Cambridge IGCSE

Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

COMBINED SCIENCE **0653/41**

Paper 4 (Extended) **October/November 2019**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 20.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **19** printed pages and **1** blank page.

DC (LK/CB) 176926/3

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[Turn over

1 Fig. 1.1 shows some cells. The diagrams are not to scale.

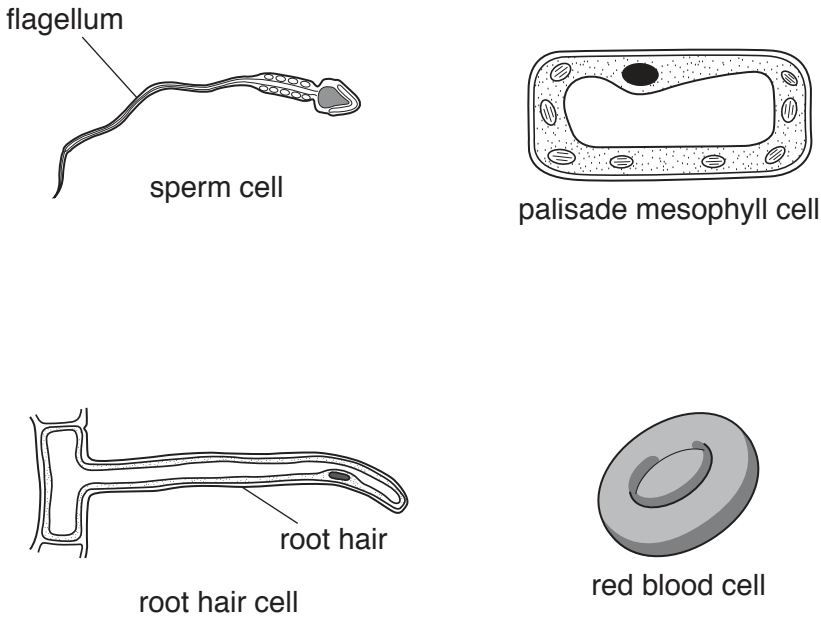

Fig. 1.1

(a) On Fig. 1.1 use label lines to name **two** structures in the palisade mesophyll cell which are absent from the red blood cell. [2]

(b) Describe the function of the root hair shown in Fig. 1.1.

.....

..... [1]

(c) **(i)** The flagellum is one of the adaptive features of a sperm cell.

Suggest the function of the flagellum.

.....

..... [1]

(ii) State **one other** adaptive feature of a sperm cell.

.....

..... [1]

(d) Fig. 1.2 is a diagram of some body cells surrounded by capillaries.

Substances in the blood can reach the body cells by moving out of the capillaries.

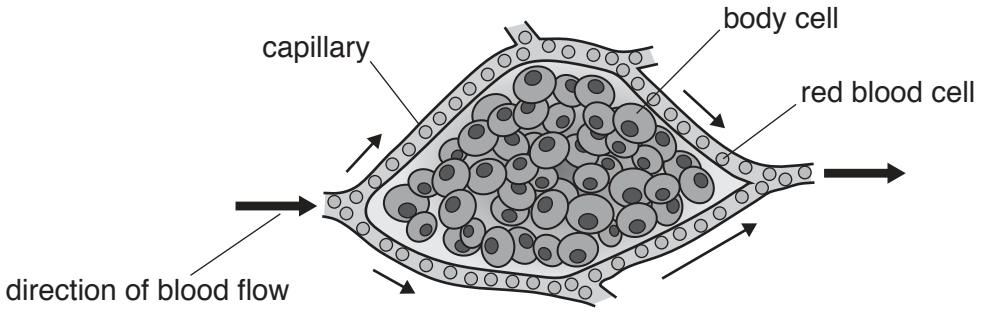

Fig. 1.2

(i) Circle **one** substance in the list that leaves the capillaries to enter the body cells.

amylase **carbon dioxide** **glucose** **glycogen** **starch**

[1]

(ii) Use words or phrases from the list to complete the following sentences about oxygen in the blood.

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

diffusion **dissolving** **fat** **haemoglobin** **osmosis**

platelets **red blood cells** **white blood cells**

Oxygen is carried in the blood by the ..... molecules which are contained in the ..... .

Oxygen moves out of the capillary by the process of ..... .

[3]

(iii) Describe how the structure of capillaries enables some substances to pass through their walls.

..... [1]

[Total: 10]

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2 Hydrocarbons are composed of the two elements carbon and hydrogen.

(a) State the type of chemical bond that forms between these two elements.

Explain your answer.

type of chemical bond .....

explanation .....

.....

.....

[2]

(b) Cracking is a process used to make smaller alkene molecules from larger alkane molecules.

(i) State **two** reaction conditions needed for cracking hydrocarbons.

1. .....

2. .....

[2]

(ii) During cracking, one molecule of decane, $C_{10}H_{22}$, breaks down to form one molecule of ethane, C_2H_6, and four molecules of another hydrocarbon.

Complete the balanced symbol equation for the cracking of decane.

$$C_{10}H_{22} \longrightarrow C_2H_6 + 4 \text{ .....}$$ [1]

(c) During the complete combustion of hydrocarbons, carbon dioxide and water are produced.

(i) Draw a dot-and-cross diagram to show all of the outer shell electrons in the atoms in one molecule of carbon dioxide.

[2]

(ii) State **one** effect of an increase in the amount of carbon dioxide in the atmosphere.

.....

..... [1]

[Total: 8]

3 Fig. 3.1 shows how a small hydroelectric power station is used to supply electricity.

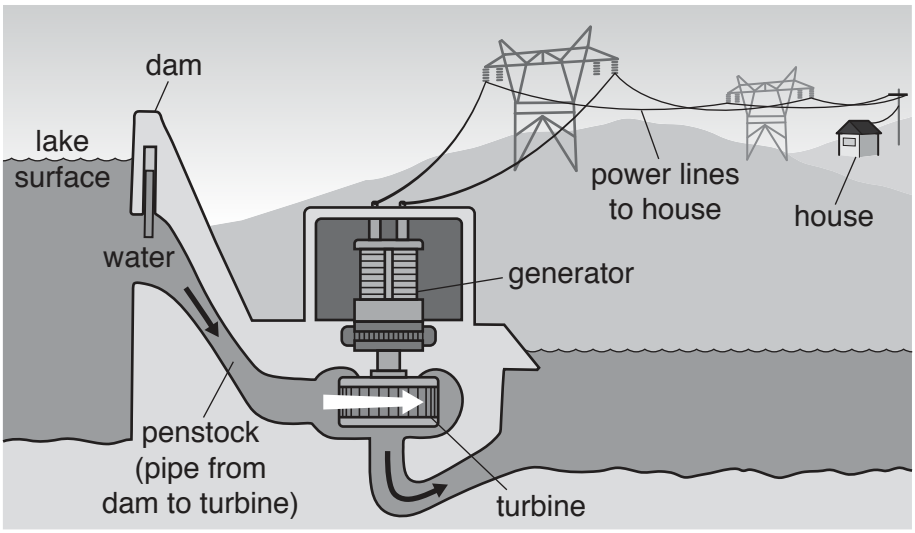

Fig. 3.1

(a) The flowing water turns the turbine which then turns the generator.

Identify, using the names on Fig. 3.1:

(i) **one** place where the gravitational potential energy of the water is at a maximum

..... [1]

(ii) **two** places where kinetic energy is part of the sequence of energy transfers.

..... and ..... [1]

(b) Hydroelectric power is an example of a renewable source of energy.

State **one** advantage and **one** disadvantage of hydroelectric power in terms of its environmental impact.

advantage .....

.....

disadvantage .....

.....

[2]

(c) In a house, electricity is used to power a television set.

An aerial for the television set receives signals in the radio wave region of the electromagnetic spectrum with a frequency of 600×10^6 Hz (600 MHz).

(i) State the speed at which these signals travel.

..... [1]

(ii) Use your answer to **(i)** to calculate the wavelength of the signal.

Show your working.

wavelength = ... m [2]

(iii) Fig. 3.2 shows the electromagnetic spectrum.

gamma radiation	X-rays	ultraviolet	visible light	infrared	microwaves	radio waves

Fig. 3.2

State the part of the electromagnetic spectrum used in television transmissions from satellites.

..... [1]

(d) The television set emits sound waves.

Describe how sound waves are transmitted in air.

You may wish to draw a diagram as part of your answer.

.....

.....

.....

[2]

[Total: 10]

[Turn over

4 **(a)** Plants make glucose by the process of photosynthesis.

Complete the balanced symbol equation for photosynthesis.

(i) .....CO_2 + 6..... $\xrightarrow[\text{chlorophyll}]{\text{light}}$ $C_6H_{12}O_6$ + ... [2]

(ii) State **two** uses of the glucose made by photosynthesis.

1. .....

2. .....

[2]

(b) Fig. 4.1 shows a diagram of the cross-section of a leaf. The letters refer to the layers of cells in the leaf.

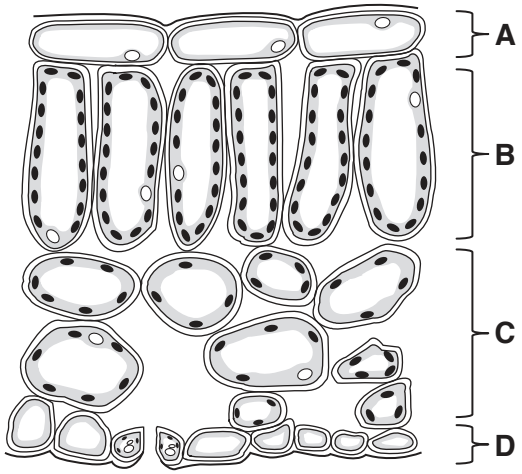

Fig. 4.1

(i) State the **letter** of the layer of the leaf where the greatest amount of photosynthesis takes place.

..... [1]

(ii) Explain your answer to **(i)**.

.....

.....

..... [2]

(c) During transpiration water vapour is lost from leaves through the stomata.

When the air surrounding the leaves becomes more humid, the rate of transpiration decreases.

Explain why the rate of transpiration decreases.

.....

.....

..... [2]

[Total: 9]

5 **(a)** Aluminium is a Group III metal. It is **not** a transition metal.

Copper is a transition metal. It forms coloured compounds.

State **one other** property of copper that is not a property of aluminium.

..... [1]

(b) Fig. 5.1 shows the apparatus used to extract copper from aqueous copper(II) chloride by electrolysis.

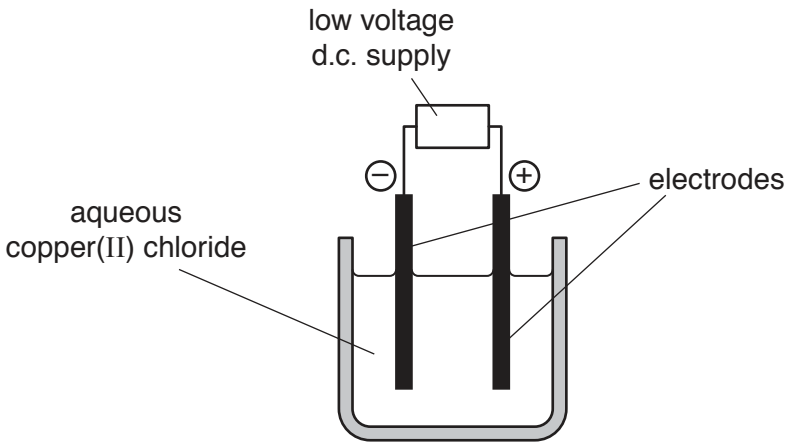

Fig. 5.1

(i) During this process copper forms at the negative electrode.

State the name of the negative electrode.

..... [1]

(ii) Explain how copper(II) ions change into copper atoms.

.....

..... [2]

(c) Copper is also extracted by heating copper oxide with carbon.

The word equation for the reaction is:

carbon + copper oxide ⟶ copper + carbon dioxide

(i) Name the reducing agent in this redox reaction.

..... [1]

(ii) Explain why aluminium **cannot** be extracted from aluminium oxide by heating with carbon.

.....

..... [1]

(d) At a water treatment works, a scientist thinks that the water is contaminated with a soluble copper compound containing copper(II) ions.

Describe a test that is used to detect the presence of aqueous copper(II) ions.

Give the positive result for this test.

test .....

.....

result .....

.....
[2]

[Total: 8]

6 Table 6.1 gives some data about the planets Earth, Mars, Mercury and Venus.

Table 6.1

	Earth	Mars	Mercury	Venus
mass	5.97×10^{24} kg	6.42×10^{23} kg	3.29×10^{23} kg	4.87×10^{24} kg
volume	1.08×10^{21} m^3	1.63×10^{20} m^3	6.08×10^{19} m^3	9.28×10^{20} m^3
gravitational field strength *g*	9.81 N/kg	3.71 N/kg	3.70 N/kg	8.87 N/kg
mean temperature at surface	15 °C	–63 °C	167 °C	462 °C
pressure of atmosphere	101 000 N/m^2	600 N/m^2	0	9 300 000 N/m^2
percentage of Sun's radiation reflected	31%	25%	7%	69%

(a) Use data from Table 6.1 to state which planet has the greatest volume.

..... [1]

(b) Use data from Table 6.1 to calculate the density of Mercury.

Show your working and give the units of your answer.

density = ... units ..... [3]

(c) A mass of 5 kg is placed on each planet, 10 m above the planet's surface.

State on which planet this mass has the greatest gravitational potential energy.

Give a reason for your answer.

planet .....

reason .....

.....

[2]

(d) The surface of a planet reflects a percentage of the Sun's radiation back into space. The rest of the radiation is absorbed by the planet.

Suggest **one** reason why the percentage of the Sun's radiation reflected by the surface of Mercury is so low.

..... [1]

(e) A space probe of mass 50 kg descends through the atmosphere on Venus. The probe is slowed down by the atmosphere much more than it would be by the resistance of the Earth's atmosphere.

Use data from Table 6.1 to explain this in terms of difference in the arrangement of the molecules in the atmosphere.

.....

.....

.....

..... [2]

[Total: 9]

7 Fig. 7.1 shows the flow of energy through a forest ecosystem.

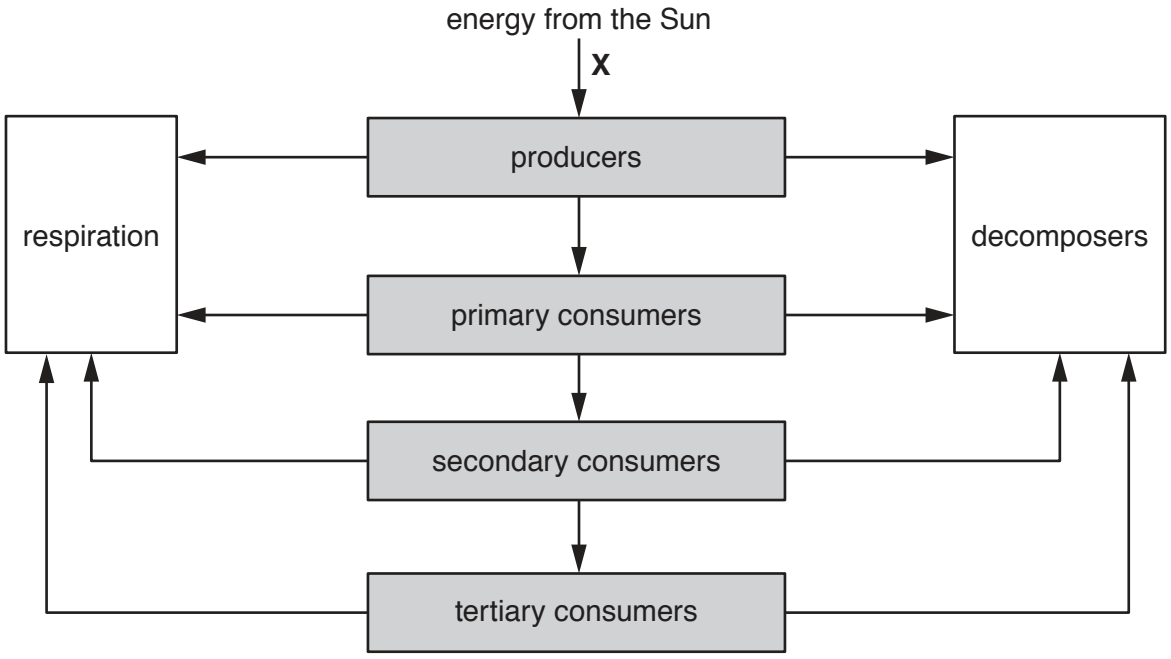

Fig. 7.1

(a) **(i)** Define the term *ecosystem*.

.....

.....

..... [2]

(ii) Complete the sentence about the energy transfer at **X**.

At **X** ..... energy is transferred to

..... energy. [2]

(b) The shaded boxes in Fig. 7.1 show the trophic levels in the ecosystem.

Energy is lost from the organisms at each trophic level.

State **two** ways in which energy is lost from the organisms at each trophic level.

1. .....

.....

2. .....

.....
[2]

(c) The trees are the main producers in the forest. They are cut down and taken away from the ecosystem.

Suggest what happens to the primary consumers in the forest.

Explain your answer.

.....

.....

..... [2]

[Total: 8]

8 Table 8.1 shows data about Group I metals.

The data for rubidium is missing.

Table 8.1

element	melting point / °C	rate of reaction with water
lithium	181	slow
sodium	98	moderate
potassium	64	fast
rubidium		
caesium	29	very violent

(a) (i) Suggest the melting point of rubidium.

..... °C [1]

(ii) Predict the rate of reaction of rubidium with water.

..... [1]

(b) Rubidium reacts with water to form rubidium hydroxide solution and hydrogen.

(i) Suggest the formula of rubidium hydroxide.

..... [1]

(ii) Suggest the pH of rubidium hydroxide solution.

Explain your answer.

pH .....

explanation .....

.....

[2]

(c) Rubidium hydroxide has a higher melting point than water.

Explain the difference in the melting point of rubidium hydroxide and of water.

In your answer refer to the type of bonds and the attractive forces.

.....

.....

.....

.....

.....

..... [3]

(d) The reaction between rubidium and water is exothermic.

Describe what happens during an exothermic reaction. Use ideas about chemical energy and thermal energy in your answer.

.....

.....

.....

..... [2]

[Total: 10]

[Turn over

9 **(a)** Fig. 9.1 shows a circuit containing three resistors, R_1, R_2 and R_3.

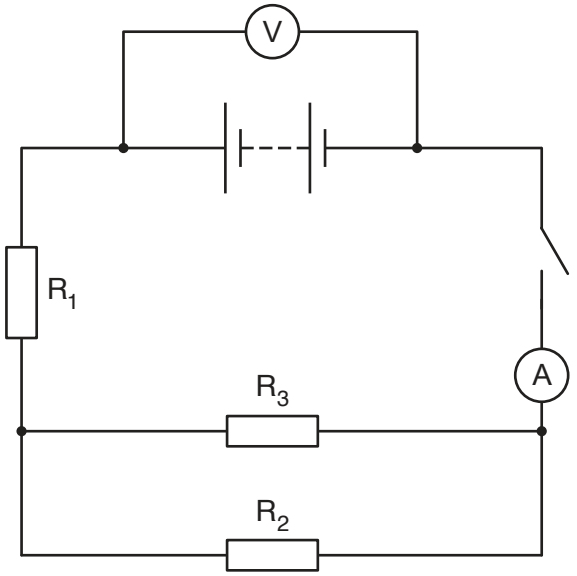

Fig. 9.1

(i) R_1 has a value of 8.0 Ω.

R_2 has a value of 3.0 Ω.

R_3 has a value of 6.0 Ω.

Complete steps **1** and **2** to calculate the value of the combined resistance of the three resistors in this circuit.

Show your working.

Step **1**: Calculate the combined resistance of R_2 and R_3.

combined resistance of R_2 and R_3 = ... Ω

Step **2**: Calculate the total resistance of the three resistors.

total resistance = ... Ω

[3]

(ii) The reading on the ammeter is 2.7 A.

The current in R_2 is 1.8 A

Determine the current in R_3.

Show your working.

current = ... A [1]

(iii) Explain your answer to **(a)(ii)**.

.....

..... [1]

(iv) With the switch closed and the current flowing in the circuit, the reading on the voltmeter is 27 V.

The switch is opened, so no current flows in the circuit. The reading on the voltmeter increases to 30 V.

Suggest an explanation for this observation.

.....

..... [1]

(b) A circuit with a total resistance of 5.0 Ω has a current of 9.0 A.

Calculate the power consumed in the circuit.

Show your working.

power = ... W [2]

[Total: 8]

The Periodic Table of Elements

Group I	Group II						Group III	Group IV	Group V	Group VI	Group VII	Group 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.).