Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CO-ORDINATED SCIENCES **0654/31**

Paper 3 Theory (Core) **May/June 2025**

2 hours

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.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = $9.8 \, m/s^2$).

INFORMATION

- The total mark for this paper is 120.
- 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 **28** pages. Any blank pages are indicated.

[Turn over

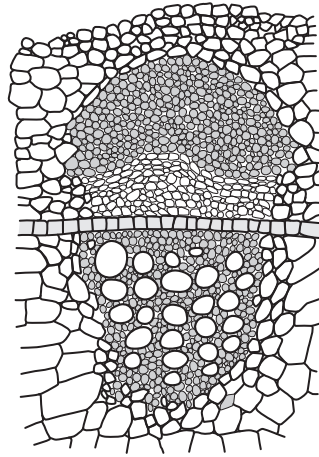**1** Fig. 1.1 shows a part of a cross-section of a plant stem.

Fig. 1.1

(a) On Fig. 1.1, draw a label line and the letter **Y** to identify the part of the stem that transports sucrose. [1]

(b) Sucrose is a type of carbohydrate.

Complete the sentences about carbohydrates in plants.

Plants make carbohydrates using the process of ....

This process requires water and .... in the presence of

.... energy and chlorophyll.

[3]

(c) Water travels through the plant from the roots to the leaves.

Complete the flow chart to show the pathway of water through a plant.

roots
| root hair cells |

| root .... cells |

| xylem |
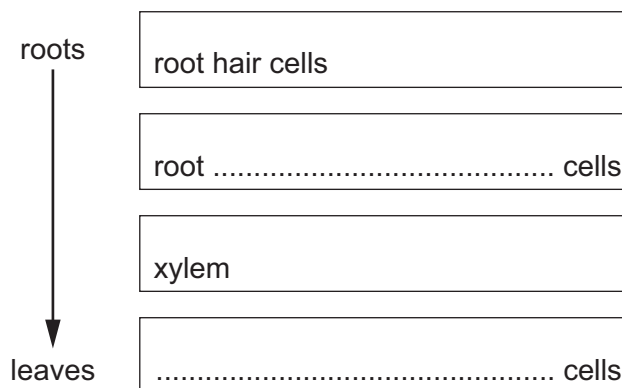
leaves
| .... cells |

[2]

(d) Water evaporates inside the leaves to form water vapour.

Water vapour is then lost from the leaves.

(i) State the name of the process that describes the loss of water vapour from leaves.

.... [1]

(ii) Circle the part where water vapour exits the leaf.

cuticle   palisade   stomata   vascular bundles

[1]

[Total: 8]

2   **(a)**   Fig. 2.1 is a diagram of the human digestive system.
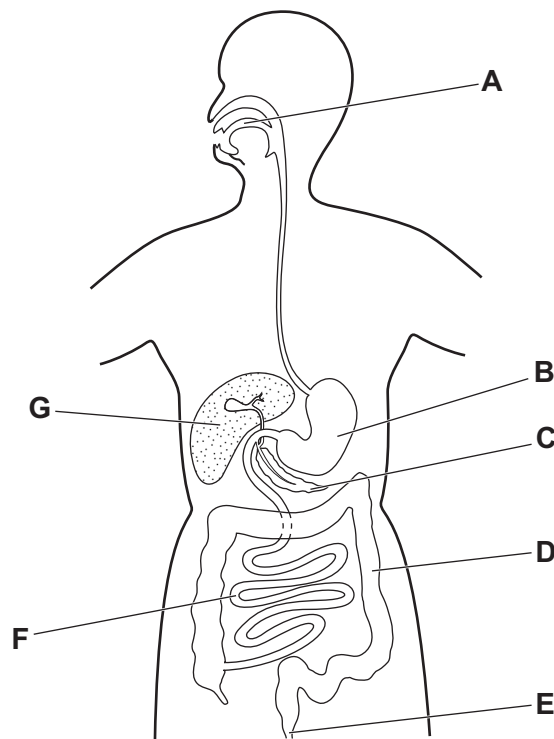
Fig. 2.1

     (i)   Using letters **A–G** in Fig. 2.1, identify:

         the anus ....

         the liver. ....

           [2]

     (ii)   Using letters **A–G** in Fig. 2.1, identify an organ where these processes occur:

         absorption ....

         digestion. ....

           [2]

   (b)   Complete the sentences about digestion.

     The breakdown of food into smaller pieces is called .... digestion.

     This increases the surface area of the food.

     The food is then broken down from large .... molecules to small

     .... molecules.

     This is called .... digestion and produces molecules that can be
absorbed.

           [4]

(c) Table 2.1 shows the nutrition label from a bag of rice.

Table 2.1

nutrient	typical values per 235 g bag of rice / g
fats and oils	2.1
carbohydrate	76.6
fibre	1.4
protein	8.5

(i) Use Table 2.1 to calculate the percentage of protein in the rice.

....% [2]

(ii) Table 2.1 gives four types of nutrients needed for a healthy diet.

State **one** other type of nutrient needed for a healthy diet.

.... [1]

[Total: 11]

3 Fig. 3.1 is a diagram of a palisade cell from a potato plant.
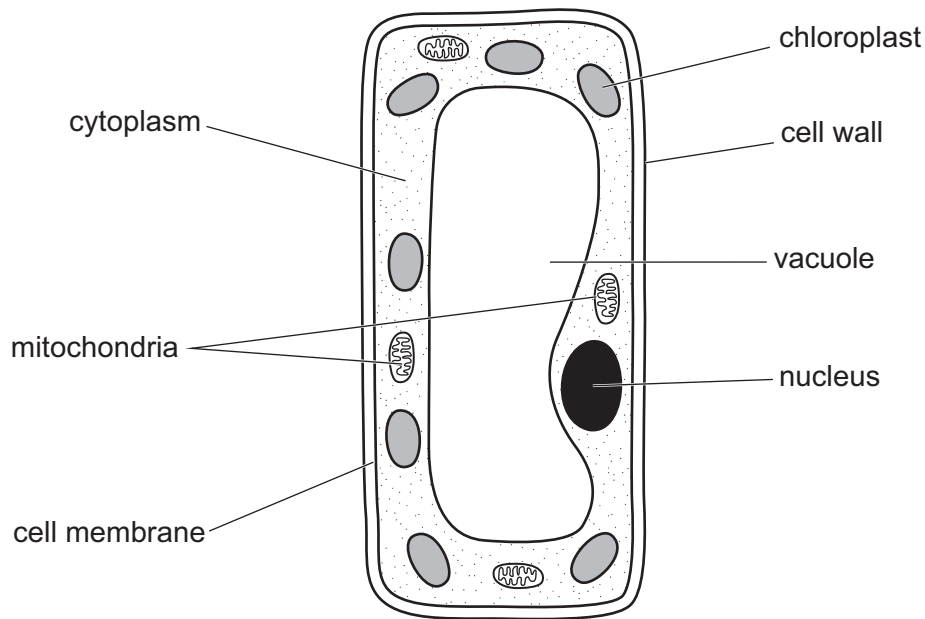
Fig. 3.1

(a) (i) Identify **all** the structures, labelled in Fig. 3.1, that are also in animal cells.

....

.... [2]

(ii) Describe the functions of the cytoplasm and the cell wall.

cytoplasm ....

....

cell wall ....

....
[2]

(b) Aerobic respiration takes place in mitochondria to release energy.

(i) State the word equation for aerobic respiration.

.... [2]

(ii) State **one** use of energy from respiration in living organisms.

.... [1]

(c) A student cuts a small piece of potato.

The student measures the mass of the piece of potato.

The student puts the piece of potato in pure water (water with no chemical impurities).

Describe the effect of the pure water on the mass of the piece of potato.

Include the name of the process in your answer.

description ....

....

....

name of process ....

[3]

(d) Plants are made up of different parts.

Use words from the list to complete the sentence about plants.

        organs   **tissues**   **cells**   **organ systems**

Plant leaves are thin, flat .... made up of

.... including phloem and epidermis.

[2]

[Total: 12]

4 Fig. 4.1 shows part of a food web on a remote island.
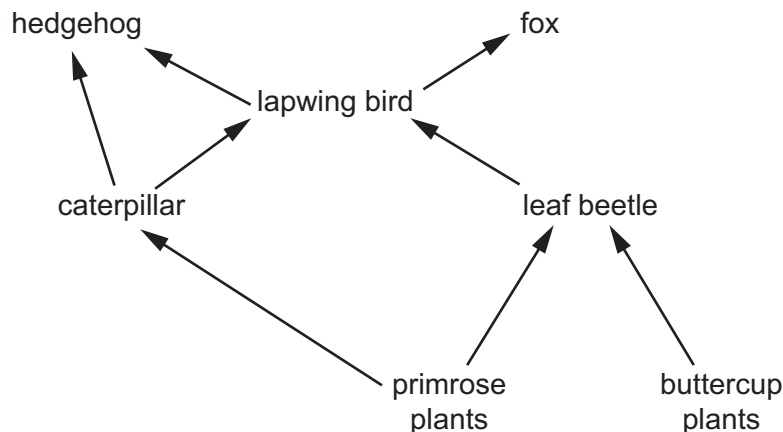
Fig. 4.1

(a) State the principal source of energy input to the food web in Fig. 4.1.

.... [1]

(b) Identify the **two** organisms in Fig. 4.1 that the lapwing bird eats.

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

(c) Identify **all** the producers in the food web in Fig. 4.1.

.... [1]

(d) Hedgehogs are introduced to the island by humans.

Use Fig. 4.1 to describe how hedgehogs affect the population of lapwing birds.

....

....

....

....

.... [3]

(e) When organisms in the food web die, other organisms like earthworms get their energy from the dead organic material.

State the type of organism that gets its energy from dead organic material.

.... [1]

(f) Hedgehogs hunt at night when it is dark.

Complete the sentences about how hedgehogs detect their prey.

Choose words from the list.

ciliated   **chemicals**   **light**   **motor**   **receptor**   **sound**

Hedgehogs use their sense of smell to detect .... in the air.

Their nose contains groups of .... cells which detect the smell.

[2]

[Total: 9]

5 **(a)** Table 5.1 contains information about 6 **atoms** or **ions** A, B, C, D, E and F.

Table 5.1

atom or ion	number of protons	number of neutrons	number of electrons	electronic configuration
A	1	0	1	1
B	6	6	6	2.4
C	6	8	6	2.4
D	10	10	10	2.8
E	17	18	17	2.8.7
F	17	18	18	2.8.8

State the letter or letters that:

(i) is an atom of hydrogen .... [1]

(ii) is in Group VII of the Periodic Table .... [1]

(iii) is a noble gas .... [1]

(iv) is an ion .... [1]

(v) are isotopes of the same element .... and .... [1]

(b) The melting point of hydrogen is −259 °C.

The boiling point of hydrogen is −253 °C.

Suggest a temperature at which hydrogen would be a liquid.

temperature = ...°C [1]

(c) The temperature of a fixed volume of hydrogen gas is increased.

State the effect of this increase on the pressure of the hydrogen gas.

.... [1]

(d) State the chemical test for hydrogen gas.

Give the positive result.

test ....

result ....
[2]

(e) Some water is made by reacting hydrogen gas with oxygen gas.

Describe how to test for the purity of the water made by using boiling point information.

....

.... [1]

[Total: 10]

6   **(a)**   Sulfuric acid has the formula H_2SO_4.

Determine the relative molecular mass, M_r, of sulfuric acid.

[A_r : H, 1; O, 16; S, 32]

relative molecular mass = ... [1]

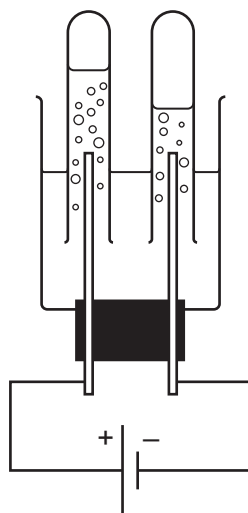**(b)**   Fig. 6.1 shows the apparatus used for the electrolysis of dilute sulfuric acid.

Fig. 6.1

   (i)   On Fig. 6.1, draw a label line and the letter **A** to indicate the anode and a label line and the letter **C** to indicate the cathode. [1]

   (ii)   On Fig. 6.1, draw a label line and the letter **E** to indicate the electrolyte. [1]

   (iii)   Name the gas formed at the anode and the gas formed at the cathode in Fig. 6.1.

anode ....

cathode ....
[2]

   (iv)   Graphite is often used as inert electrodes.

Graphite is a giant covalent structure formed of carbon atoms.

Name **one** other giant covalent structure formed of carbon atoms.

.... [1]

(c) (i) Describe the effect of dilute sulfuric acid on:

blue litmus indicator

....

methyl orange indicator.

....

[2]

(ii) Suggest the pH of dilute sulfuric acid.

pH = ... [1]

(iii) State the **two** products of the neutralisation reaction between an acid and an alkali.

1 ....

2 ....

[1]

[Total: 10]

7 **(a)** Iron is extracted from its ore by reduction in a blast furnace.

(i) Explain what is meant by reduction.

....

.... [1]

(ii) State the name of the ore of iron that is used in the blast furnace.

.... [1]

(b) Iron rusts.

Complete the sentence.

The conditions required for the rusting of iron include the presence of

.... and ....

[2]

(c) Iron reacts with dilute hydrochloric acid to make pale green aqueous iron(II) chloride and hydrogen gas.

(i) Explain why the sentence above suggests that iron is a transition metal.

....

.... [1]

(ii) Complete the balanced symbol equation for the reaction between iron and dilute hydrochloric acid.

Include state symbols.

$$Fe(s) \; + \; ... \, HCl(aq) \; \longrightarrow \; FeCl_2(...) \; + \; H_2(...)$$

[2]

(d) Iron is a good thermal conductor and a good electrical conductor.

State **one** other general physical property of iron that is characteristic of most metals.

.... [1]

[Total: 8]

15

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[Turn over

8 **(a)** Natural gas and petroleum are two fossil fuels.

(i) State the name of **one** other fossil fuel.

.... [1]

(ii) State the name of the main compound present in natural gas.

.... [1]

(b) Fig. 8.1 shows the process used to make refinery gas, gasoline / petrol, naphtha, diesel oil / gas oil and bitumen from petroleum.
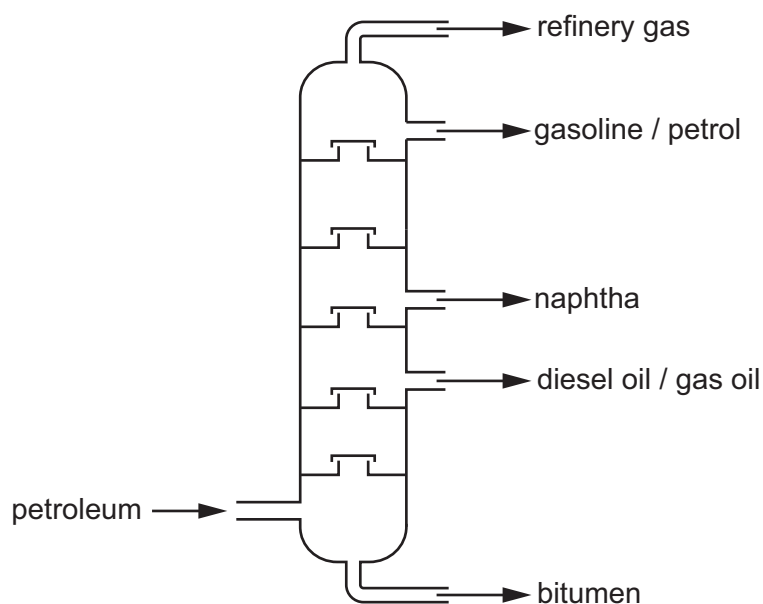
Fig. 8.1

(i) State the name of the process shown in Fig. 8.1.

.... [1]

(ii) Explain why the process identified in **(b)(i)** is a physical change and **not** a chemical change.

....

.... [1]

(iii) State **one** use for bitumen.

.... [1]

(c) Octane is a hydrocarbon obtained from petroleum.

Fig. 8.2 shows the structure of a molecule of octane.
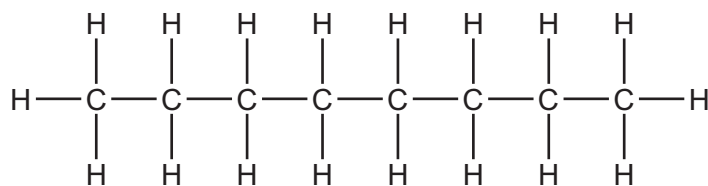
octane

Fig. 8.2

(i) Explain why octane is a hydrocarbon.

....

.... [2]

(ii) State the formula of octane.

.... [1]

(iii) State the type of chemical bonding present in octane.

.... [1]

(iv) Explain why octane is described as a saturated hydrocarbon.

....

.... [1]

(v) State the **two** products of the complete combustion of octane.

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

[Total: 12]

9 **(a)** Fig. 9.1 shows a horse and cart.
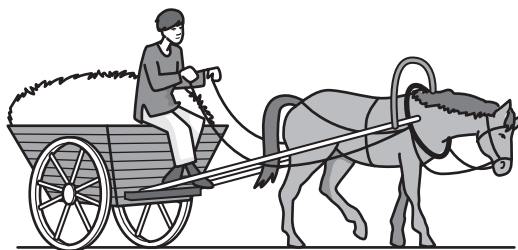
Fig. 9.1

(i) The horse and cart travel for a distance of 400 m in 300 s.

Calculate the average speed of the horse and cart.

average speed = ... m / s [2]

(ii) The horse pulls the cart with a constant force of 1200 N.

Show that the work done by the horse on the cart over a distance of 400 m is 480 000 J.

[1]

(iii) Calculate the power output of the horse over the time of 300 s.

power output = ... W [2]

(b) The audible frequency range for a horse is from 55 Hz to 33 kHz.

Compare this range to that of a human.

....

....

.... [2]

(c) The horse is treated by a vet (a doctor who treats animals).

The vet uses the isotope iridium-192 which decays by β-emission.

The nuclide notation for iridium-192 is $^{192}_{77}$Ir.

(i) State the number of protons in an atom of iridium-192.

number of protons = ... [1]

(ii) Deduce the number of neutrons in an atom of iridium-192.

number of neutrons = ... [1]

(iii) The half-life of iridium-192 is 74 days.

Calculate the time taken for the mass of iridium-192 to decay to 25% of its original mass.

time taken = ... days [2]

[Total: 11]

10 (a) The Sun is the closest star to the Earth.

(i) State the name of the force that keeps the Earth in orbit around the Sun.

.... [1]

(ii) State the name of the galaxy which contains the Sun.

.... [1]

(b) Energy from the Sun is used to power an electric car.

The energy is stored in a battery in the car.

The battery supplies a current of 96A at 120V to the motor that drives the car.

(i) Calculate the electrical energy transferred to the motor in 900s.

State the unit of your answer.

energy = ... unit .... [3]

(ii) The current supplied by the battery is direct current (d.c.).

Describe the difference between direct current (d.c.) and alternating current (a.c.).

....

.... [1]

(c) The car driver uses a wrench to remove a wheel from the car.

The driver puts the wrench on a wheel nut as shown in Fig. 10.1.
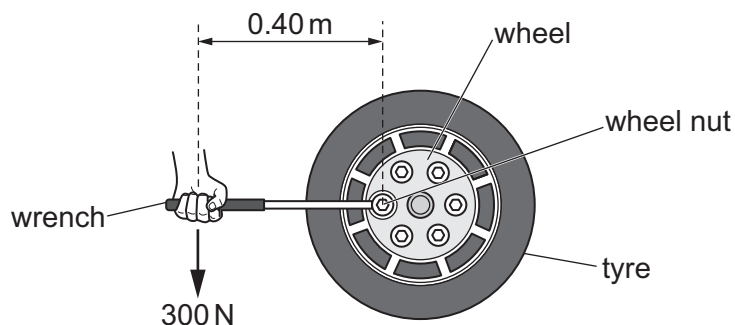
Fig. 10.1

The driver uses a force of 300 N at a distance 0.40 m from the wheel nut.

(i) Calculate the moment of the force about the centre of the wheel nut.

moment = ... N m [2]

(ii) Fig. 10.2 shows the tyre in contact with the road.
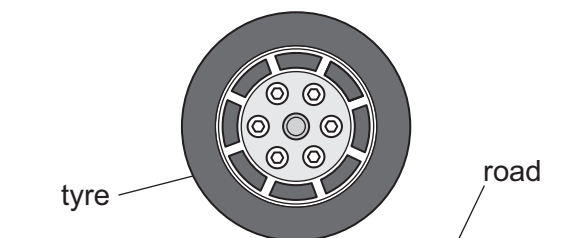
Fig. 10.2

The area in contact with the road is 180 cm^2.

The tyre exerts a pressure of 20 N/cm^2 on the road.

Calculate the force exerted by the tyre on the road.

force = ... N [2]

[Total: 10]

11 **(a)** A student uses the following equipment to determine the resistance of a lamp.

2 cells
ammeter
connecting wires
lamp
switch
voltmeter

(i) Draw the circuit diagram for the circuit that the student makes to determine the resistance of the lamp.

[4]

(ii) The student writes down the readings seen on the voltmeter and ammeter.

State the formula that the student uses to determine the resistance of the lamp.

.... [1]

(b) The lamp emits visible light.

Visible light is part of the electromagnetic spectrum.

(i) Write visible light in the correct place in the incomplete electromagnetic spectrum in Fig. 11.1.

	X-rays				microwaves	

Fig. 11.1

[1]

(ii) Name the region of the electromagnetic spectrum with waves of the highest frequency.

.... [1]

(c) Fig. 11.2 shows a ray of light of one frequency passing into a glass block.

air glass block
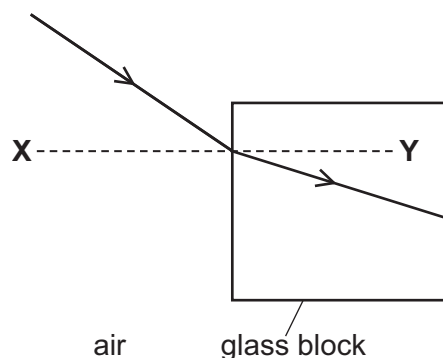
Fig. 11.2

(i) State the name of the line **XY**.

.... [1]

(ii) State the name of the effect shown in Fig. 11.2.

.... [1]

(iii) On Fig. 11.2, label the angle of incidence with the letter *i*. [1]

(iv) On Fig. 11.2, complete the diagram to show how the ray of light emerges into the air. [1]

[Total: 11]

12 (a) A climber climbs to the top of a rock face.

At the top, there is snow that is melting in the sunshine.

(i) State the melting temperature of water at standard atmospheric pressure.

.... °C [1]

(ii) Describe, in terms of the motion and arrangement of particles, how liquid water is different from solid water.

motion ....

....

arrangement ....

....
[2]

(iii) The climber is exposed to ultraviolet radiation from the Sun.

Describe **one** danger to humans of too much exposure to ultraviolet radiation.

....

.... [1]

(b) Fig. 12.1 shows the climber moving down the rock face from **A** to **B**.
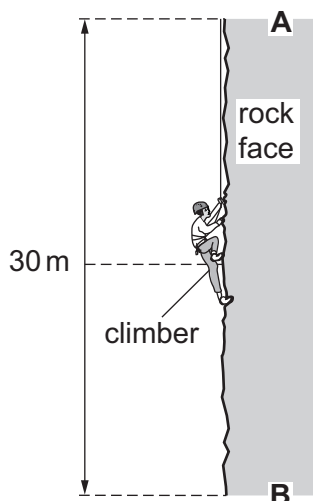
Fig. 12.1

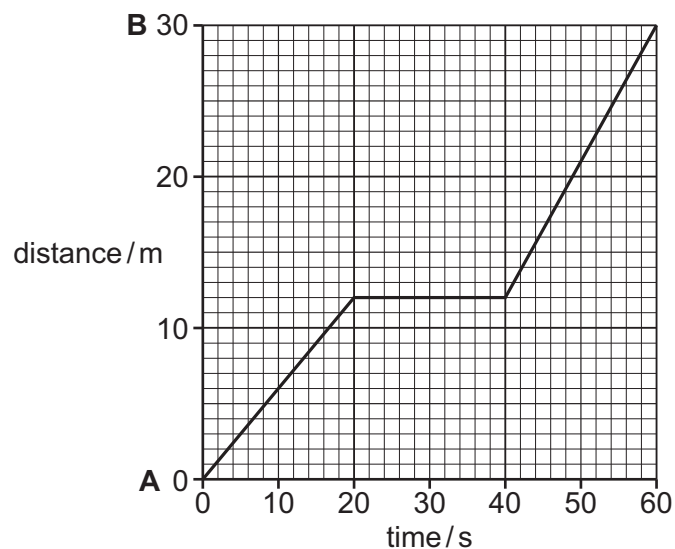Fig. 12.2 shows a distance–time graph for the climber's descent.

Fig. 12.2

(i) Describe the motion of the climber between time = 20 s and time = 40 s.

.... [1]

(ii) Calculate the maximum speed of the climber.

maximum speed = ... m / s [2]

(iii) As the climber descends, the rope passes through the climber's hands as he controls his speed of descent and his hands get hot.

Name the force between two surfaces that produces heating.

.... [1]

[Total: 8]

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The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

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 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* 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 T*l* 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 F*l* flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).