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COMBINED SCIENCE

0653/31

Paper 3 Theory (Core)

October/November 2024

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 **24** pages. Any blank pages are indicated.



1 (a) Fig. 1.1 shows the flower of a plant.

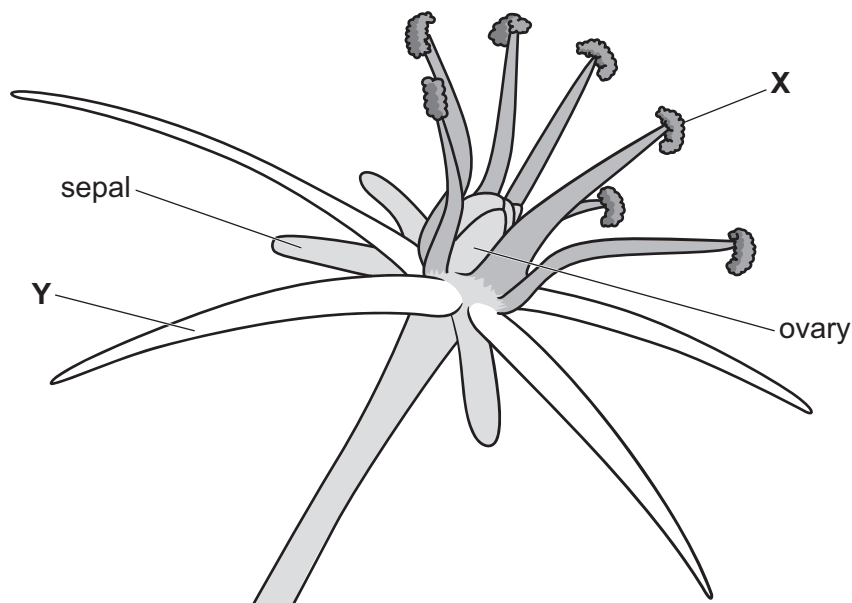


Fig. 1.1

(i) State the name of the part labelled **X** on Fig. 1.1.

..... [1]

(ii) State the name and function of the part labelled **Y** on Fig. 1.1.

name

function

[2]

(iii) Complete the description of what happens in the ovary of the flower.

The ovary is where the process of takes place.

The nucleus of a grain fuses with the nucleus of

an

[3]



(b) Fig. 1.2 shows a food web.

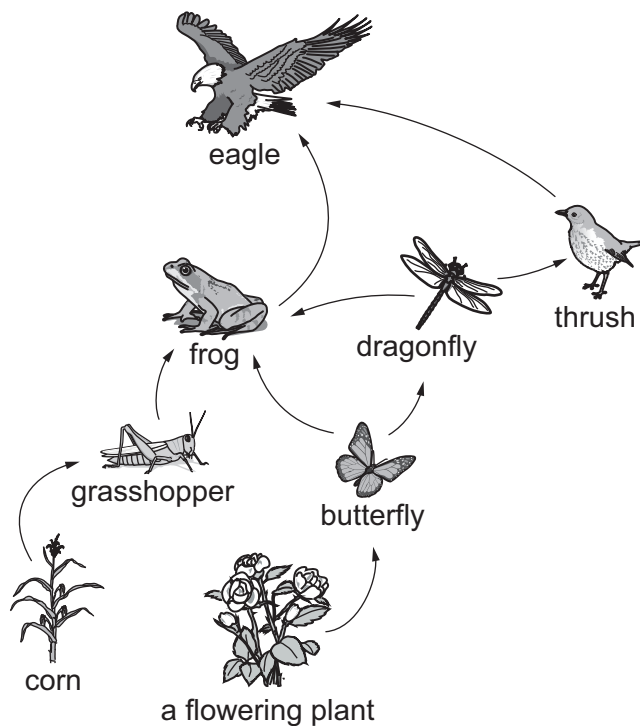


Fig. 1.2

Table 1.1 shows some terms that can be used to describe some of the organisms in Fig. 1.2.

Tick (✓) the boxes in Table 1.1 to show **all** the terms used to describe each organism.

Table 1.1

organism	carnivore	herbivore	primary consumer	producer
butterfly				
corn				
thrush				

[3]

[Total: 9]



- 2 A student investigates the rate of reaction between solid magnesium carbonate and dilute hydrochloric acid.

Fig. 2.1 shows the apparatus.

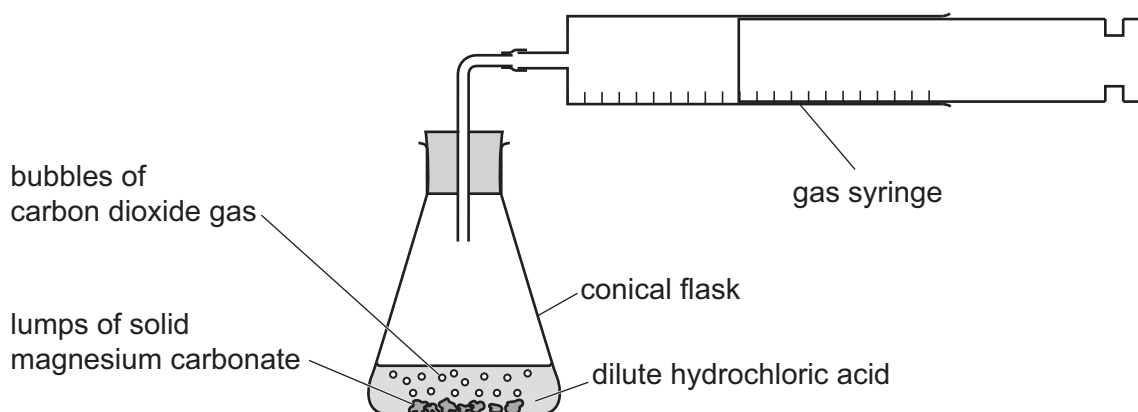
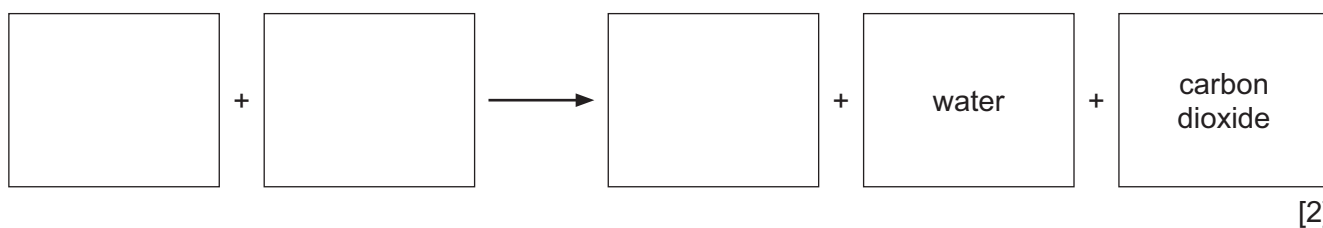


Fig. 2.1

- (a) Complete the word equation for the reaction shown in Fig. 2.1.



- (b) The student investigates this reaction using three different concentrations, **A**, **B** and **C**, of dilute hydrochloric acid. All other variables are kept constant.

Fig. 2.2 shows the volume of carbon dioxide gas produced over a period of 100 s.

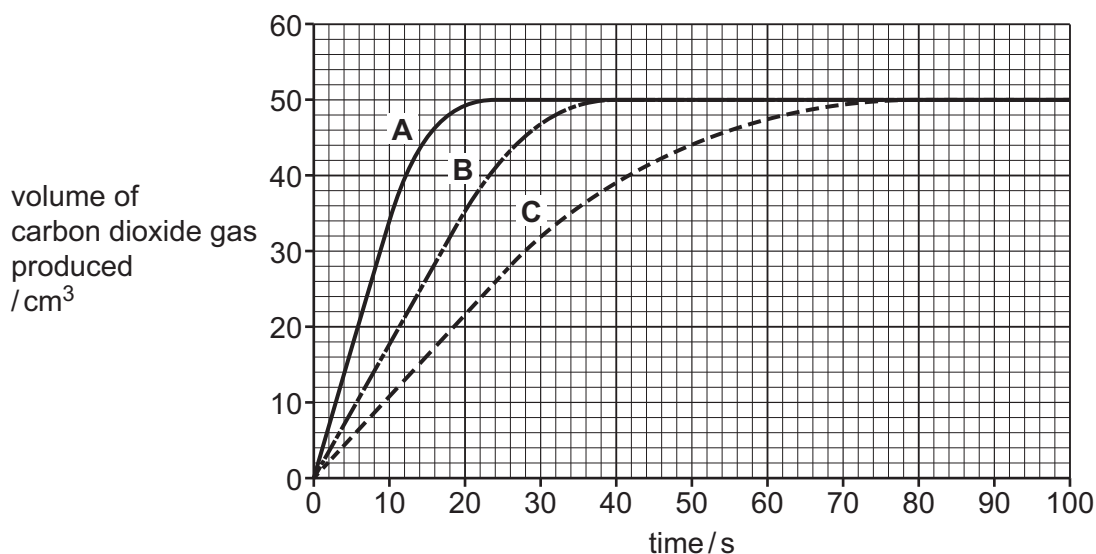


Fig. 2.2

- (i) Identify the time at which the acid with concentration **B** stops reacting.

time = ... s [1]

- (ii) Use Fig. 2.2 to identify which concentration, **A**, **B** or **C**, is the lowest concentration of dilute hydrochloric acid.

Explain your answer.

concentration

explanation

.....

.....

[2]

- (iii) Changing the concentration of dilute hydrochloric acid affects the rate of reaction.

State **two** other ways of affecting the rate of reaction.

1

2

[2]





(c) The reaction between dilute hydrochloric acid and magnesium carbonate produces water.

(i) State the name of the type of chemical bonding in a water molecule.

..... [1]

(ii) Complete the dot-and-cross diagram in Fig. 2.3 to show the bonding in a water molecule, H_2O .

Show **all** the outer-shell electrons.

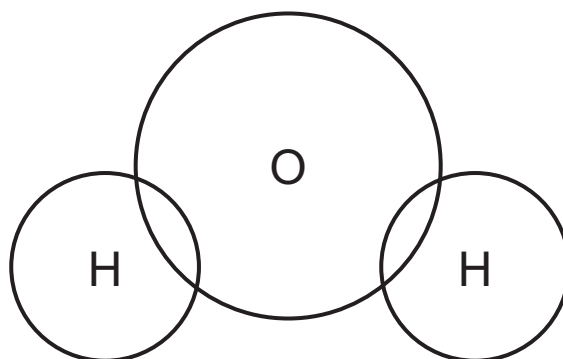


Fig. 2.3

[2]

[Total: 10]





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3 Fig. 3.1 shows a block of wood.

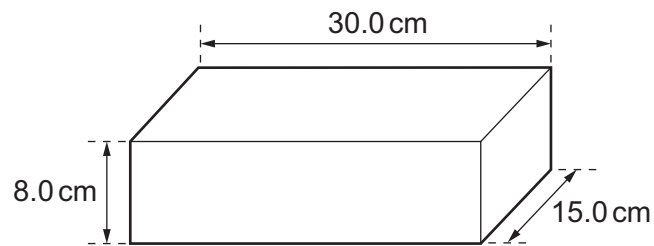


Fig. 3.1

The mass of the block of wood is 2.7 kg.

(a) (i) Calculate the weight of the block of wood.

The gravitational force on unit mass is 10 N/kg.

weight = ... N [2]

(ii) Show that the volume of the block is 0.0036 m^3 .

[2]

(iii) Calculate the density of the wood.

density = ... kg/m^3 [2]



(b) Fig. 3.2 shows the block of wood on the bottom shelf (shelf 1) of some bookshelves.

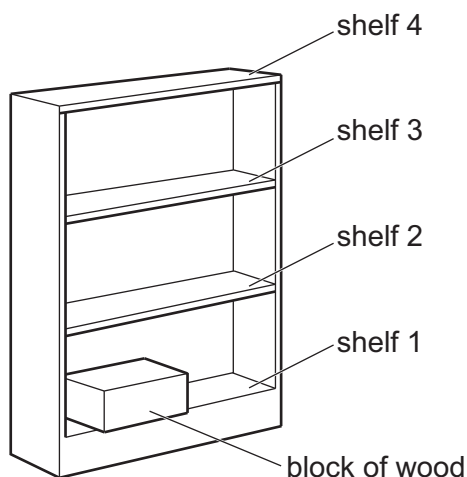


Fig. 3.2

- (i) A student lifts the block from shelf 1 to shelf 2.

At the beginning of this event, the block is at rest on shelf 1.

At the end of this event, the block is at rest on shelf 2.

Circle the type of potential energy that increases as a result of this event.

chemical

elastic

electrical

gravitational

[1]

- (ii) The student now lifts the block of wood from shelf 2 to shelf 4.

Complete the sentences about work done. Use **one** word in each gap.

Work done is related to both the magnitude of a force and the

..... moved in the of
the force.

Therefore, the work done lifting the block from shelf 2 to shelf 4 is

..... than the work done lifting the block from shelf 1 to
shelf 2.

[3]

[Total: 10]





4 Anaemia is caused by a deficiency of iron in the diet.

(a) Fig. 4.1 shows diagrams of the blood of a person **without** anaemia and the blood of a person **with** anaemia.

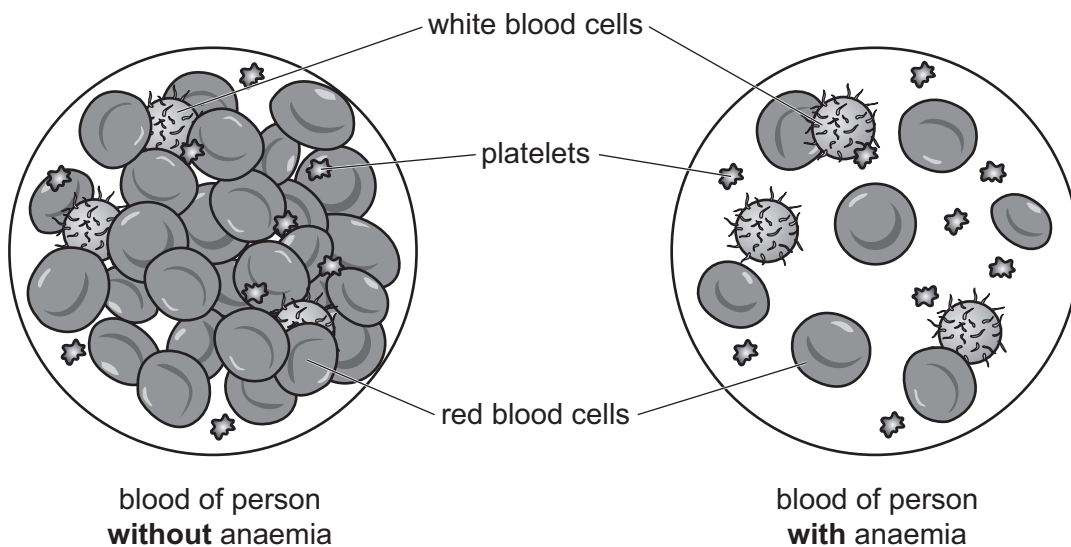


Fig. 4.1

(i) Describe **one** visible difference between the two types of blood shown in Fig. 4.1.

.....
 [1]

(ii) The boxes on the left show the components of blood labelled in Fig. 4.1.

The boxes on the right show the functions of the components.

Draw **one** straight line from each component to its function.

component	function
platelets	transportation of oxygen
red blood cells	phagocytosis
white blood cells	blood clotting

[2]





(b) Foods containing iron are needed as part of a balanced diet.

(i) Circle **one** food that is a principal source of iron.

apples

bread

meat

rice

[1]

(ii) State what is meant by the term balanced diet.

.....

..... [1]

(iii) Protein is part of a balanced diet.

All proteins contain the elements carbon, hydrogen and oxygen.

State **one** other element contained in **all** proteins.

..... [1]





(c) Fig. 4.2 shows the pulse rate of a person before, during and after physical activity.

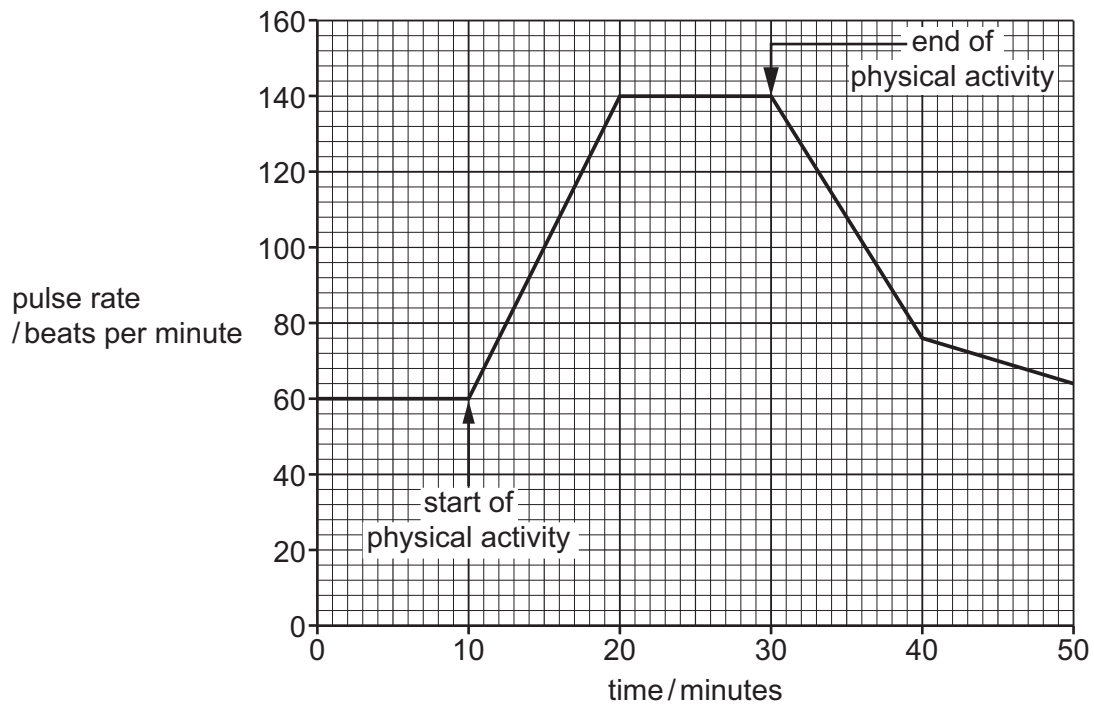


Fig. 4.2

- (i) Calculate the percentage increase in pulse rate of the person between the start and end of physical activity.

pulse rate at start of physical activity = ... beats per minute

pulse rate at end of physical activity = ... beats per minute

change in pulse rate = ... beats per minute

percentage increase in pulse rate = ... %
[3]

- (ii) During exercise, muscles need more oxygen for respiration.

Define the term respiration.

.....

 [2]

[Total: 11]





6 Copper is a metal.

(a) Copper is used to make wires for electrical circuits.

State **one** property of copper that makes it suitable for use as a wire for electrical circuits.

..... [1]

(b) (i) Complete the sentences about copper. Use **one** word in each gap.

Copper is a solid at a room temperature of 21 °C.

The point of copper is 1080 °C. At this temperature, copper changes state from a solid to a liquid.

The point of copper is 2560 °C. At this temperature, copper changes state from a liquid to a gas.

[2]

(ii) Describe how the arrangement and the separation of molecules in a solid differ from the arrangement and the separation of molecules in a gas.

arrangement

.....

separation

.....

[2]



(c) A smooth piece of copper is used as a plane mirror.

Fig. 6.1 shows a ray of light incident on the copper mirror.

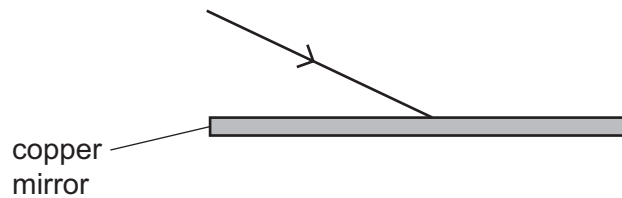


Fig. 6.1

On Fig. 6.1, draw:

- the normal
- the angle of incidence i
- the reflected ray of light.

[3]

[Total: 8]





7 (a) Fig. 7.1 shows a student's drawing of a cross-section of a leaf.

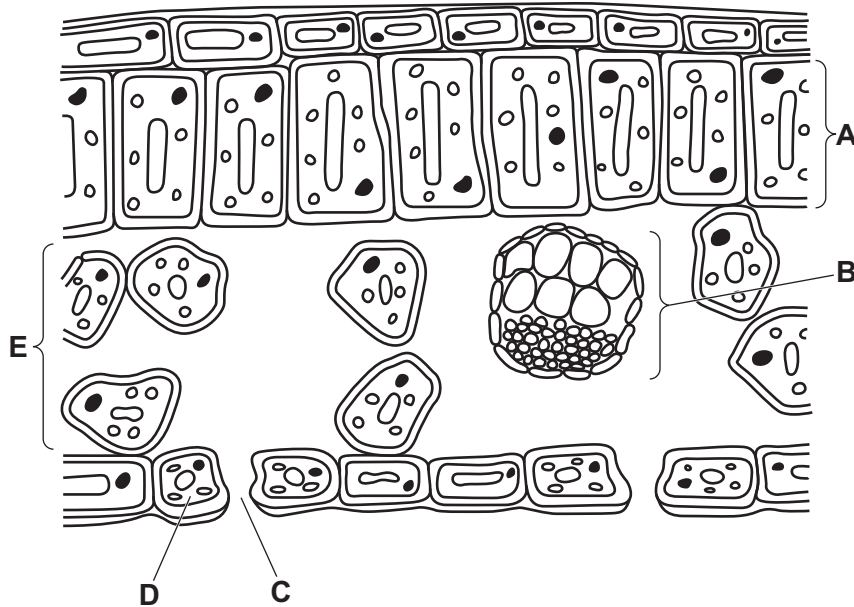


Fig. 7.1

(i) State the letter in Fig. 7.1 that identifies:

a guard cell

a vascular bundle

where water vapour diffuses out from the leaf.

[3]

(ii) Use a label line and the letter **X** to identify a cuticle in Fig. 7.1.

[1]



(b) Fig. 7.2 shows the pathway taken by water from the soil to the leaves.

Complete Fig. 7.2.

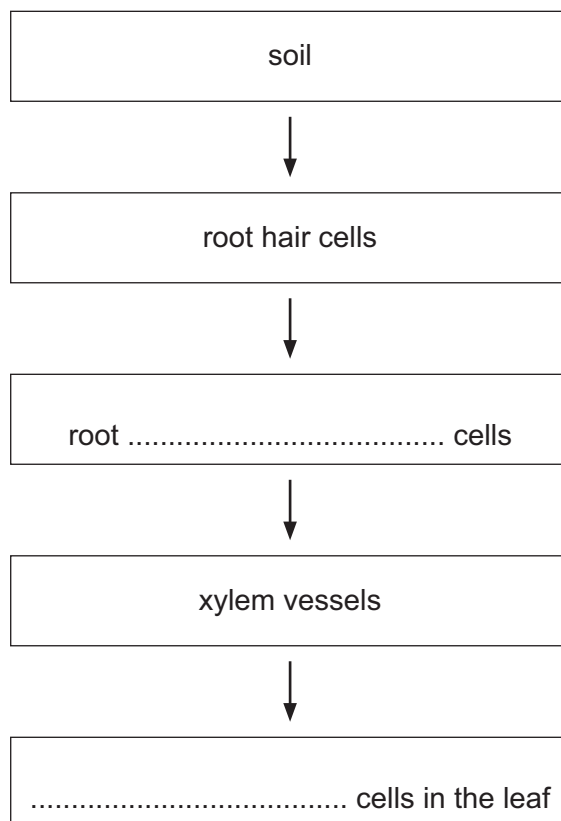


Fig. 7.2

[2]

(c) Plants are an important part of the carbon cycle.

Circle the process that **decreases** the amount of carbon dioxide in the atmosphere.

combustion

decomposition

photosynthesis

respiration

transpiration

[1]

[Total: 7]





8 (a) Complete the sentences about fuels.

Use words from the list. Each word may be used once or not at all.

bitumen

fossil

hydrocarbon

methane

petroleum

Coal, ... and natural gas are fuels.

The main constituent of natural gas is

[3]

(b) Petroleum is separated into useful fractions by fractional distillation.

Draw **one** line from each fraction to its use.

fraction

use

refinery gas

fuel in cars

naphtha

road surfaces

bitumen

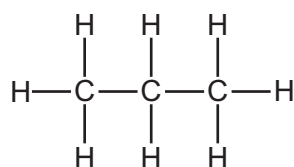
chemical feedstock

heating and cooking

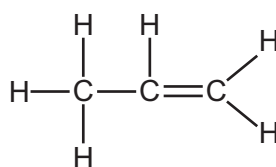
[3]



(c) The diagrams in Fig. 8.1 show the structures of compound **F** and compound **G**.



compound **F**



compound **G**

Fig. 8.1

- (i) State the name of the group of hydrocarbons to which compound **F** belongs.

..... [1]

- (ii) Compound **G** is an unsaturated hydrocarbon.

Describe what is meant by unsaturated.

.....

..... [1]

- (iii) Describe **one** chemical test to distinguish between compounds **F** and **G**.

State the observation for each compound.

test

compound **F**

compound **G**

[3]

[Total: 11]





- 9 Fig. 9.1 shows an electrical circuit used to investigate the resistance of a lamp.

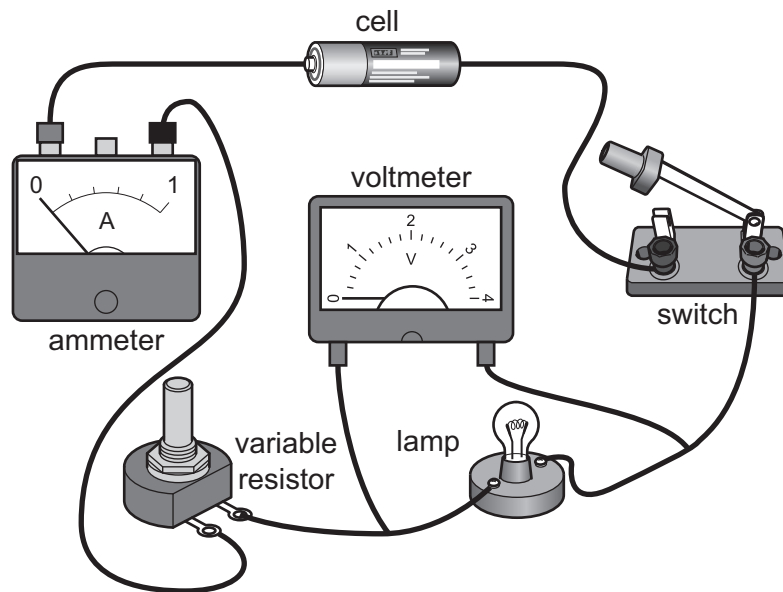


Fig. 9.1

- (a) Complete Fig. 9.2 to show the circuit diagram for the electrical circuit in Fig. 9.1.

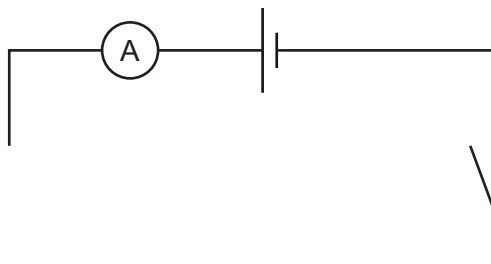


Fig. 9.2

[3]





(b) State the name of the component in the circuit that:

- is used to change the current in the circuit
- measures potential difference (p.d.)
- provides an electromotive force (e.m.f.) for the circuit.

[3]

(c) The switch is closed.

The reading on the voltmeter is 1.3V. The reading on the ammeter is 0.38A.

Calculate the resistance of the lamp.

Give the unit of your answer.

resistance = ... unit [3]

[Total: 9]







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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	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	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 —	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 —

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
	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.).





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- 1 (a) Fig. 1.1 shows the alimentary canal and associated organs of a human.

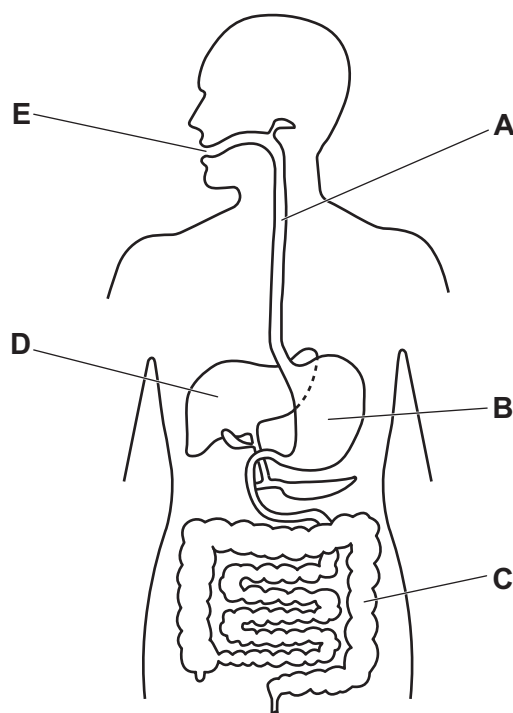


Fig. 1.1

- (i) State the letter in Fig. 1.1 that identifies the:

liver

oesophagus.

[2]

- (ii) Circle the function of the part labelled **E** in Fig. 1.1.

egestion

excretion

ingestion

reproduction

[1]

- (b) Enzymes are found in the alimentary canal.

- (i) Complete the definition of enzymes.

Enzymes are that function as

biological

[2]



(ii) Fig. 1.2 is a graph showing the effect of temperature on an enzyme.

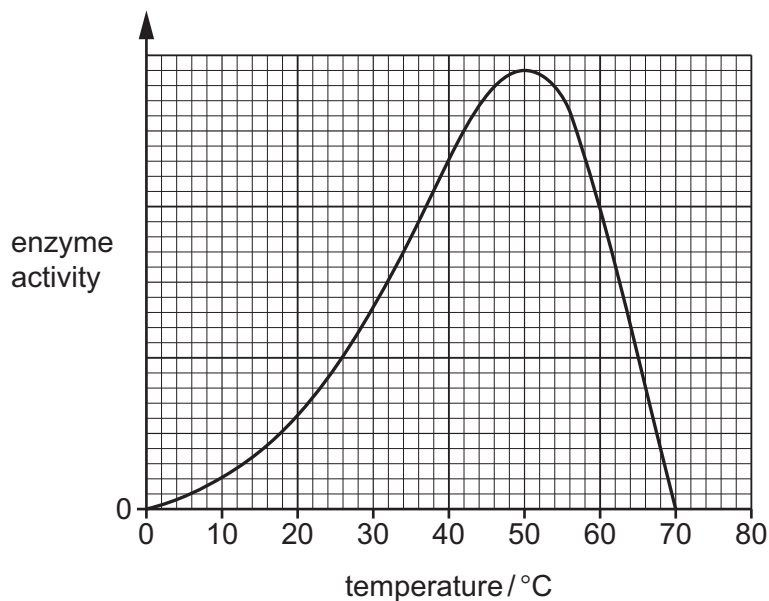


Fig. 1.2

Describe the effect of temperature on enzyme activity shown in Fig. 1.2.

Include data in your answer.

.....

.....

.....

..... [2]

(c) Fats are digested in the alimentary canal.

(i) Circle **one** food that is a principal source of fat.

bread

cheese

oranges

tomatoes

[1]

(ii) Use **two** words to complete the sentence.

The name of the test for fats is the
test.

[1]

[Total: 9]





- 2 A student investigates the rate of reaction between pieces of calcium metal and dilute hydrochloric acid.

The mass is recorded every 30 s during the reaction.

Fig. 2.1 shows the apparatus.

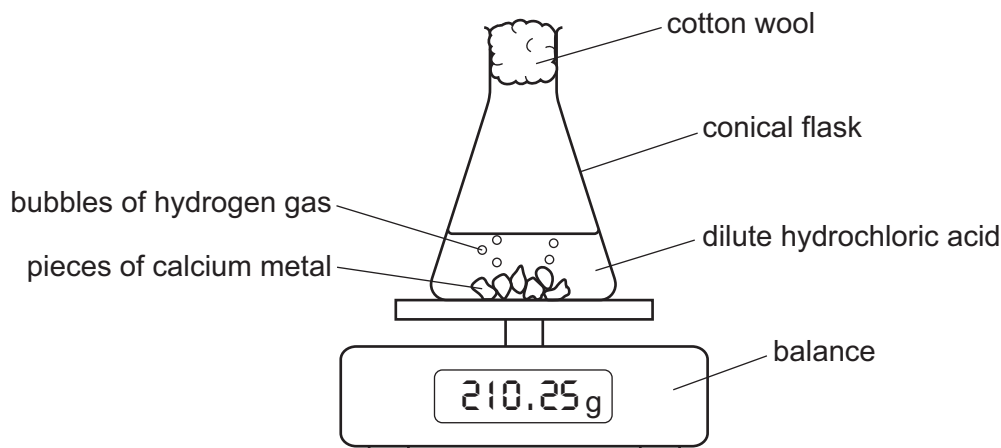
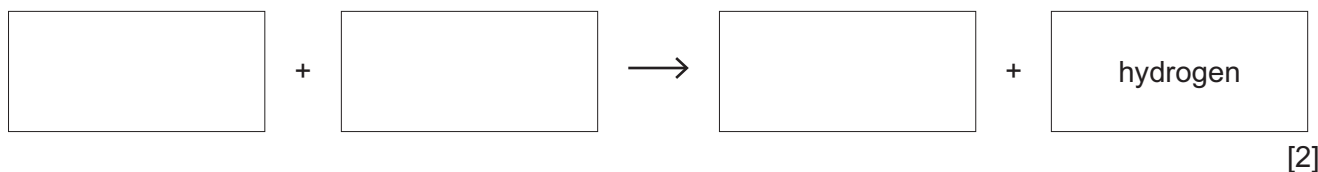


Fig. 2.1

- (a) The reaction produces hydrogen gas.

- (i) Complete the word equation for this reaction.



- (ii) Describe the test for hydrogen gas.

State the observation for the positive result.

test

observation

[2]

- (iii) The conical flask becomes hot during the reaction.

State the term for chemical reactions that release heat.

..... [1]





- (b) The student repeats the experiment using iron, magnesium and zinc instead of calcium.

The pieces of metal used are all the same size.

The dilute hydrochloric acid is in excess.

Table 2.1 shows the results.

Table 2.1

time /s	mass of conical flask + acid + metal /g			
	calcium	iron	magnesium	zinc
0	210.25	211.55	212.50	209.50
30	209.35	211.25	211.80	209.10
60	208.30	210.85	210.90	208.70
90	207.20	210.50	210.15	208.35
120	206.30	210.15	209.40	207.80

- (i) Table 2.2 shows the change in mass for three of the metals.

Complete Table 2.2 by calculating the change in mass for zinc.

Table 2.2

metal	change in mass/g
calcium	3.95
iron	1.40
magnesium	3.10
zinc	

[1]





- (ii) Use the information in Table 2.1 and Table 2.2 to identify the **least** reactive metal.

Explain your answer.

metal

explanation

[2]

- (c) Iron is a transition element.

- (i) State **two** physical properties of iron.

1

2

[2]

- (ii) Iron is used to make alloys.

Suggest why alloys are used instead of pure metals.

.....

..... [1]

[Total: 11]





- 3 (a) Fig. 3.1 shows the electrical symbol for a circuit component.



Fig. 3.1

State the name of the component.

..... [1]

- (b) Fig. 3.2 shows a circuit used to determine the resistance of resistor **X**.

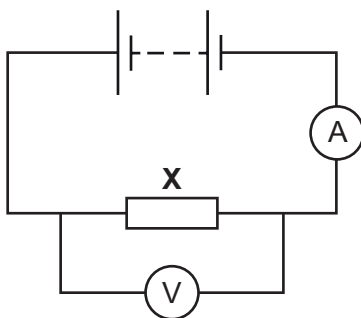


Fig. 3.2

The reading on the ammeter is 0.16A.

The reading on the voltmeter is 2.4 V.

Calculate the resistance of resistor **X**.

Give the unit of your answer.

resistance = ... unit [3]



- (c) (i) Resistor **Y** is connected in series with resistor **X**, as shown in Fig. 3.3.

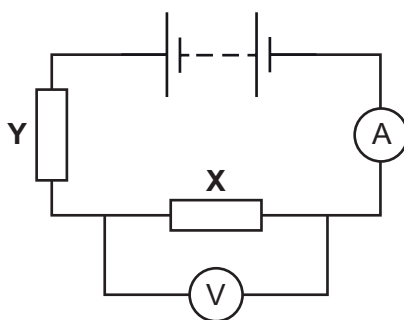


Fig. 3.3

Describe how the reading on the ammeter in Fig. 3.3 compares with the reading on the ammeter in **(b)**. Give a reason for your answer.

reading

reason

[1]

- (ii) Resistor **Y** is now connected in parallel with resistor **X**, as shown in Fig. 3.4.

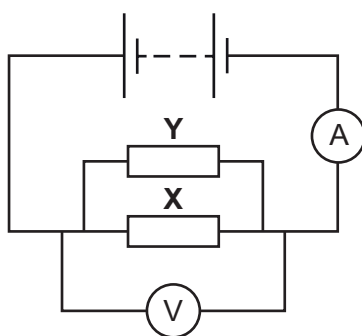


Fig. 3.4

Describe how the reading on the ammeter in Fig. 3.4 compares with the reading on the ammeter in **(b)**. Give a reason for your answer.

reading

reason

[2]

[Total: 7]





- 4 (a) Fig. 4.1 is a diagram of the circulatory system in humans where the arrows show the direction of blood flow.

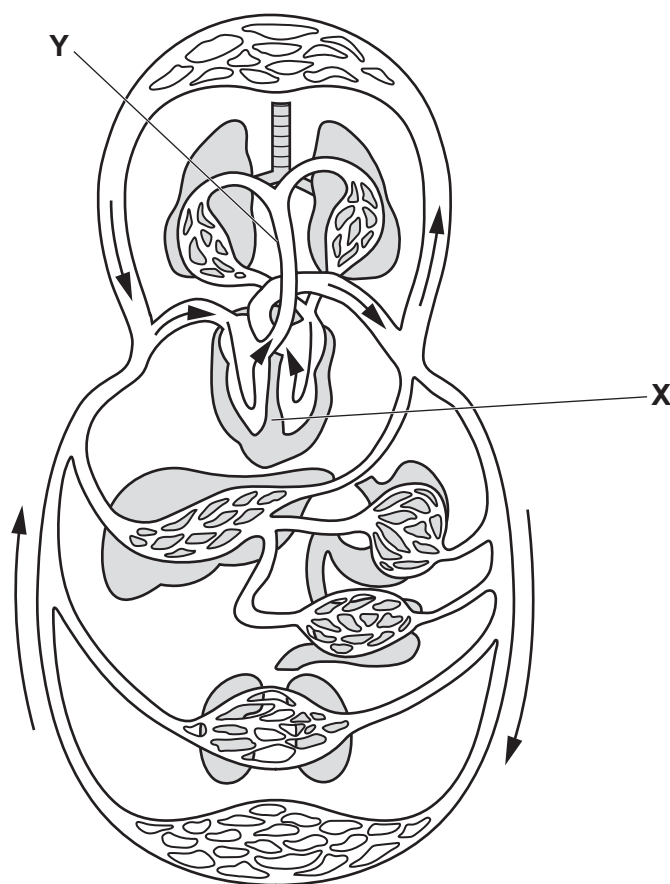


Fig. 4.1

- (i) Identify the part of the heart labelled X in Fig. 4.1.

..... [1]

- (ii) A student states that the part labelled Y in Fig. 4.1 is the pulmonary artery.

Describe evidence from Fig. 4.1 that supports this statement.

.....

 [2]

- (iii) Describe what happens to the flow of blood through the circulatory system during increased physical activity.

.....
 [1]





(b) Two components of blood are red blood cells and plasma.

State **one** similarity between the function of red blood cells and the function of plasma and **one** difference.

similarity

.....

difference

.....

[2]

(c) White blood cells are another component of blood.

(i) State the name of **one** structure found in a plant cell but **not** found in a white blood cell.

..... [1]

(ii) Describe how water moves into a cell.

.....

.....

..... [2]

[Total: 9]





5 (a) Complete the sentences about air.

Use the words from the list. Each word may be used once, more than once or not at all.

compound methane mixture nitrogen oxygen

- Air is a
- The gas with the largest percentage in clean air is
- 21% of clean air is

[3]

(b) Fig. 5.1 shows models of the molecular structures of two air pollutants, **A** and **B**.

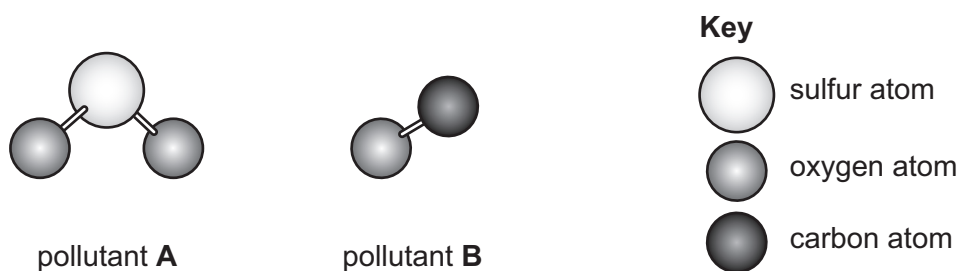


Fig. 5.1

(i) State the name of pollutant **A**.

..... [1]

(ii) Pollutant **B** is carbon monoxide.

State **one** effect of carbon monoxide on human health.

..... [1]

(c) Methane is a greenhouse gas.

Fig. 5.2 shows the molecular structure of methane.

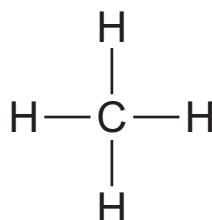


Fig. 5.2



- (i) State the group of hydrocarbons to which methane belongs.

..... [1]

- (ii) Draw lines to show which descriptions are true for methane.

One line has been drawn for you.

	description
methane	main constituent of natural gas
	generally unreactive
	hydrocarbon
	unsaturated
	decolourises aqueous bromine

[2]

- (iii) Complete the dot-and-cross diagram in Fig. 5.3 to show the bonding in a methane molecule, CH_4 .

Show **all** the outer shell electrons.

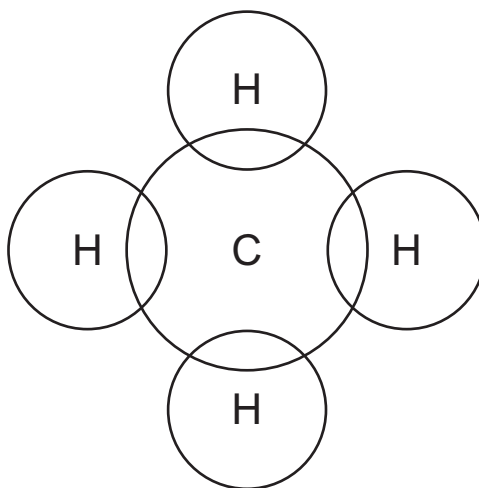


Fig. 5.3

[1]

[Total: 9]



6 Fig. 6.1 shows a horse pulling a cart along a flat, horizontal road.

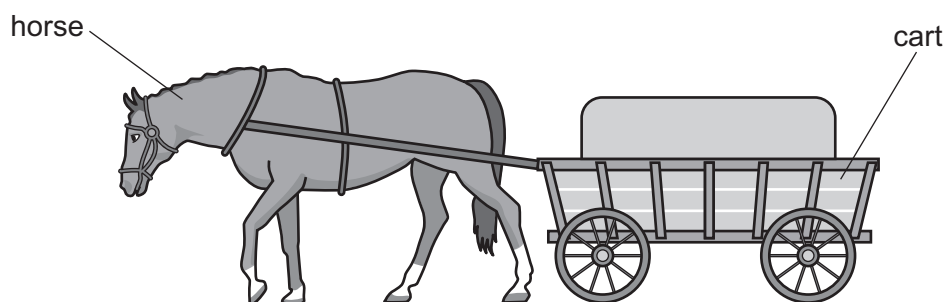


Fig. 6.1

The horse and cart move forward at a constant speed of 3.2 km/h.

(a) Complete the sentences about the horse using **one** word in each gap.

The horse is moving at constant speed, so the energy of the horse must be constant.

The horse is moving along a flat, horizontal road, so the potential energy of the horse must be constant.

The of the horse is related to the work done by the horse and the time taken to do the work.

[3]

(b) Calculate the time taken, in hours, for the horse and cart to move a distance of 4.0 km.

time = ... h [2]



- (c) The horse pulls the cart forward with constant force F .

Fig. 6.2 shows force F acting on the cart.

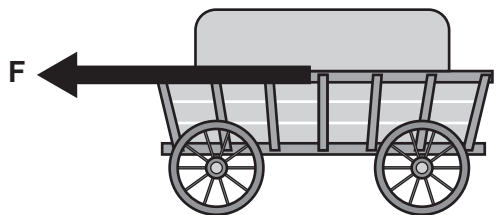


Fig. 6.2

Force F keeps the cart moving at constant speed.

Suggest why force F does **not** increase the speed of the cart.

.....

.....

..... [2]

- (d) The hearing range of the horse is different from the hearing range of a healthy human.

The range of audible frequencies for the horse is 55 Hz to 33.5 kHz.

- (i) State what is meant by a frequency of 55 Hz.

.....

..... [1]

- (ii) Use data to describe how the hearing range of the horse is different from the hearing range of a healthy human.

.....

.....

.....

..... [2]

[Total: 10]





7 Plants manufacture carbohydrates by the process of photosynthesis.

The carbohydrates are then stored as starch in the leaves.

(a) Three plants of the same type, **A**, **B** and **C**, are placed in different conditions.

After two days, a leaf from each plant is tested with iodine solution.

Table 7.1 shows the results.

Table 7.1

plant	conditions	colour of iodine solution
A	carbon dioxide available but no light	orange
B	carbon dioxide and light available	blue-black
C	light available but no carbon dioxide	orange

(i) Explain why the result for plant **B** is different from the results for plants **A** and **C**.

.....

.....

.....

..... [2]

(ii) Plants need chlorophyll for photosynthesis.

Circle the mineral ion needed by plants for making chlorophyll.

calcium

magnesium

potassium

sodium

zinc

[1]

(iii) Water is a raw material for photosynthesis.

Complete these sentences about the movement of water in a plant.

- Water enters the roots through root cells.
- Water is transported from the roots to the leaves in vessels.
- Water is then lost from the leaves through pores (holes) called

[3]





(b) Plants are the producers in a food chain.

Fig. 7.1 shows information about organisms in one food chain.

- butterflies feed on parts of flowers
- frogs eat the butterflies
- herons eat the frogs

Fig. 7.1

(i) Construct a food chain using **all** the organisms in Fig. 7.1.

..... [2]

(ii) Identify the primary consumer in Fig. 7.1.

..... [1]

[Total: 9]





8 Fig. 8.1 shows apparatus for the electrolysis of dilute sulfuric acid using inert electrodes.

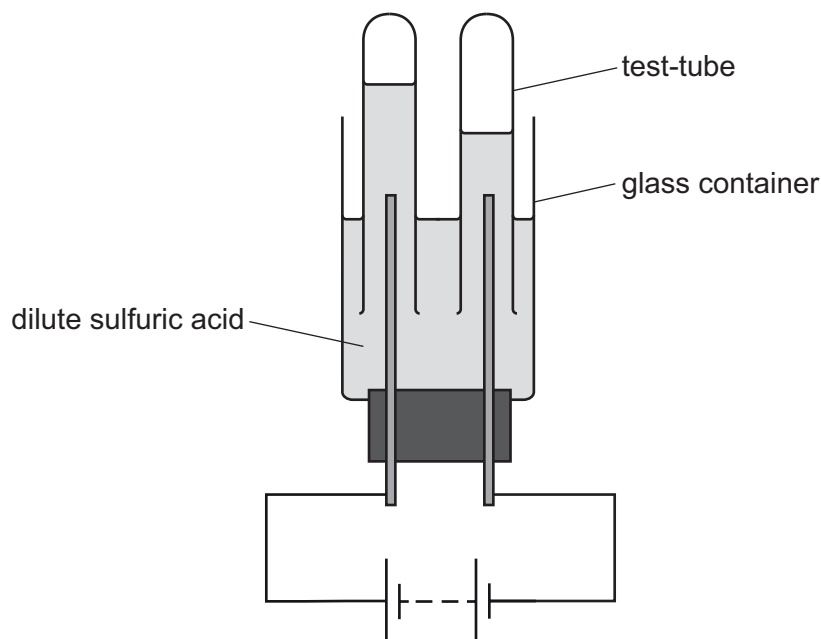


Fig. 8.1

- (a) (i) Label the cathode on Fig. 8.1. [1]
- (ii) State the name of the product formed at the:
- positive electrode
- negative electrode. [2]
- (iii) State the name of an element used to make inert electrodes. [1]
- (b) State the formula of sulfuric acid. [1]
- (c) Dilute sulfuric acid is the electrolyte in this electrolysis.
- Complete the sentence about electrolytes.
- Electrolytes must be in aqueous solution or for electrolysis to occur. [1]

[Total: 6]





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9 Fig. 9.1 shows a candle made of wax.

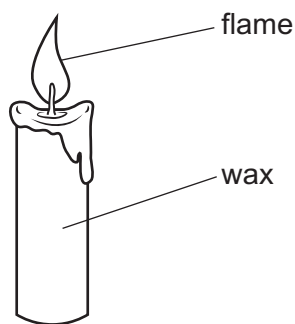


Fig. 9.1

(a) (i) On Fig. 9.1, draw and label a force arrow to show the weight of the candle. [1]

(ii) The mass of the candle is 12g.

Calculate the weight of the candle.

The gravitational force on unit mass is 10N/kg.

weight = ... N [3]

(b) The flame of the candle emits visible light and infrared radiation.

Fig. 9.2 shows an incomplete electromagnetic spectrum.

On Fig. 9.2, write infrared in the correct place.

← increasing frequency						
gamma rays			visible light			

Fig. 9.2

[1]





(c) The candle is made of wax.

Wax melts at a temperature about half-way between room temperature (20 °C) and the boiling point of water.

Estimate the melting point of the wax. Show your working.

melting point = ... °C [2]

(d) When wax melts, the volume of the wax increases.

State the effect this has on the density of the wax.

Explain why the density changes in this way. Use ideas about particles in your explanation.

effect on density

explanation

.....

.....

[3]

[Total: 10]







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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 —	113 Nh nihonium —	114 Fl 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
	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 —
actinoids															

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





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COMBINED SCIENCE

0653/33

Paper 3 Theory (Core)

October/November 2024

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 **24** pages. Any blank pages are indicated.



- 1 (a) Fig. 1.1 shows the alimentary canal and associated organs of a human.

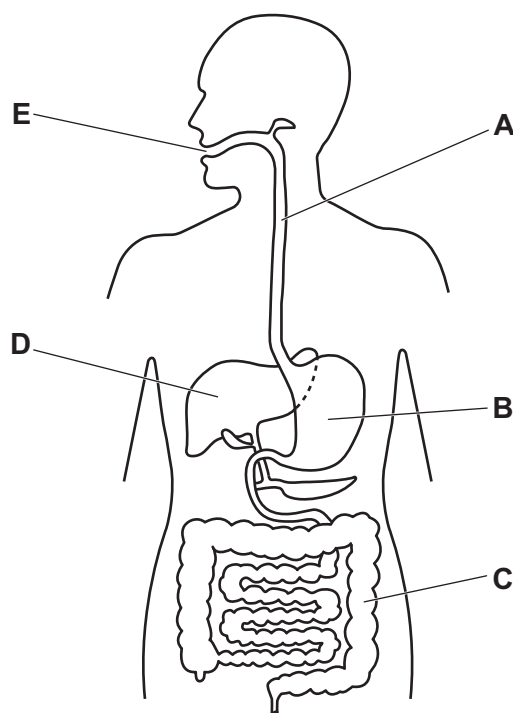


Fig. 1.1

- (i) State the letter in Fig. 1.1 that identifies the:

liver

oesophagus.

[2]

- (ii) Circle the function of the part labelled **E** in Fig. 1.1.

egestion

excretion

ingestion

reproduction

[1]

- (b) Enzymes are found in the alimentary canal.

- (i) Complete the definition of enzymes.

Enzymes are that function as

biological

[2]



(ii) Fig. 1.2 is a graph showing the effect of temperature on an enzyme.

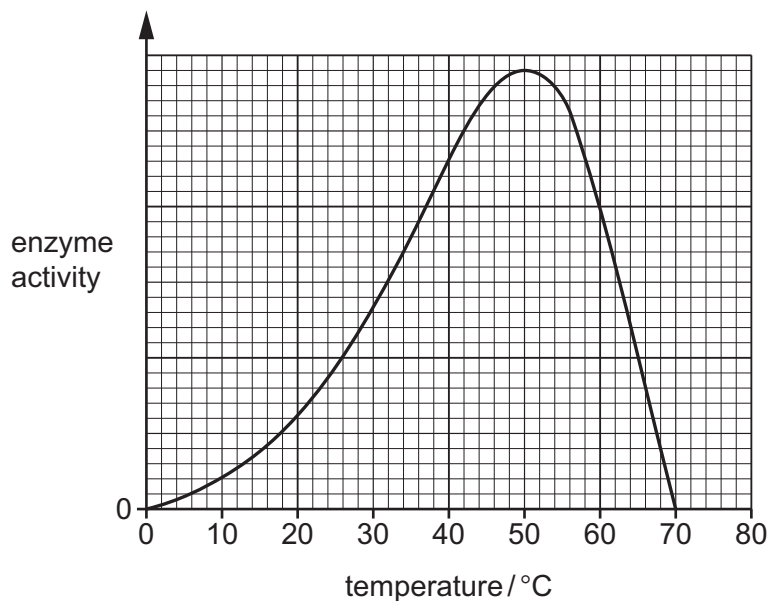


Fig. 1.2

Describe the effect of temperature on enzyme activity shown in Fig. 1.2.

Include data in your answer.

.....

.....

.....

..... [2]

(c) Fats are digested in the alimentary canal.

(i) Circle **one** food that is a principal source of fat.

bread

cheese

oranges

tomatoes

[1]

(ii) Use **two** words to complete the sentence.

The name of the test for fats is the
test.

[1]

[Total: 9]





- 2 A student investigates the rate of reaction between pieces of calcium metal and dilute hydrochloric acid.

The mass is recorded every 30 s during the reaction.

Fig. 2.1 shows the apparatus.

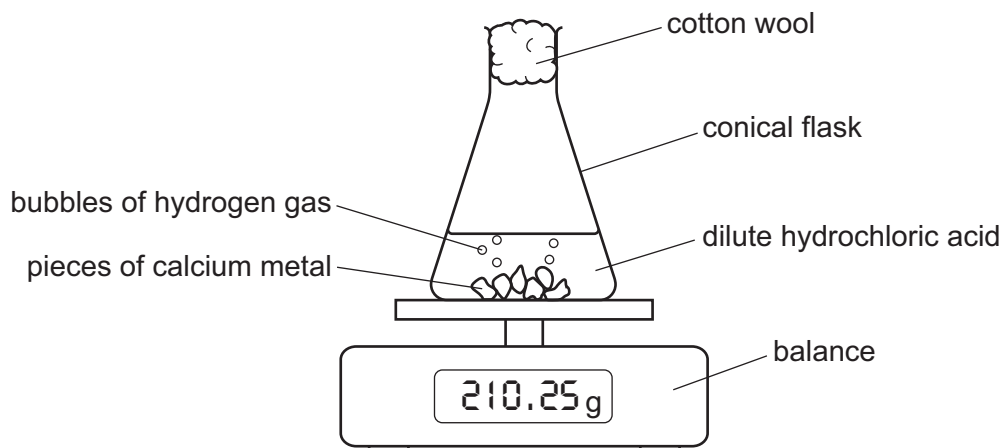
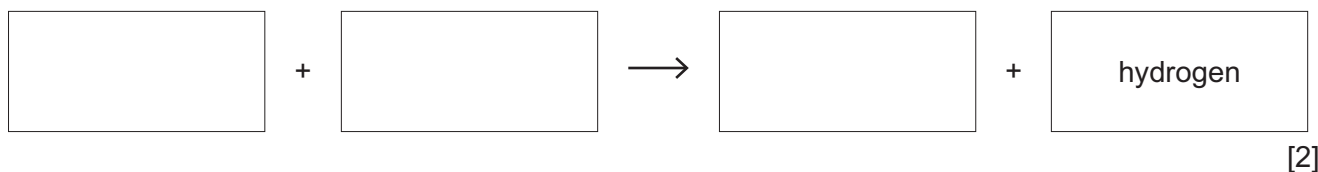


Fig. 2.1

- (a) The reaction produces hydrogen gas.

- (i) Complete the word equation for this reaction.



- (ii) Describe the test for hydrogen gas.

State the observation for the positive result.

test

observation

[2]

- (iii) The conical flask becomes hot during the reaction.

State the term for chemical reactions that release heat.

..... [1]





(b) The student repeats the experiment using iron, magnesium and zinc instead of calcium.

The pieces of metal used are all the same size.

The dilute hydrochloric acid is in excess.

Table 2.1 shows the results.

Table 2.1

time /s	mass of conical flask + acid + metal /g			
	calcium	iron	magnesium	zinc
0	210.25	211.55	212.50	209.50
30	209.35	211.25	211.80	209.10
60	208.30	210.85	210.90	208.70
90	207.20	210.50	210.15	208.35
120	206.30	210.15	209.40	207.80

(i) Table 2.2 shows the change in mass for three of the metals.

Complete Table 2.2 by calculating the change in mass for zinc.

Table 2.2

metal	change in mass/g
calcium	3.95
iron	1.40
magnesium	3.10
zinc	

[1]





(ii) Use the information in Table 2.1 and Table 2.2 to identify the **least** reactive metal.

Explain your answer.

metal

explanation

..... [2]

(c) Iron is a transition element.

(i) State **two** physical properties of iron.

1

2 [2]

(ii) Iron is used to make alloys.

Suggest why alloys are used instead of pure metals.

.....

..... [1]

[Total: 11]





- 3 (a) Fig. 3.1 shows the electrical symbol for a circuit component.



Fig. 3.1

State the name of the component.

..... [1]

- (b) Fig. 3.2 shows a circuit used to determine the resistance of resistor **X**.

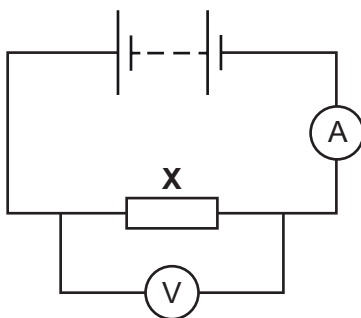


Fig. 3.2

The reading on the ammeter is 0.16A.

The reading on the voltmeter is 2.4 V.

Calculate the resistance of resistor **X**.

Give the unit of your answer.

resistance = ... unit [3]



- (c) (i) Resistor **Y** is connected in series with resistor **X**, as shown in Fig. 3.3.

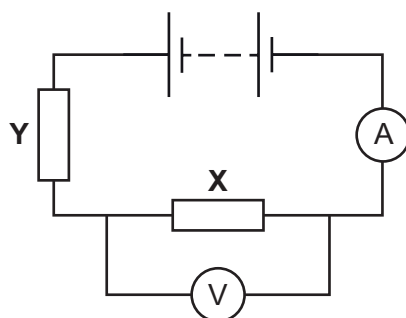


Fig. 3.3

Describe how the reading on the ammeter in Fig. 3.3 compares with the reading on the ammeter in **(b)**. Give a reason for your answer.

reading

reason

[1]

- (ii) Resistor **Y** is now connected in parallel with resistor **X**, as shown in Fig. 3.4.

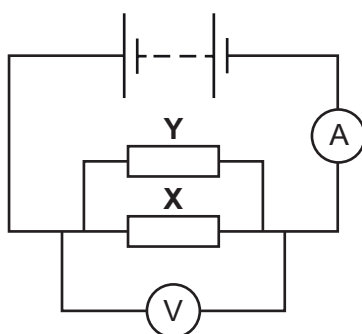


Fig. 3.4

Describe how the reading on the ammeter in Fig. 3.4 compares with the reading on the ammeter in **(b)**. Give a reason for your answer.

reading

reason

[2]

[Total: 7]





- 4 (a) Fig. 4.1 is a diagram of the circulatory system in humans where the arrows show the direction of blood flow.

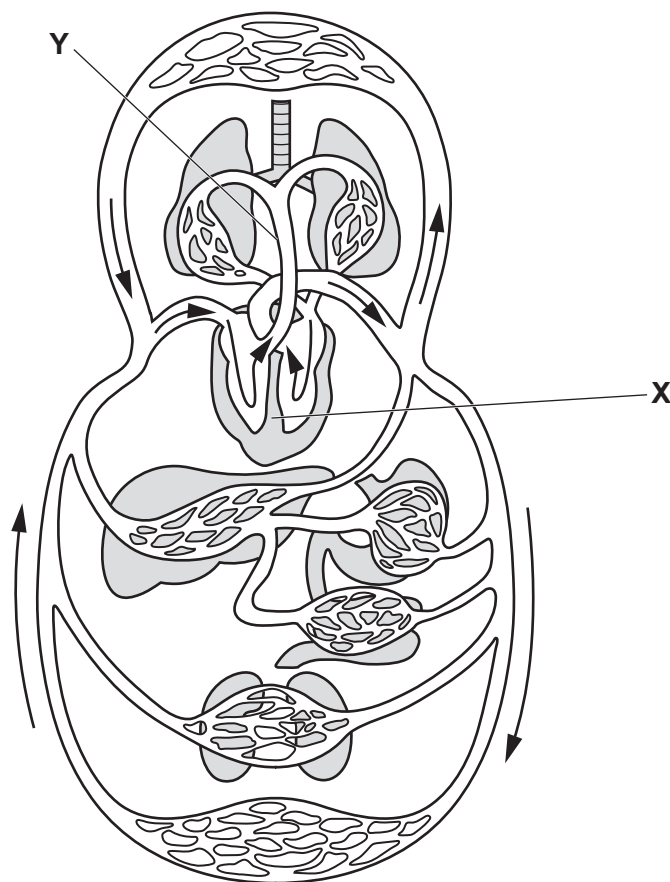


Fig. 4.1

- (i) Identify the part of the heart labelled **X** in Fig. 4.1.

..... [1]

- (ii) A student states that the part labelled **Y** in Fig. 4.1 is the pulmonary artery.

Describe evidence from Fig. 4.1 that supports this statement.

.....

 [2]

- (iii) Describe what happens to the flow of blood through the circulatory system during increased physical activity.

.....
 [1]





(b) Two components of blood are red blood cells and plasma.

State **one** similarity between the function of red blood cells and the function of plasma and **one** difference.

similarity

.....

difference

.....

[2]

(c) White blood cells are another component of blood.

(i) State the name of **one** structure found in a plant cell but **not** found in a white blood cell.

..... [1]

(ii) Describe how water moves into a cell.

.....

.....

..... [2]

[Total: 9]





5 (a) Complete the sentences about air.

Use the words from the list. Each word may be used once, more than once or not at all.

compound methane mixture nitrogen oxygen

- Air is a
- The gas with the largest percentage in clean air is
- 21% of clean air is

[3]

(b) Fig. 5.1 shows models of the molecular structures of two air pollutants, **A** and **B**.

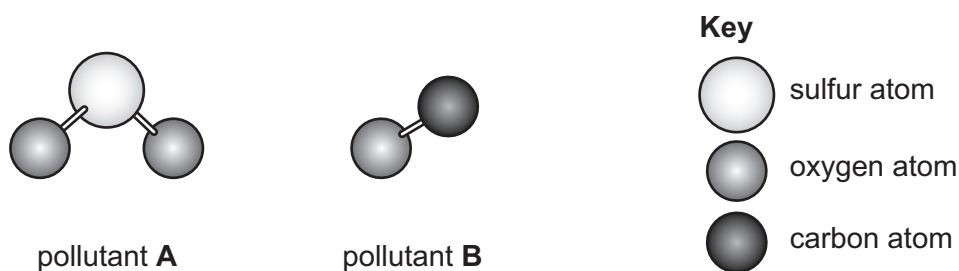


Fig. 5.1

(i) State the name of pollutant **A**.

..... [1]

(ii) Pollutant **B** is carbon monoxide.

State **one** effect of carbon monoxide on human health.

..... [1]

(c) Methane is a greenhouse gas.

Fig. 5.2 shows the molecular structure of methane.

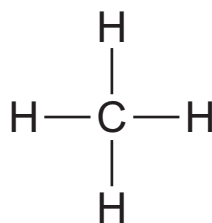


Fig. 5.2



- (i) State the group of hydrocarbons to which methane belongs.

..... [1]

- (ii) Draw lines to show which descriptions are true for methane.

One line has been drawn for you.

	description
methane	main constituent of natural gas
	generally unreactive
	hydrocarbon
	unsaturated
	decolourises aqueous bromine

[2]

- (iii) Complete the dot-and-cross diagram in Fig. 5.3 to show the bonding in a methane molecule, CH_4 .

Show **all** the outer shell electrons.

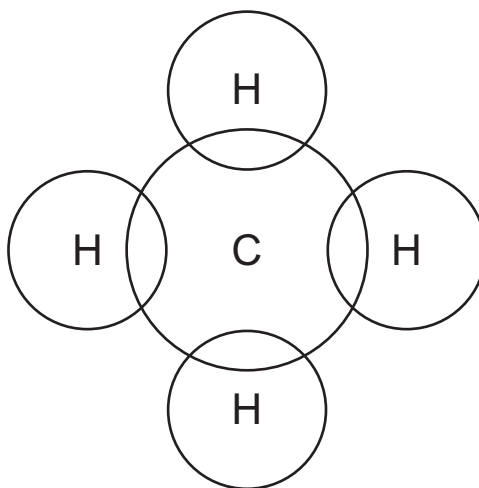


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[1]

[Total: 9]





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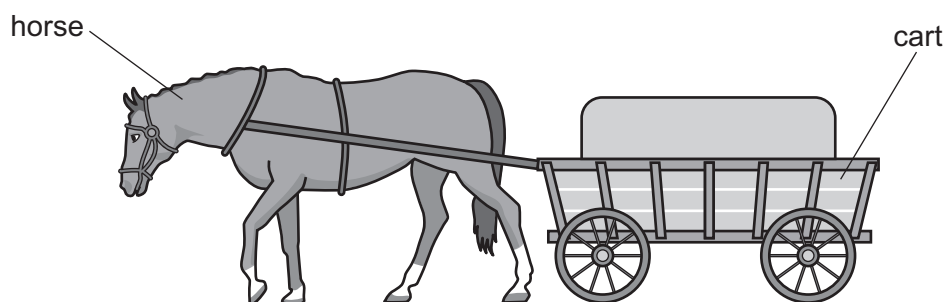


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[3]

(b) Calculate the time taken, in hours, for the horse and cart to move a distance of 4.0 km.

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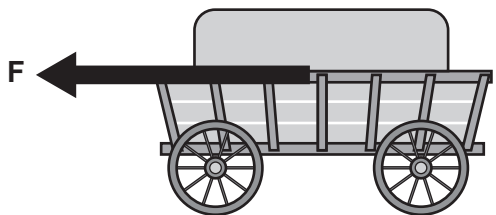


Fig. 6.2

Force F keeps the cart moving at constant speed.

Suggest why force F does **not** increase the speed of the cart.

.....

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- (d) The hearing range of the horse is different from the hearing range of a healthy human.

The range of audible frequencies for the horse is 55 Hz to 33.5 kHz.

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The carbohydrates are then stored as starch in the leaves.

(a) Three plants of the same type, **A**, **B** and **C**, are placed in different conditions.

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B	carbon dioxide and light available	blue-black
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(i) Explain why the result for plant **B** is different from the results for plants **A** and **C**.

.....

.....

.....

..... [2]

(ii) Plants need chlorophyll for photosynthesis.

Circle the mineral ion needed by plants for making chlorophyll.

calcium

magnesium

potassium

sodium

zinc

[1]

(iii) Water is a raw material for photosynthesis.

Complete these sentences about the movement of water in a plant.

- Water enters the roots through root cells.
- Water is transported from the roots to the leaves in vessels.
- Water is then lost from the leaves through pores (holes) called

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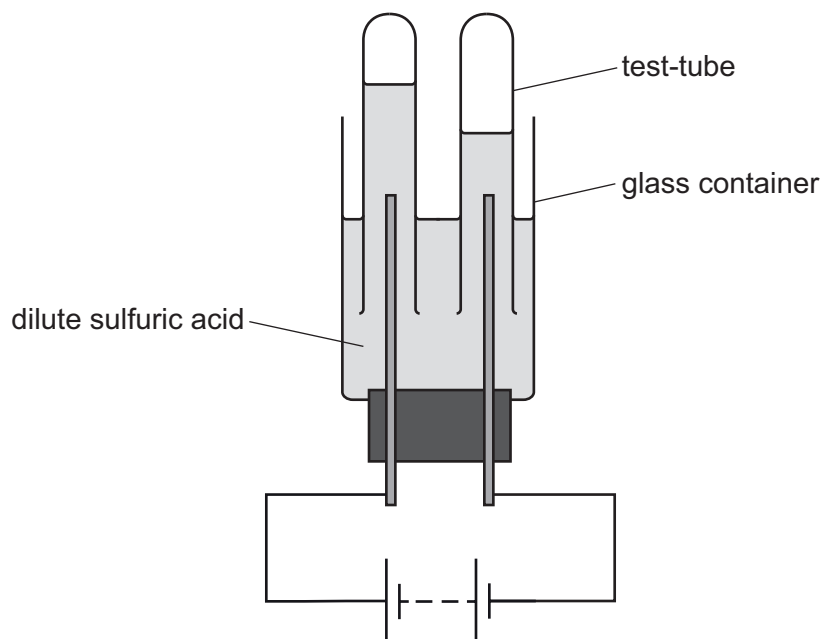


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- (a) (i) Label the cathode on Fig. 8.1. [1]
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- (c) Dilute sulfuric acid is the electrolyte in this electrolysis.
- Complete the sentence about electrolytes.
- Electrolytes must be in aqueous solution or for electrolysis to occur. [1]

[Total: 6]





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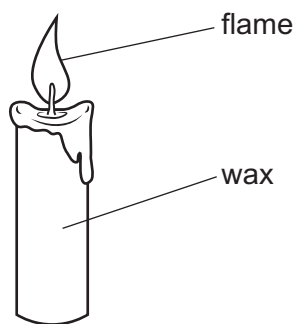


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Calculate the weight of the candle.

The gravitational force on unit mass is 10N/kg.

weight = ... N [3]

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On Fig. 9.2, write infrared in the correct place.

← increasing frequency						
gamma rays			visible light			

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Wax melts at a temperature about half-way between room temperature (20 °C) and the boiling point of water.

Estimate the melting point of the wax. Show your working.

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(d) When wax melts, the volume of the wax increases.

State the effect this has on the density of the wax.

Explain why the density changes in this way. Use ideas about particles in your explanation.

effect on density

explanation

.....

.....

[3]

[Total: 10]







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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 —

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
	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.).

