

- products

.....

- observations

.....

.....

[4]

(b) State the colour change when excess aqueous sodium hydroxide is added to a solution of litmus in dilute sulfuric acid.

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

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(c) (i) Describe how universal indicator can be used to find the pH of an acidic solution.

.....

.....

..... [2]

(ii) Choose the pH value that is acidic.

Draw a circle around your answer.

pH 2 **pH 7** **pH 10** **pH 14** [1]

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

(i) Choose the type of reaction that occurs.

Draw a circle around your answer.

addition **neutralisation** **polymerisation** **reduction** [1]

(ii) The method for preparing pure dry crystals of zinc chloride is given.

Complete the missing steps 3 and 6.

1 Add excess zinc oxide to dilute hydrochloric acid.

2 Warm the mixture to complete the reaction.

3 .....

4 Evaporate the filtrate until the point of crystallisation and leave for crystals to form.

5 Remove the crystals.

6 .....
[2]

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(e) (i) Small pieces of zinc react with excess dilute hydrochloric acid at different temperatures. The time taken for each reaction to finish is recorded.

The temperatures are:
- 20 °C
- 40 °C
- 60 °C.

All other conditions stay the same.

Complete the table by writing the temperatures in the first column.

temperature of acid / °C	time taken for the reaction to finish / s
	64
	16
	256

[1]

(ii) Describe the effect on the time taken for the reaction to finish when it is carried out with dilute hydrochloric acid of a higher concentration.

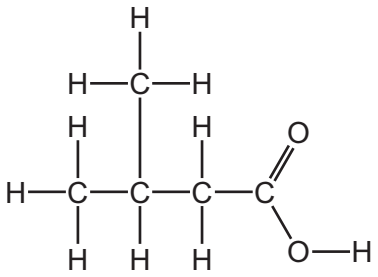
All other conditions stay the same.

..... [1]

[Total: 14]

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7 **(a)** The structure of compound **T** is shown.



(i) Choose from the list the word that describes compound **T**.

alcohol
alkane
alkene
carboxylic acid

..... [1]

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

..... [1]

(b) Compound **T** reacts with ethanol in the presence of a catalyst.

(i) State the meaning of the term *catalyst*.

..... [1]

(ii) Complete the sentence about ethanol using a word from the list.

combustion **cracking** **electrolysis** **fermentation**

Ethanol is manufactured from ethene or by ..... . [1]

(c) Ethene can be produced from ethanol.

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

[1]

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(ii) Ethene is a gas at room temperature.

Use the kinetic particle model to describe the separation of the particles in a gas.

..... [1]

(iii) Ethene can be produced by cracking long-chain hydrocarbons to form short-chain hydrocarbons.

Explain why long-chain hydrocarbons are cracked to form short-chain hydrocarbons.

.....

..... [1]

(iv) Ethene can be polymerised.

State the name of the polymer formed.

..... [1]

(d) *Terylene* is a polymer.

Give **one** use of *Terylene*.

..... [1]

(e) Name a polymer that is a constituent of food.

..... [1]

[Total: 10]

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8 This question is about metals.

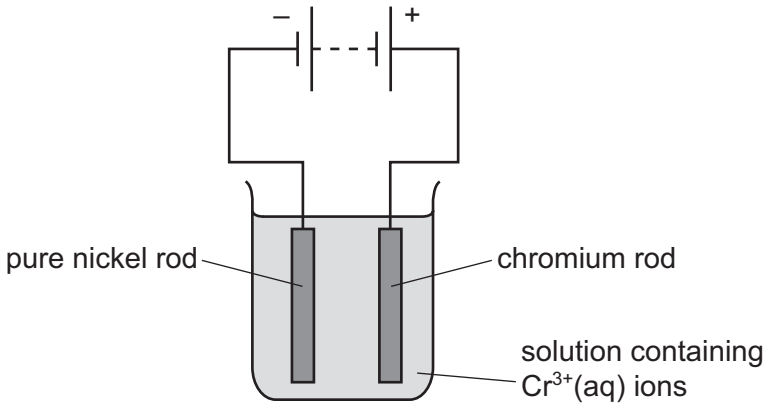
(a) Chromium is a transition element. Potassium is an element in Group I of the Periodic Table. Chromium has a higher density than potassium.

Give two **other** ways in which the physical properties of chromium differ from the physical properties of potassium.

1 .....

2 .....
[2]

(b) The apparatus used to electroplate a nickel rod with chromium is shown.



(i) Choose a word from the list which describes the nickel rod.

Draw a circle around your answer.

anode **cathode** **cation** **electrolyte** **mixture** [1]

(ii) One use of electroplating is to make objects attractive.

Describe one **other** reason for electroplating an object.

..... [1]

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

$^{54}_{24}Cr$

number of electrons .....

number of neutrons .....
[2]

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[Turn over

(d) A compound of chromium has the formula CrH_2O_6.

Complete the table to calculate the relative molecular mass of CrH_2O_6.

atom	number of atoms	relative atomic mass	
chromium	1	52	$1 \times 52 = 52$
hydrogen		1	
oxygen		16	

relative molecular mass = ... [2]

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

metal	rate of reaction
chromium	reacts very slowly only when heated strongly
silver	does not react at room temperature or when heated strongly
sodium	reacts quickly at room temperature
uranium	reacts slowly at room temperature

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

least reactive ⟶ most reactive

[2]

[Total: 10]

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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.).

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