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CHEMISTRY **0620/33**

Paper 3 Theory (Core) **May/June 2026**

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. Do **not** use correction fluid or tape.
- 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.

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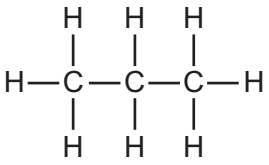
1 Six substances, **A** to **F**, are shown in Figure 1.1.

A

O_2

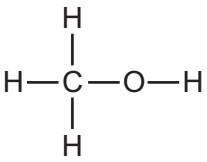
B



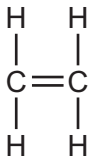
C

NH_3

D



E



F

H_2O

Figure 1.1

Answer the following questions about these substances.

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

View solution

(a) State which substance:

(i) is an alkene

..... [1]

(ii) reacts with methane in a combustion reaction View solution

..... [1]

(iii) is in the same homologous series as ethanol View solution

..... [1]

(iv) is a gas that is approximately 21% of clean, dry air View solution

..... [1]

(v) turns damp red litmus paper blue View solution

..... [1]

(vi) is in a homologous series with the general formula C_nH_{2n}.

..... [1]

View solution

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(b) State which **two** substances are hydrocarbons.

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

[Total: 8]

View solution

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2 The halogens are in Group VII of the Periodic Table.

(a) Halogens exist as diatomic molecules.

View solution

Explain what is meant by the term diatomic.

..... [1]

(b) **(i)** Aqueous bromine reacts with aqueous sodium iodide.

View solution

Complete the symbol equation for this reaction.

$Br_2 + 2NaI \rightarrow$ ..... + ... [2]

(ii) Identify the type of reaction that takes place when aqueous bromine reacts with aqueous sodium iodide.

View solution

Draw a circle around your chosen answer.

addition **displacement** **neutralisation** **substitution** [1]

(iii) Explain why aqueous iodine does **not** react with aqueous sodium bromide.

View solution

.....

..... [1]

(c) Complete Figure 2.1 to show the dot-and-cross diagram for a molecule of fluorine.

View solution

Show outer shell electrons only.

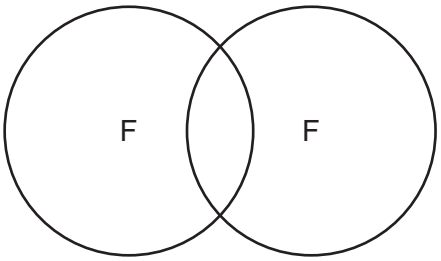

Figure 2.1

[2]

(d) Fluorine forms fluoride ions.

View solution

State the electronic configuration of a fluoride ion.

..... [1]

[Total: 8]

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3 The equation for the reaction of calcium carbonate with dilute hydrochloric acid is shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

View solution

(a) (i) State the meaning of the symbol (aq) in this equation.

..... [1]

(ii) Name the salt formed when calcium carbonate reacts with dilute hydrochloric acid.

..... [1]

View solution

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(b) A student investigates the reaction of large pieces of calcium carbonate with dilute hydrochloric acid. The calcium carbonate is in excess.

View solution

Figure 3.1 shows how the mass of large pieces of calcium carbonate changes as the reaction proceeds.

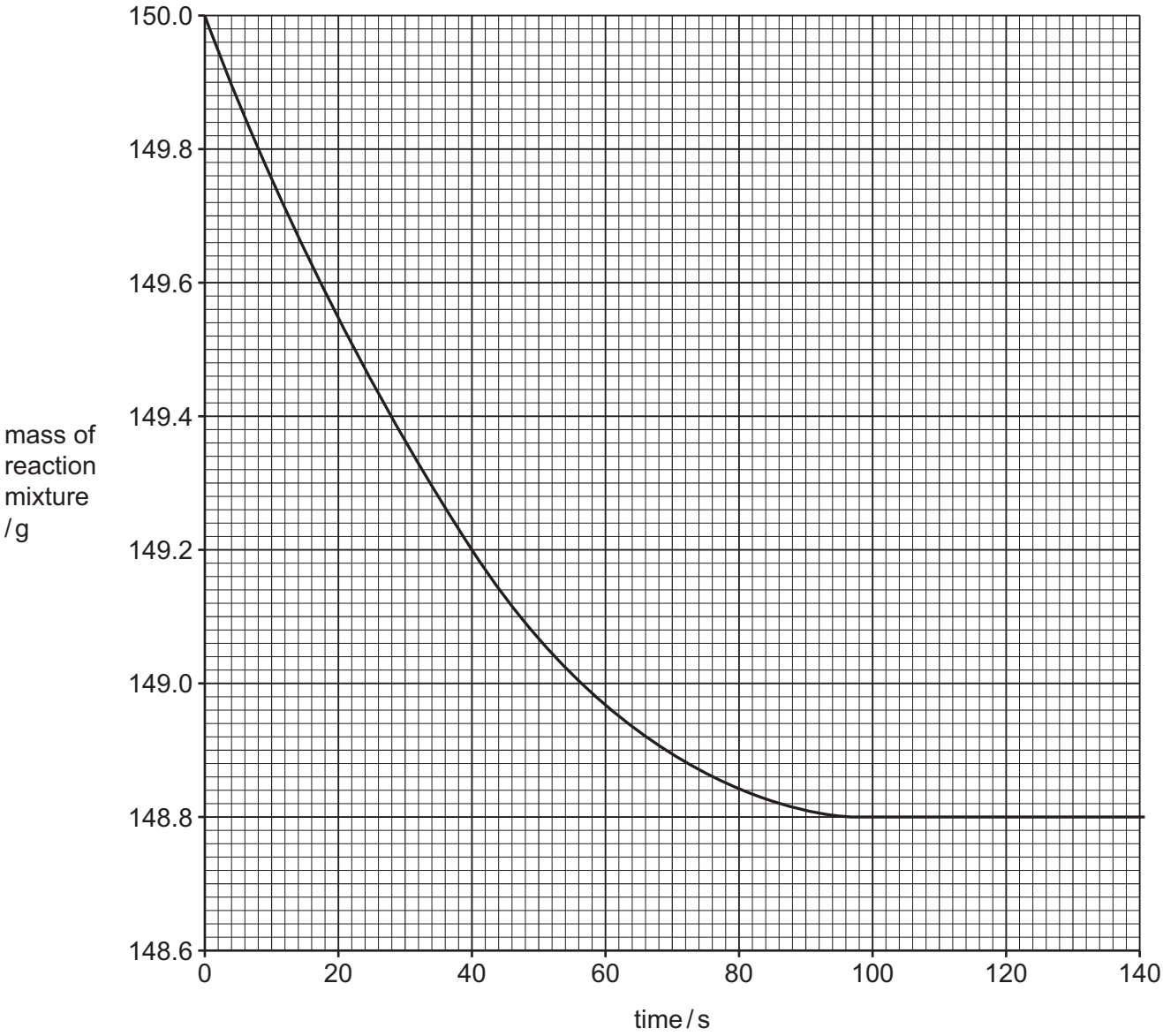

Figure 3.1

(i) State why the mass of the reaction mixture decreases.

..... [1]

(ii) Deduce the mass of the reaction mixture at 40 s.

mass = ... g [1]

(iii) On Figure 3.1, draw an **X** to show where the rate of reaction is the fastest. [1]

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(iv) The student repeats the experiment using the same volume of dilute hydrochloric acid but with smaller pieces of calcium carbonate.

Draw a line on the grid in Figure 3.1 to show how the mass of the reaction mixture changes when smaller pieces of calcium carbonate are used. [2]

(v) State how the rate of reaction differs, if at all, when a higher temperature is used.

..... [1]

(vi) State how the rate of reaction differs, if at all, when a catalyst is added.

..... [1]

View solution

(c) Changing the concentration of a reactant changes the rate of a reaction.

Identify the unit of concentration.

Draw a circle around your answer.

mol / dm^3 **dm^3 / mol** **mol / dm** **dm / mol^3** [1]

View solution

(d) **(i)** Sodium hydroxide is an alkali.

State the meaning of the term alkali.

..... [1]

(ii) Dilute aqueous sodium hydroxide is added to a solution of thymolphthalein indicator in acid until the sodium hydroxide is in excess.

View solution

State the colour change seen.

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

[Total: 13]

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4 Table 4.1 shows the properties of some alkanes.

Table 4.1

alkane	number of carbon atoms in one molecule	melting point in °C	boiling point in °C	density of liquid alkane in g/cm^3
methane	1	–182	–162	0.47
ethane	2	–183	–88	0.57
propane	3	–188		0.59
butane	4		0	0.60
pentane	5	–130	36	0.63

Use the information in Table 4.1 to answer the following questions.

View solution

(a) (i) Predict the boiling point of propane.

..... [1]

(ii) Suggest why it is difficult to predict the melting point of butane.

..... [1]

(iii) State the trend in the density of the alkanes as the number of carbon atoms increases.

..... [1]

(iv) Deduce the physical state of pentane at –1 °C.

Give a reason for your answer.

physical state .....

reason .....

.....

[2]

(v) Give the general formula for alkanes.

..... [1]

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(b) Compound **N** is unsaturated.

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Figure 4.1 shows the displayed formula of compound **N**.

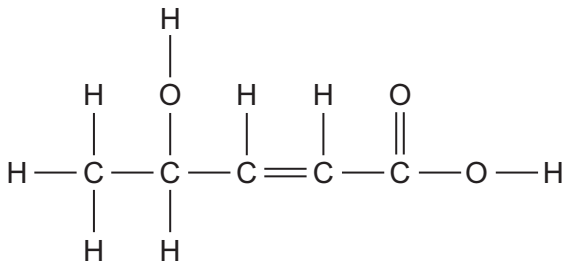

Figure 4.1

(i) On Figure 4.1 draw a circle around the carboxylic acid functional group. [1]

(ii) Deduce the molecular formula of compound **N**.

View solution

..... [1]

(iii) State why compound **N** is unsaturated.

View solution

..... [1]

(c) Outline how ethanol is manufactured from ethene and steam.

View solution

In your answer, include:

- the name of this reaction
- **two** conditions that are needed.

name of reaction .....

condition 1 .....

condition 2 .....

[3]

[Total: 12]

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5 Three states of matter are solid, liquid and gas.

(a) State **two** general properties of a gas.

View solution

1 .....

.....

2 .....

.....

[2]

(b) Complete Table 5.1 to describe the arrangement and motion of particles in a solid and a liquid.

View solution

Table 5.1

physical state	arrangement of particles	motion of particles
solid		
liquid		

[4]

(c) Draw a line from each statement to the correct change of state.

View solution

statement	change of state
liquid oxygen changes into solid oxygen	melting
solid copper changes into liquid copper	condensing
bromine gas changes into liquid bromine	freezing

[2]

(d) A gas syringe contains 80 cm^3 of nitrogen gas.

View solution

State how the volume of nitrogen gas changes, if at all, when the pressure is increased at a constant temperature.

..... [1]

[Total: 9]

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6 Titanium is a metal.

(a) (i) State the period number of titanium in the Periodic Table.

View solution

..... [1]

(ii) Deduce the number of electrons, neutrons and protons in the titanium ion shown.

View solution

$^{48}_{22}Ti^{2+}$

number of electrons .....

number of neutrons .....

number of protons .....

[3]

(b) Titanium is a transition element.

View solution

State **two** properties of transition elements that are different from Group I metals.

1 .....

2 .....

[2]

(c) (i) Titanium reacts with oxygen to form titanium(III) oxide.

View solution

Complete the symbol equation for this reaction.

$$.....Ti + ...O_2 \rightarrow 2Ti_2O_3$$ [1]

(ii) State if titanium(III) oxide is an acidic oxide or a basic oxide.

View solution

Give a reason for your answer.

.....

..... [1]

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(d) Another compound of titanium is titanium(III) chloride.

View solution

Molten titanium(III) chloride is electrolysed using graphite electrodes.

Name the products formed at each electrode during the electrolysis of molten titanium(III) chloride, and give the observations at the positive electrode.

product at the negative electrode .....

product at the positive electrode .....

observations at the positive electrode .....

.....

[3]

(e) Titanium forms a compound with the nitrate ion. The formula of the compound is $Ti(NO_3)_2$.

View solution

Complete Table 6.1 to calculate the relative formula mass of $Ti(NO_3)_2$.

Table 6.1

type of atom	number of atoms	relative atomic mass	
titanium	1	48	1 × 48 = 48
nitrogen		14	
oxygen		16	

relative formula mass = ... [2]

[Total: 13]

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7 **(a)** Natural water sources can be polluted with sewage and nitrates.

View solution

State why sewage and nitrates in river water are harmful.

sewage .....

.....

nitrates .....

.....

[2]

(b) Some fertilisers contain nitrates.

View solution

State why fertilisers are used.

..... [1]

(c) Sea water contains sodium ions.

View solution

Name the test to identify sodium ions. Give the observations for a positive result.

test .....

observations .....

[2]

(d) The domestic water supply is treated to make it safe to drink.

View solution

(i) Describe how solids are removed from the domestic water supply.

..... [1]

(ii) Name the substance added to the domestic water supply to remove tastes and odours.

..... [1]

(e) State the colour change when water is added to anhydrous copper(II) sulfate.

View solution

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

[Total: 9]

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8 **(a)** Stainless steel is an alloy of iron.

View solution

(i) Give **one** reason why alloys are more useful than pure metals.

..... [1]

View solution

(ii) Brass is an alloy.

Name the **two** metals in brass.

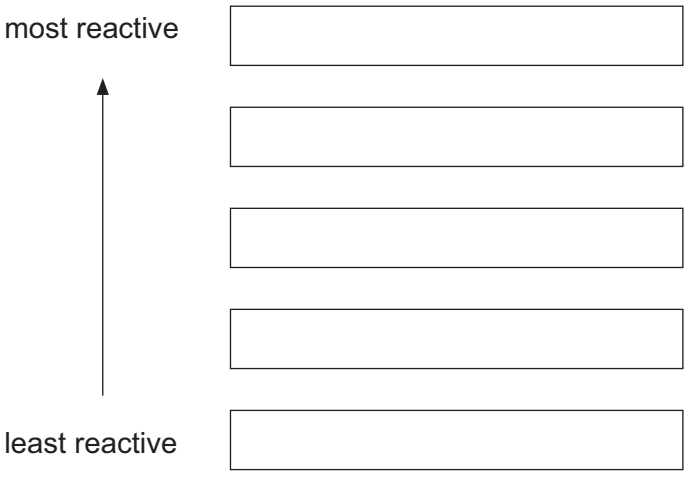
..... and ..... [2]

View solution

(b) Five metals are shown.

copper **gold** **iron** **magnesium** **zinc**

Put these metals in order of their reactivity.
Put the most reactive metal at the top.



[2]

View solution

(c) Iron is extracted from its ore in a blast furnace.

(i) Name the ore used in the blast furnace to extract iron.

..... [1]

(ii) State **one** reason why coke is added to the blast furnace during the extraction process.

..... [1]

(iii) Name the compound used to reduce iron(III) oxide in the blast furnace.

..... [1]

[Total: 8]

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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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).