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0653/41

October/November 2019

1 hour 15 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

A copy of the Periodic Table is printed on page 20.

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.

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

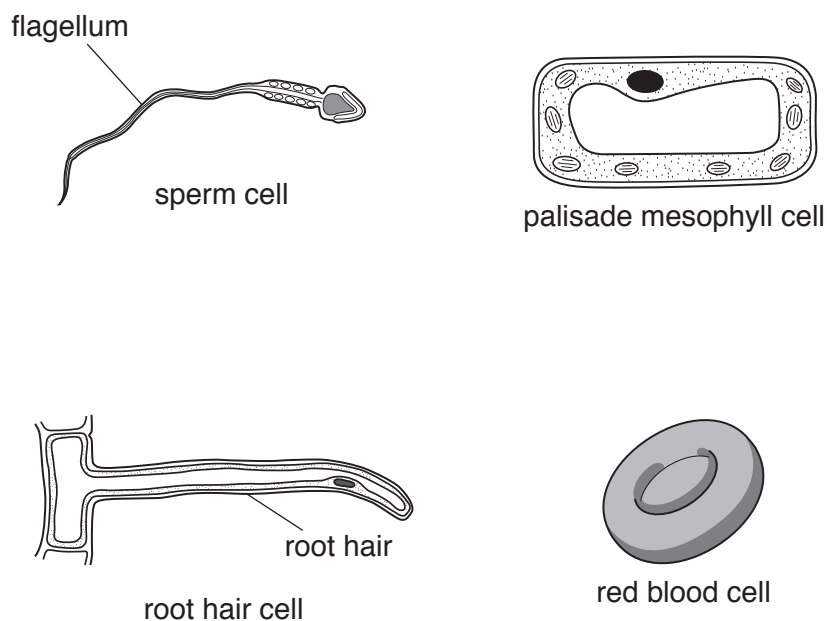


Fig. 1.1

(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.

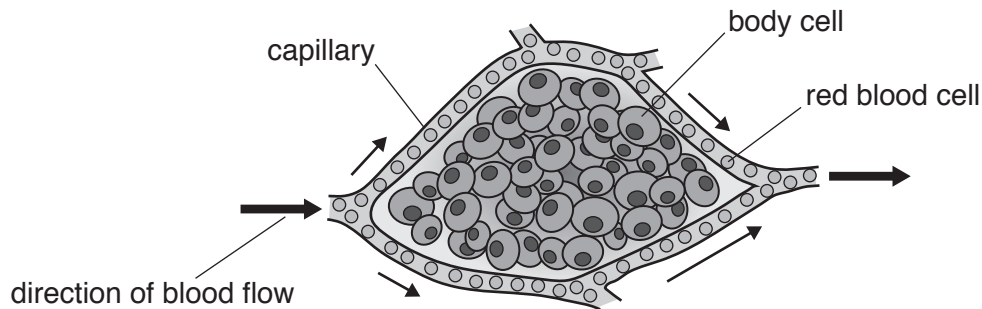


Fig. 1.2

(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) 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.

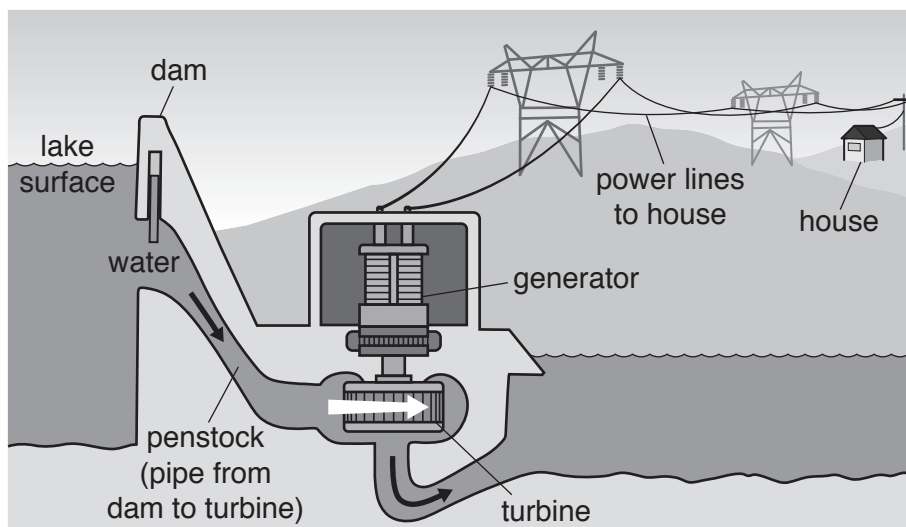


Fig. 3.1

- (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 $600 \times 10^6 \text{ Hz}$ (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.

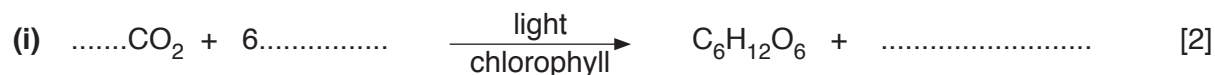
.....

 [2]

[Total: 10]

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

Complete the balanced symbol equation for photosynthesis.



- (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.

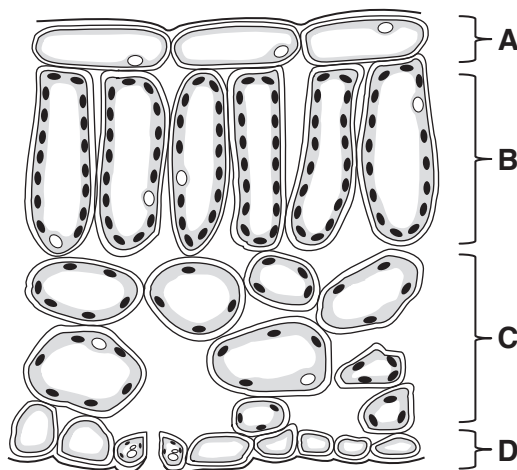


Fig. 4.1

- (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.

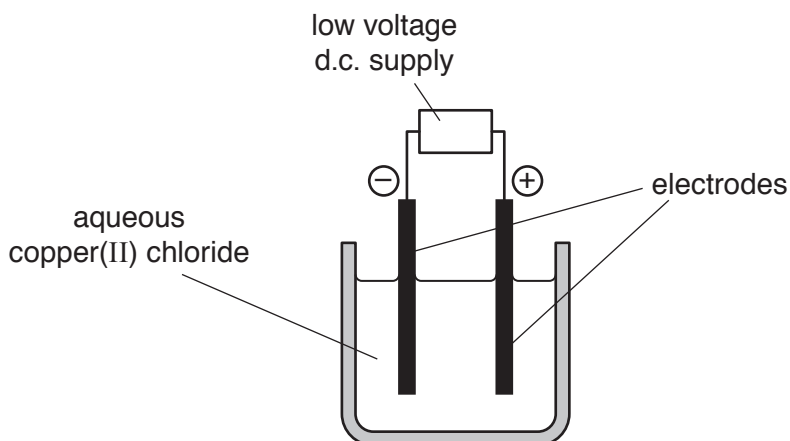


Fig. 5.1

- (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:



- (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	$5.97 \times 10^{24} \text{ kg}$	$6.42 \times 10^{23} \text{ kg}$	$3.29 \times 10^{23} \text{ kg}$	$4.87 \times 10^{24} \text{ kg}$
volume	$1.08 \times 10^{21} \text{ m}^3$	$1.63 \times 10^{20} \text{ m}^3$	$6.08 \times 10^{19} \text{ m}^3$	$9.28 \times 10^{20} \text{ m}^3$
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 50kg 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.

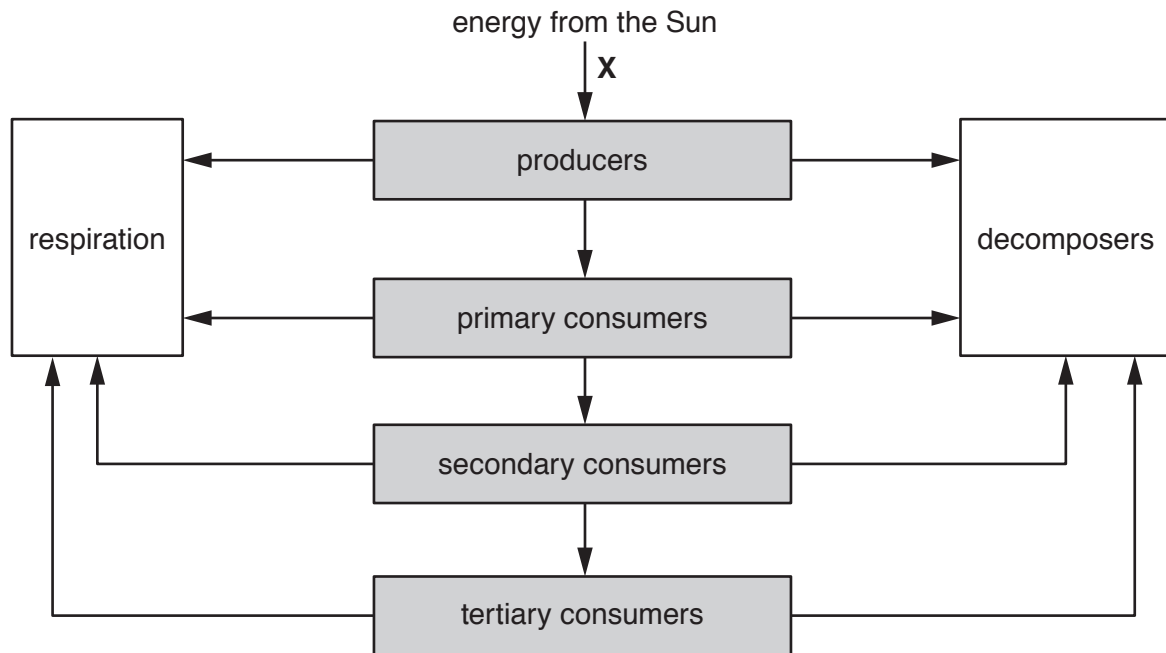


Fig. 7.1

(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]

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

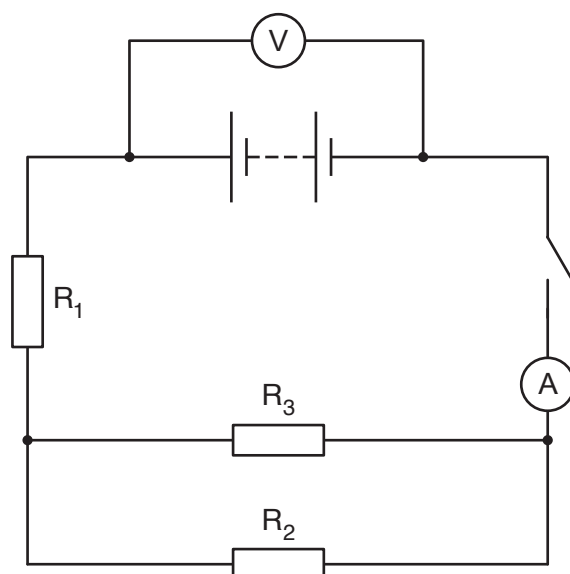


Fig. 9.1

- (i) R_1 has a value of $8.0\ \Omega$.

R_2 has a value of $3.0\ \Omega$.

R_3 has a value of $6.0\ \Omega$.

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 $5.0\ \Omega$ has a current of 9.0 A.

Calculate the power consumed in the circuit.

Show your working.

power = ... W [2]

[Total: 8]

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The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										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 —				

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 dm³ at room temperature and pressure (r.t.p.).



- 1 (a) A student investigates the volumes of air breathed in and out of their lungs before and during exercise.

Fig. 1.1 shows graphs of the results.

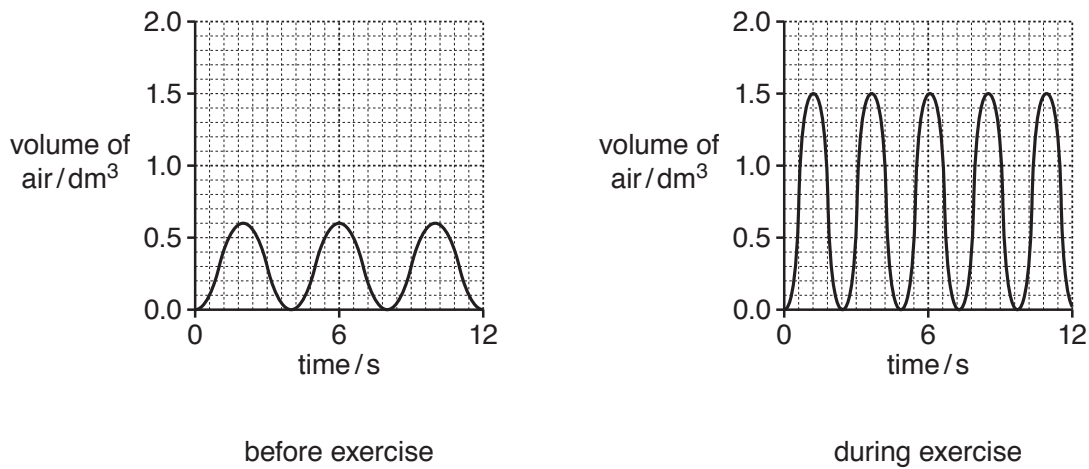


Fig. 1.1

- (i) Use data from Fig. 1.1 to calculate the **extra** volume breathed in with each breath during exercise.

extra volume = ... dm³ [1]

- (ii) Use data from Fig. 1.1 to calculate the **increase** in breathing rate during exercise.

Write your answer in breaths per minute.

increase = ... breaths per minute [2]

- (b) The pattern of breathing changes during exercise due to the change in the carbon dioxide concentration in the blood.

Explain the change in carbon dioxide concentration in the blood.

change in concentration

explanation

[2]

- (c) Smoking tobacco has harmful effects on the gas exchange system.

Describe the effect of carbon monoxide in tobacco smoke.

.....

.....

..... [2]

- (d) Suggest **one** disease caused by the tar in tobacco smoke.

..... [1]

[Total: 8]

- 2 (a) Fig. 2.1 shows a fractional distillation column used in the separation of petroleum.

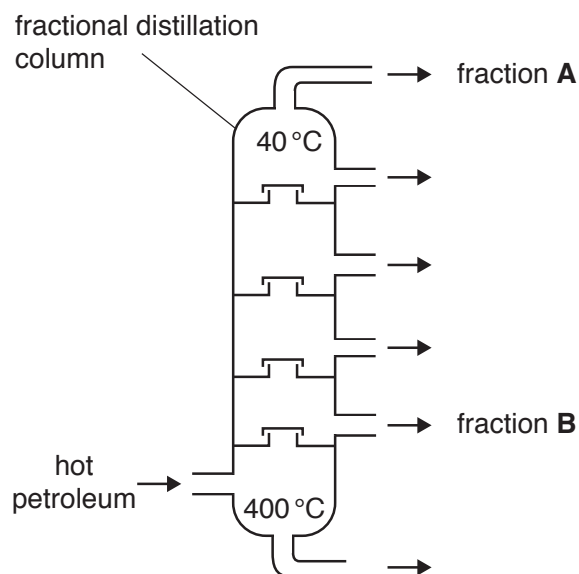


Fig. 2.1

- (i) Describe **one similarity** of the molecules in fraction **A** and fraction **B**.

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

- (ii) Describe **one difference** between the molecules in fraction **A** and fraction **B**.

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

(b) Methane and propane are both members of the homologous series of alkanes.

(i) State what is meant by a *homologous series*.

.....

 [2]

(ii) Complete Fig. 2.2 to show the structure of a molecule of propane, C_3H_8 .

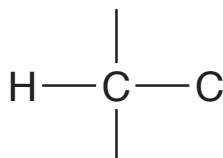


Fig. 2.2

[2]

(c) During the complete combustion of propane, carbon dioxide and water are formed.

(i) Construct the balanced symbol equation for the complete combustion of propane.

..... [2]

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

.....
 [1]

(iii) Draw a dot-and-cross diagram of a molecule of carbon dioxide.

Show all of the outer shell electrons.

[2]

- 3 (a) Fig. 3.1 shows how a spring is stretched when a force is applied to one end.

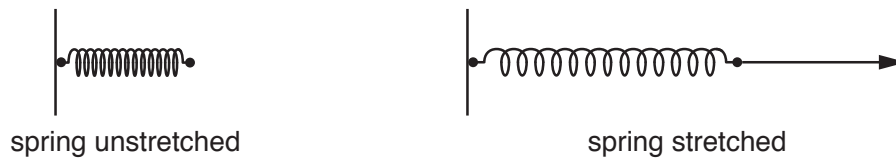


Fig. 3.1

- (i) State Hooke's Law.

.....
 [1]

- (ii) The unstretched spring is a length of 0.10 m. When a force of 2.0 N is applied, the spring stretches to a length of 0.14 m.

Calculate the total force required to stretch the spring to a length of 0.16 m.

Show your working.

total force = ... N [2]

- (iii) The spring is released and it returns to its original length. An average force of 0.75 N is then used to extend the spring by 0.015 m.

Calculate the work done in extending the spring.

Show your working.

work done = ... J [2]

- (b) A ball of mass 125 g is projected vertically upwards by a spring.

The initial kinetic energy of the ball is 2.0 J.

- (i) Calculate the maximum increase in the vertical height of the ball.

gravitational field strength $g = 10 \text{ N/kg}$

Show your working.

increase in height = ... m [3]

- (ii) Suggest **one** reason why the ball will **not** reach the maximum height calculated in (b)(i).

.....

..... [1]

[Total: 9]

- 4 (a) Fig. 4.1 shows a root hair cell and soil particles.

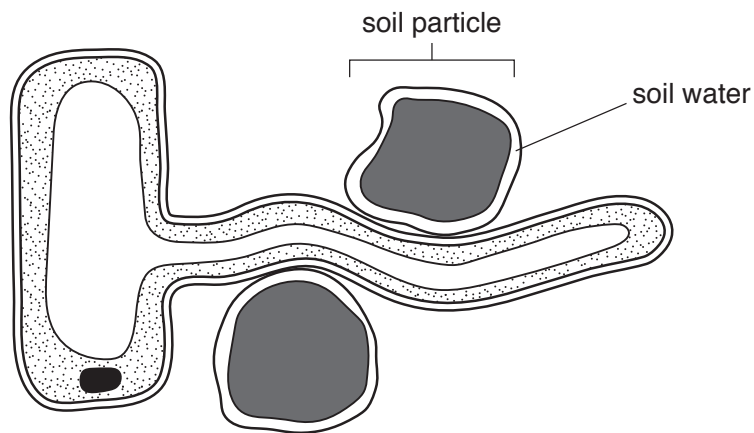


Fig. 4.1

- (i) On the root hair cell in Fig. 4.1 use label lines to identify:

1. the nucleus
2. the cell membrane.

[2]

- (ii) Explain how the structure of the root hair cell is adapted for water uptake.

.....

 [2]

- (b) Plants need a supply of mineral ions. These are dissolved in water in the soil.

- (i) Describe the importance of nitrate ions in a plant.

.....
 [1]

- (ii) Describe the pathway taken by nitrate ions from the root hair cells to the mesophyll cells in the leaf.

.....

 [2]

(c) Humans need vitamin D.

(i) Describe **one** effect of vitamin D deficiency in humans.

..... [1]

(ii) Name a food which is a rich source of vitamin D.

..... [1]

[Total: 9]

5 (a) Aluminium ore is mainly aluminium oxide. Aluminium is extracted from its ore by electrolysis.

(i) Name the ore from which aluminium is extracted.

..... [1]

(ii) The chemical formula of aluminium oxide is Al_2O_3 .

The formula of an oxide ion is O^{2-} .

Deduce the formula of an aluminium ion.

..... [1]

(iii) Fig. 5.1 shows the industrial apparatus used for the extraction of aluminium by electrolysis.

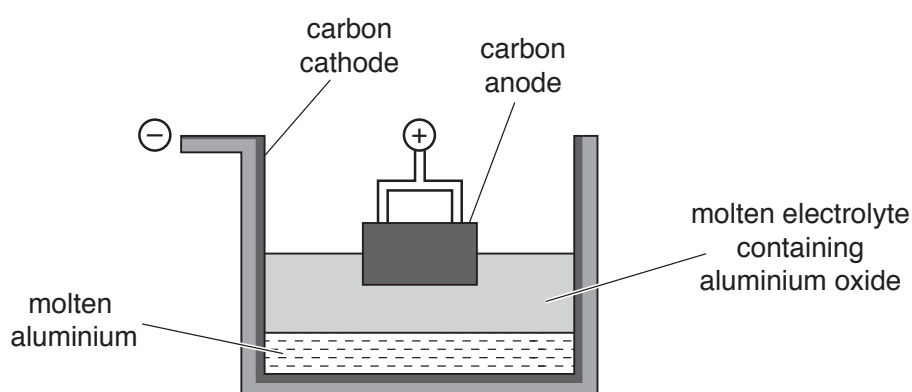


Fig. 5.1

Describe how aluminium atoms form from aluminium ions.

Use ideas about the movement of ions and electrons in your answer.

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

- (iv) Copper is extracted from copper oxide by heating with carbon.

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

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

- (b) Explain why aluminium alloys, rather than pure aluminium, are used in aircraft construction.

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

[Total: 6]

6 Fig. 6.1 shows an electric hair dryer.



Fig. 6.1

(a) Fig. 6.2 shows a label on the hair dryer.

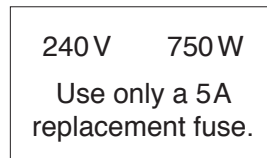


Fig. 6.2

Use data from Fig. 6.2 to explain why a 5A fuse is the correct fuse rating to be used in the hair dryer when replacing the fuse.

Show your working.

explanation

.....

[3]

(b) The hair dryer contains:

- an electrical heater to heat the air used to dry the hair
- a fan driven by an electric motor to blow the air over the wet hair
- a two-way switch that enables the motor to drive the fan at slow speed or high speed.

Fig. 6.3 shows the circuit diagram for the hair dryer with the two-way switch in two different positions.

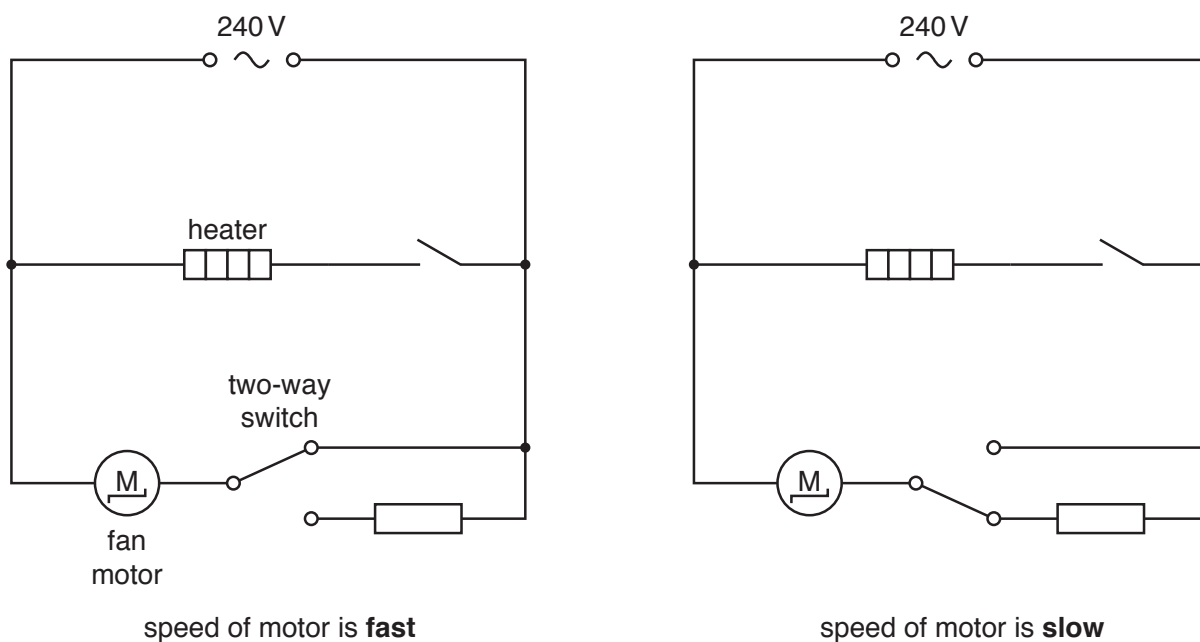


Fig. 6.3

The two-way switch changes the speed of the motor between fast and slow.

Suggest why use of the two-way switch in this circuit changes the speed of the motor.

Use the term *potential difference* in your answer.

.....

.....

.....

..... [3]

- (c) When the hair dryer blows air over wet hair, the water evaporates.

Explain in terms of water molecules why wet hair dries faster when air is blown across it, and even faster if the air is heated.

.....

.....

..... [2]

[Total: 8]

- 7 (a) A person is investigating the effect of the enzyme lipase on milk.

The person adds lipase to some milk in a test-tube.

After 10 minutes the contents of the test-tube are tested with Universal Indicator.

The results show that the contents of the test-tube have become more acidic.

- (i) Explain why the contents of the test-tube have become more acidic.

.....

 [2]

- (ii) Chemical digestion takes place in the test-tube.

Explain what is meant by *chemical digestion*.

.....

 [2]

- (iii) Name **one** area in the body where lipase is secreted.

..... [1]

- (b) The investigation in (a) is repeated with boiled lipase.

There is no change in the acidity of the contents of the test-tube.

Explain in detail the effect of boiling the lipase on the action of the enzyme.

.....

 [3]

- (c) Food is chewed in the mouth before swallowing.

Explain why the chewing of food is an example of mechanical digestion.

.....

 [2]

[Total: 10]

8 Chlorine and astatine are two Group VII elements.

(a) Fig. 8.1 shows Group VII of the Periodic Table.

VII
9 F Fluorine 19
17 Cl Chlorine 35.5
35 Br Bromine 80
53 I Iodine 127
85 At Astatine —

Fig. 8.1

(i) Use Fig. 8.1 to determine the number of electrons in an astatine atom.

..... [1]

(ii) State the number of electrons in the outer shell of an astatine atom.

Explain your answer.

number of electrons

explanation

..... [2]

(iii) Deduce the formula of potassium astatide.

..... [1]

(b) Chlorine combines with sodium in an exothermic reaction to produce sodium chloride.

- (i) Describe what is meant by an *exothermic reaction*. Use ideas about energy, bond breaking and bond forming in your answer.

.....

.....

..... [2]

- (ii) Solid sodium chloride contains sodium ions, Na^+ , and chloride ions, Cl^- .

Fig. 8.2 represents part of an ionic lattice of sodium chloride.

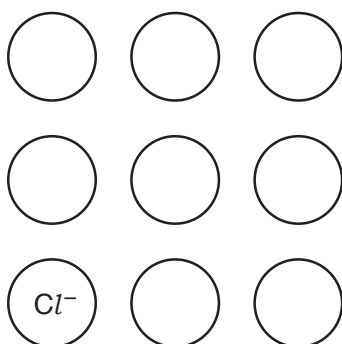


Fig. 8.2

[1]

Complete Fig. 8.2 to show the arrangement of sodium ions and chloride ions.

- (iii) The boiling point of chlorine is -34°C .

The boiling point of sodium chloride is 1465°C .

Explain the difference in these boiling points.

.....

.....

..... [2]

[Total: 9]

9 Fig. 9.1 shows a lightning bolt, which is a form of electrostatic discharge.

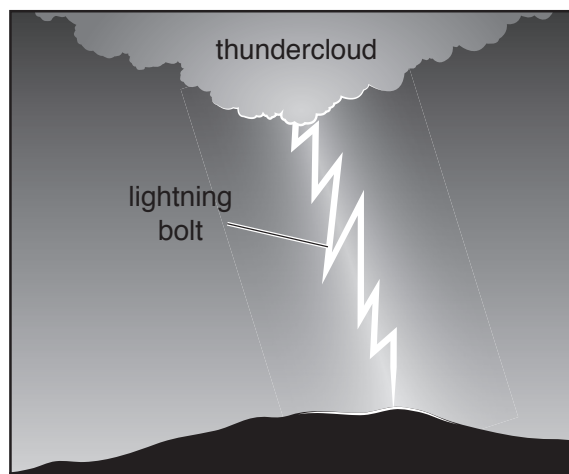


Fig. 9.1

(a) Fig. 9.2 shows the range of wavelengths of different parts of the electromagnetic spectrum.

$< 0.001 \times 10^{-9} \text{ m}$	$0.001 - 1 \times 10^{-9} \text{ m}$	$1 - 450 \times 10^{-9} \text{ m}$	$400 - 750 \times 10^{-9} \text{ m}$	$750 \times 10^{-9} \text{ m} - 0.001 \text{ m}$	$0.001 - 1.0 \text{ m}$	$> 1.0 \text{ m}$
gamma rays	X-rays				microwaves	

Fig. 9.2

A lightning bolt emits a range of wavelengths between 390 nm and 590 nm.
 (1 nm = $1 \times 10^{-9} \text{ m}$).

Identify the **two** parts of the electromagnetic spectrum emitted by lightning.

On Fig. 9.2 fill in the missing names of these parts in the correct places. [2]

(b) A person hears the thunder from a distant lightning bolt 10.0 s after the lightning is seen.

Sound travels in air at 330 m/s.

Calculate the distance of the person from the lightning bolt.

distance = ... m [2]

- (c) Lightning bolts occur when clouds become highly charged and a very high voltage exists between the thundercloud and the ground.

The current in a lightning bolt is 30 000 A, and flows for 0.000050 s

Calculate the electric charge that passes to Earth from this lightning bolt.

Show your working, and give the unit of your answer.

charge = ... unit [3]

- (d) (i) The thundercloud consists mainly of water droplets. The droplets at the bottom are negatively charged and at the top are positively charged.

Name the type of particle exchanged between the droplets to produce the charges on them.

..... [1]

- (ii) Just before a thunderstorm, some people find that their hair is standing on end.

Suggest a reason for this.

Explain your answer.

reason

explanation

..... [2]

[Total: 10]

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The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).



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0653/43

October/November 2019

1 hour 15 minutes

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

A copy of the Periodic Table is printed on page 20.

The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **20** printed pages.

- 1 (a) Fig. 1.1 is a diagram of the carbon cycle.
The arrows show the processes involved in the carbon cycle.

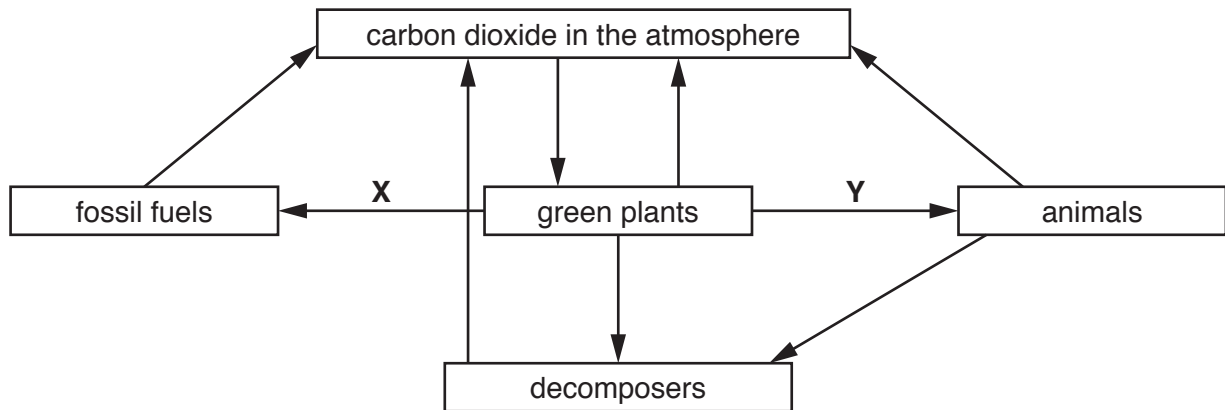


Fig. 1.1

- (i) Name processes **X** and **Y**.

X

Y

[2]

- (ii) Use Fig. 1.1 to name the group of organisms which are producers.

..... [1]

- (iii) Name a compound found in green plants which contains carbon and is used for the storage of energy.

..... [1]

- (b) Some activities of humans can affect the composition of gases of the atmosphere.

The trees in a forest are cut down and burned.

Explain in detail the effect of this deforestation on the oxygen concentration in the atmosphere.

.....

 [3]

[Total: 7]

2 (a) The formula of methanol is CH_3OH .

(i) State why methanol is **not** a hydrocarbon.

.....
 [1]

(ii) Complete the dot-and-cross diagram of a molecule of methanol.

Show all of the atoms and all of the outer shell electrons.

H C O

[3]

(b) (i) During the complete combustion of methanol, the amount of carbon dioxide in the air increases.

Suggest **one** effect of this increase on the environment.

.....
 [1]

(ii) The products of the complete combustion of methanol are the same as the products of the complete combustion of hydrocarbons.

Construct the balanced symbol equation for the complete combustion of methanol.

State symbols are **not** required.

..... [3]

[Total: 8]

- 3 (a) Fig. 3.1 shows children using a magnifying glass to view a butterfly.



Fig. 3.1

- (i) State which child, **A** or **B**, is using the magnifying glass correctly.

Give a reason for your answer.

.....
 [1]

- (ii) The magnified image of the butterfly is a virtual image.

State what is meant by a *virtual image*.

.....
 [1]

- (b) Complete the sentences below using words from the list.

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

amplitude **compressions** **frequency**
longitudinal **pitch** **transverse**

The boy listens to the radio. The radio transmits sound waves through the air to his ears as and rarefactions. These are waves.

He uses the volume control on the radio to make the sound louder, which alters the of the waves. [2]

- (c) The girl walks from home to school.

Fig. 3.2 shows a speed–time graph of her journey.

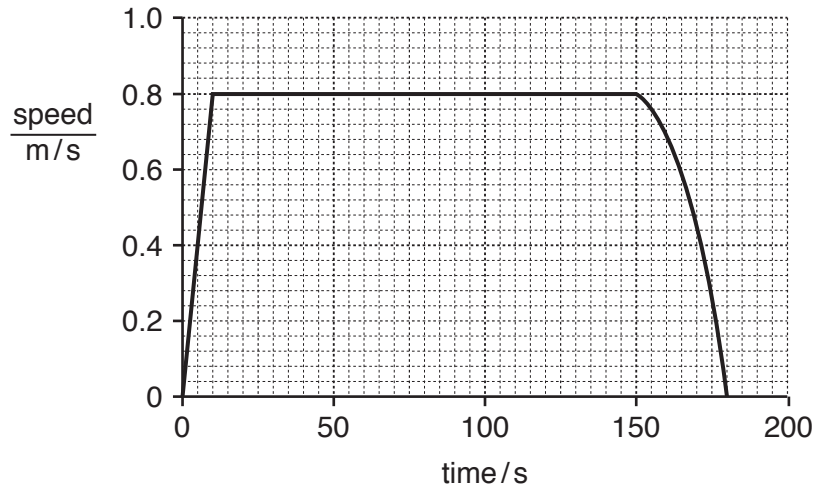


Fig. 3.2

- (i) Calculate the distance she travels between 0s and 150s.

Show your working.

distance = ... m [3]

- (ii) Explain the difference in the shape of the graph between 0s and 10s and between 150s and 180s.

.....

 [2]

- (d) The boy climbs a hill when he goes to school.

The mass of the boy is 40 kg. The hill is 50 m high.

Calculate the gravitational potential energy gained by the boy when he reaches the top of the hill.

Show your working.

gravitational field strength $g = 10 \text{ N/kg}$

gravitational potential energy gained = ... J [2]

[Total: 11]

Question 4 starts on the next page.

4 (a) Define the term *enzyme*.

.....
 [2]

(b) Enzymes are found in the digestive system where they help in the chemical digestion of food.

Fig. 4.1 shows some digestive enzymes listed in the boxes on the left.

enzyme	substrate	product
amylase	fats	amino acids
lipase	protein	fatty acids and glycerol
protease	starch	simple sugars

Fig. 4.1

(i) On Fig. 4.1:

- draw one straight line to connect each enzyme with its substrate
- draw one straight line to connect each substrate with its product.

[3]

(ii) State **one** area of the alimentary canal and its associated organs where protease is secreted.

..... [1]

(c) Explain in detail the activity of a human digestive enzyme at 70 °C.

.....

 [3]

(d) State **two** functions of hydrochloric acid in gastric juice.

1.

.....

2.

.....

[2]

[Total: 11]

5 (a) The elements in the Periodic Table, shown on page 20, are arranged in groups and periods.

(i) Chlorine is in Period 3.

State the number of elements in Period 3.

..... [1]

(ii) The number of outer shell electrons in the atoms of the elements changes across Period 3.

Describe the relationship between the number of outer shell electrons and the metallic character of these elements.

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

(b) (i) Describe a chemical test for chlorine gas and give the positive result.

test

.....

result

..... [2]

(ii) Explain how chlorination makes water safe to drink.

.....

..... [1]

(c) Chlorine gas is bubbled through aqueous potassium bromide.

Describe the colour change during this process.

Use ideas about the reactivity of the halogens to explain your answer.

colour change

.....

explanation

.....

..... [2]

(d) Chlorine gas can be obtained by the electrolysis of molten potassium chloride using inert electrodes.

(i) Name the electrode at which chlorine forms.

..... [1]

(ii) Describe how chloride ions are changed into chlorine atoms.

.....

.....

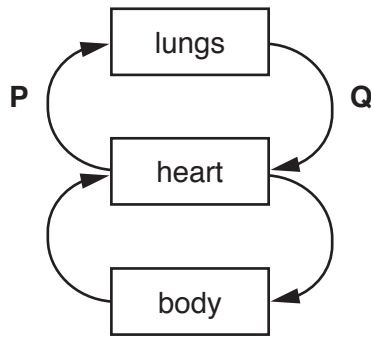
..... [2]

(iii) State the **other** product of this electrolysis.

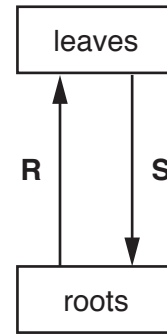
..... [1]

[Total: 11]

- 6 Fig. 6.1 shows simple diagrams of the human and plant transport systems. The arrows show the direction of flow of substances.



human transport system



plant transport system

Fig. 6.1

- (a) (i) Use Fig. 6.1 to explain why the human circulation is described as a *double circulation*.

.....

.....

.....

..... [2]

- (ii) State **two** ways in which the composition of the blood flowing in direction **P** is different from the blood flowing in direction **Q**.

1.

2. [2]

- (b) (i) Name the tissue which transports food substances in direction **S**.

.....[1]

- (ii) Explain why food is transported in direction **S**.

.....

..... [1]

- (iii) Water passes through the roots to the leaves in direction **R** in the xylem.

Some of the water from the xylem replaces water lost during transpiration.

Explain in detail why the rate of transpiration decreases when the humidity of the air increases.

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

- (iv) State **one other** function of the xylem apart from transport.

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

[Total: 9]

- 7 (a) In hot climates, some foods such as milk must be kept cool to ensure they stay fresh.

Fig. 7.1 shows a cooler made of pottery used to keep a bottle of milk cool.

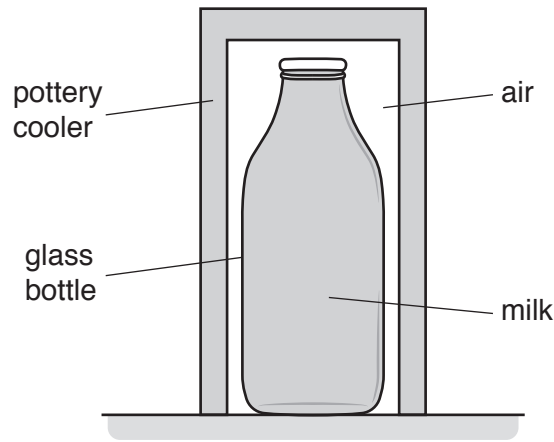


Fig. 7.1

The cooler is soaked with cold water and placed over the glass bottle containing milk.

The cooler slowly dries.

As the water evaporates, the temperature of the cooler falls below the temperature of the surroundings.

- (i) Describe in terms of molecules of water how this process results in the temperature of the cooler decreasing.

.....

.....

.....

..... [2]

- (ii) Explain in terms of the motion of the molecules why the water evaporates more quickly when the temperature of the surroundings is higher.

.....

.....

.....

.....

..... [2]

- (iii) The temperature of the milk in the glass bottle also decreases.

Describe in terms of molecular movement how thermal energy is transferred from the milk through the glass bottle by conduction.

.....

.....

.....

..... [2]

- (b) Fig. 7.2 shows a solar-powered freezer used in sunny climates. The freezer can also use a mains supply at night.

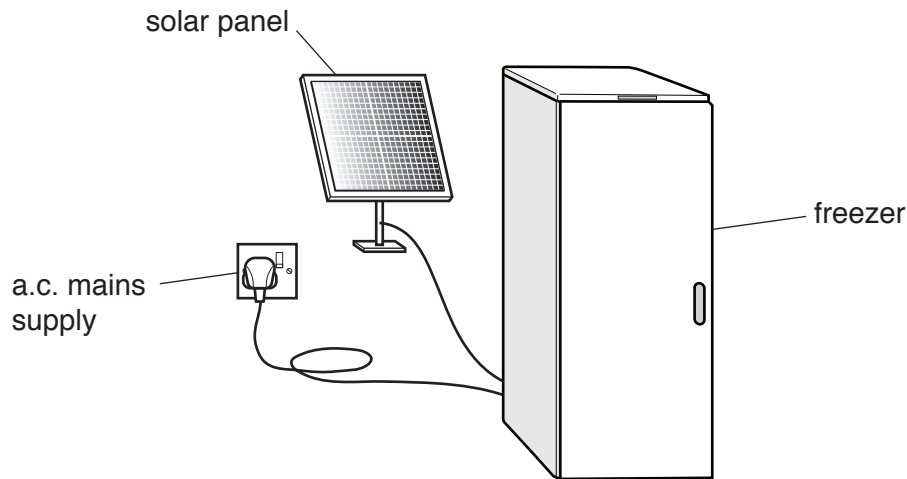


Fig. 7.2

The solar panel provides a 12 V supply to power the freezer.

At night, the mains supply powers the appliance at 240 V instead of the solar panel.

The power supplied is only 80 W when operating at 240 V and is 90 W when operating at 12 V.

The freezer has two fuses, one marked 10 A, the other marked 1 A.

Suggest why the freezer needs two separate fuses with these different values.

Show calculations as part of your answer.

.....

.....

..... [4]

[Total: 10]

8 (a) Magnesium reacts with dilute hydrochloric acid.

- (i) Explain in detail why the rate of this reaction increases when the concentration of the acid increases.

.....

.....

.....

.....

..... [3]

- (ii) State **one other** change that increases the rate of this reaction.

..... [1]

- (iii) The reaction between magnesium and hydrochloric acid is exothermic.

Explain why an *exothermic* reaction releases heat.

Use ideas about energy, bond breaking and bond forming in your answer.

.....

.....

.....

..... [2]

- (b) Iron is extracted from iron oxide in a blast furnace.

Explain why magnesium **cannot** be extracted from magnesium oxide in a blast furnace.

.....

..... [1]

[Total: 7]

9 Fig. 9.1 shows an electrically-powered bicycle.

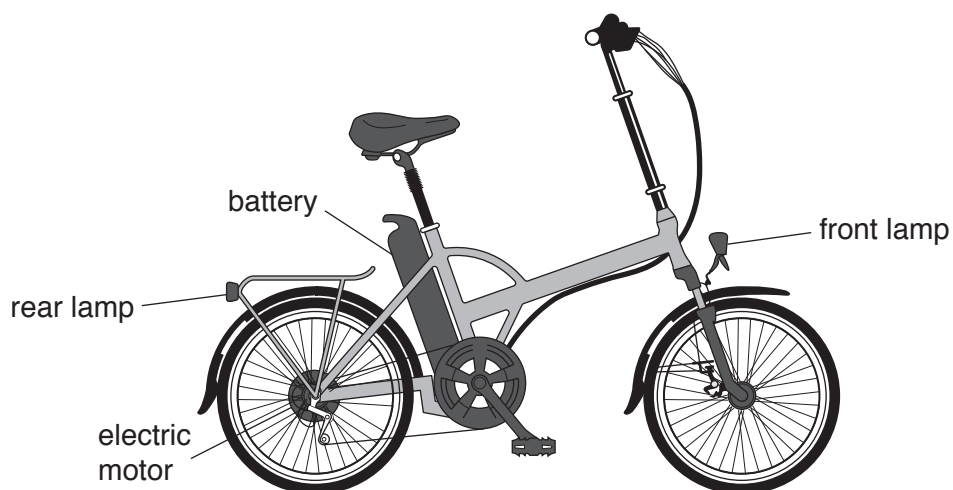


Fig. 9.1

Fig. 9.2 shows part of the circuit diagram for the lamps and electric motor on the bicycle.

The switch shown on the diagram controls only the motor and a variable resistor.

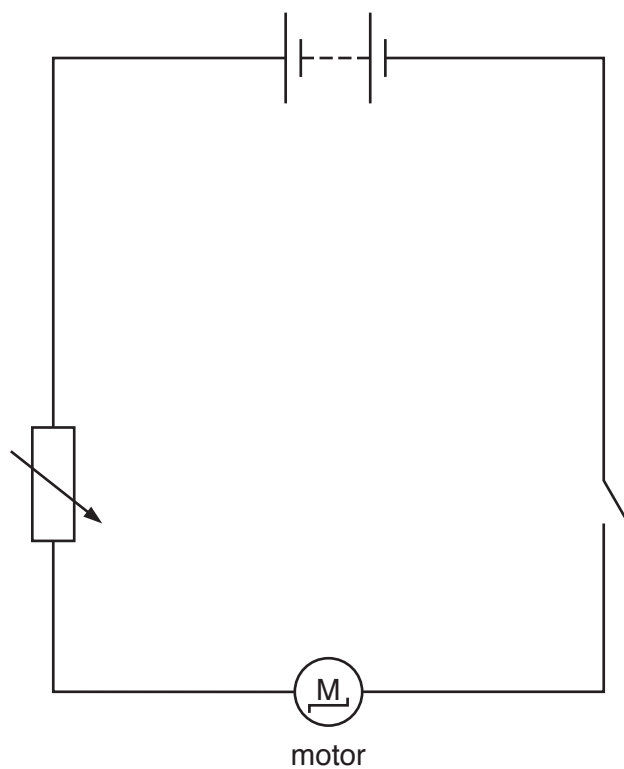


Fig. 9.2

- (a) A second switch controls the two lamps, which are connected in parallel with the motor. The two lamps are also connected in parallel with each other.

Complete the circuit diagram on Fig. 9.2 to show how the second switch and the two lamps are connected into the circuit. [3]

- (b) When both lamps are fully lit, the front lamp has a current of 2.0A and the rear lamp has a current of 1.0A.

The battery consists of eight cells, each with an e.m.f. of 1.5 V.

Use the data to calculate the combined resistance of the lamps when both are fully lit.

Show your working.

resistance = ... Ω [3]

[Total: 6]

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The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1						III	IV	V	VI	VII	VIII				
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass						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 —	127 Ts tennessine —	128 Og oganesson —	129 Nh nihonium —	130 Fl flerovium —

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
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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 —
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The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).