Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

3044808196

CO-ORDINATED SCIENCES **0654/43**

Paper 4 Theory (Extended) **May/June 2020**

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.

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. Blank pages are indicated.

1 **(a)** A scientist investigates the production of carbon dioxide by anaerobic respiration in yeast.

Two different sugars are used, glucose and sucrose.

The scientist measures the volume of carbon dioxide produced.

The results are shown in Fig. 1.1.

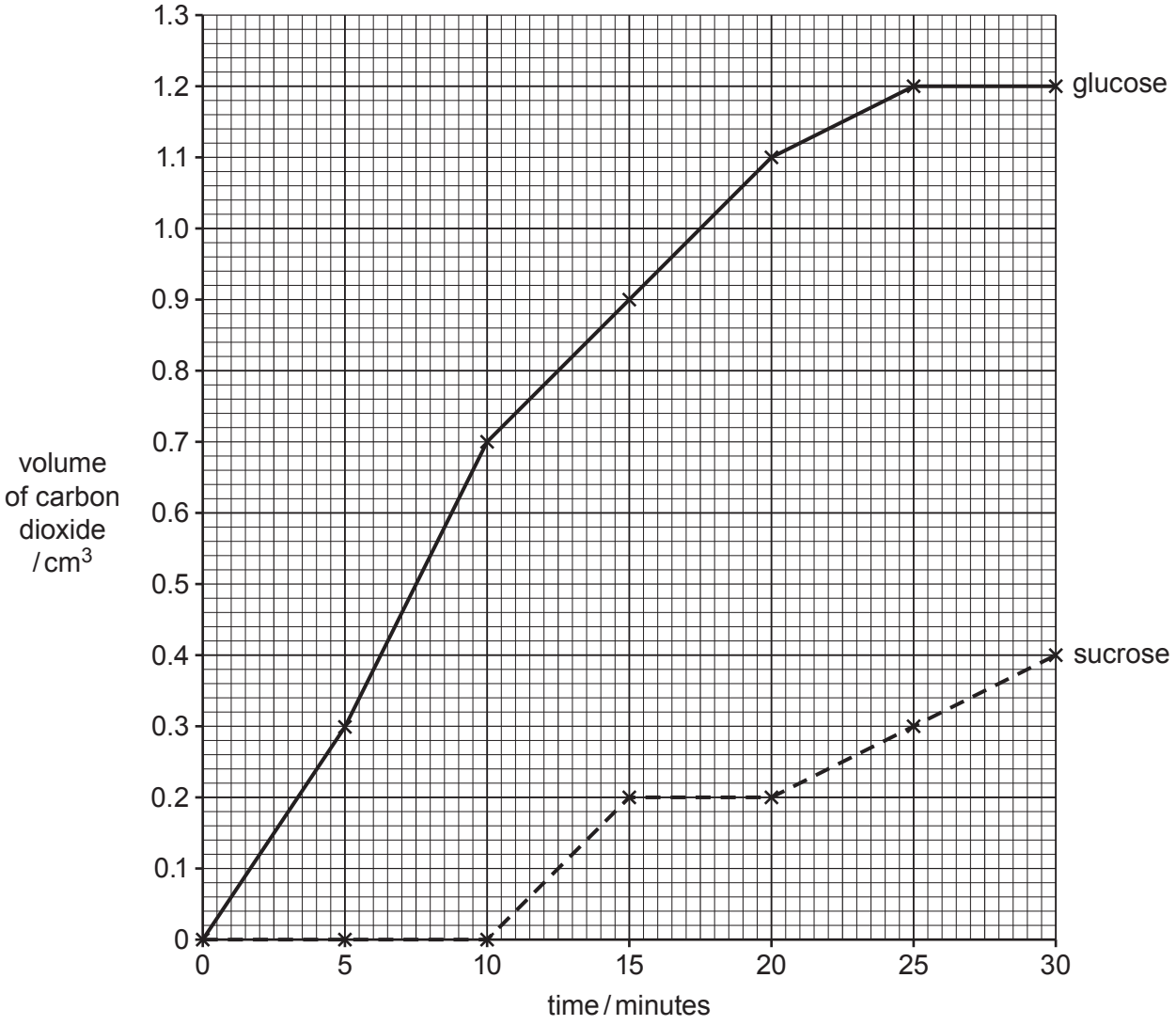


Fig. 1.1

(i) Calculate the difference in volume of carbon dioxide produced in the first 20 minutes by yeast using glucose and by yeast using sucrose.

..... cm^3 [1]

(ii) Describe **one** use of the production of carbon dioxide by anaerobic respiration in yeast.

..... [1]

(b) The investigation is repeated using yeast and glucose at 80 °C.

Explain why no carbon dioxide is produced at this temperature.

Use ideas about enzymes in your answer.

.....

.....

.....

.....

.....

..... [4]

(c) Explain why a mixture of only yeast and water would **not** produce carbon dioxide.

.....

.....

..... [1]

(d) Complete the sentences to define the term *anaerobic respiration*.

Anaerobic respiration is the ..... reactions in cells that break down nutrient molecules to release ..... without using ..... . [3]

[Total: 10]

2 Table 2.1 shows examples of chemical and physical changes.

(a) Complete Table 2.1 by putting ticks (✓) in the correct columns.

Table 2.1

	chemical change	physical change
burning magnesium	✓	
melting ice		✓
rusting iron		
dissolving salt in water		
boiling water		
neutralising an acid with a base		

[2]

(b) Magnesium, Mg, is an element.

Water, H_2O, is a compound.

Describe what is meant by an *element* and a *compound*.

element .....

.....

compound .....

.....

[2]

(c) A list of particles is shown.

Cu **CO_2** **H_2** **Na** **OH^-** **S** **Zn^{2+}**

Write each symbol or formula in Table 2.2 to show whether the particles are atoms, ions or molecules.

One has been done for you.

Table 2.2

atom	ion	molecule
Na		

[3]

(d) Fig. 2.1 shows an experiment to investigate diffusion of gases.

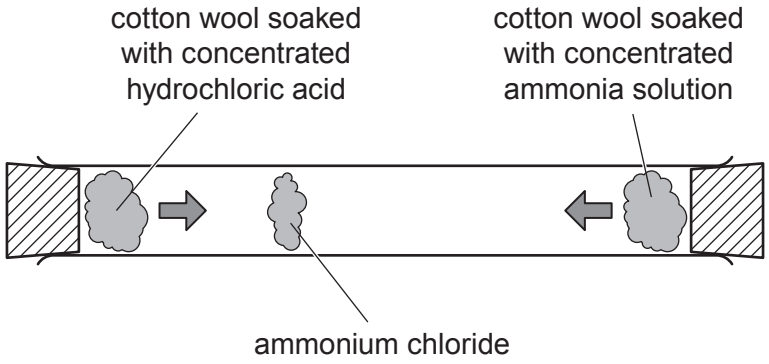


Fig. 2.1

Ammonia gas, NH_3, and hydrogen chloride gas, HCl, diffuse along the tube.

When the gases meet they react to form a white cloud of ammonium chloride.

The ammonium chloride forms at the end of the tube nearest to the hydrochloric acid.

Explain why.

.....

.....

..... [2]

[Total: 9]

3 **(a)** An athletics race is started using a starting pistol.

The sound from the starting pistol passes through the air and reaches the ears of the athletes.

Sound waves pass through the air as a series of compressions and rarefactions.

Describe one difference between a compression and a rarefaction.

.....

..... [1]

(b) An athlete in the race has a mass of 70 kg. Her acceleration is 1.6 m / s^2.

(i) Calculate the force needed to give this acceleration.

force = ... N [2]

(ii) The athlete reaches a maximum speed of 8 m / s.

Calculate the kinetic energy of the athlete when moving at this speed.

kinetic energy = ... J [2]

(iii) Explain the difference between the terms *speed* and *velocity*.

.....

.....

..... [1]

(c) At the end of the race, the athlete is sweating. The sweat of the athlete evaporates faster on a hot day.

(i) Suggest in terms of molecules why this happens.

.....

.....

..... [1]

(ii) State one other way by which the rate of evaporation from the surface of a liquid can be increased.

..... [1]

(d) At the end of a long race athletes are sometimes wrapped in a shiny foil blanket to reduce thermal energy losses.

Explain why the shiny foil blanket helps reduce energy losses.

.....

.....

.....

..... [2]

[Total: 10]

[Turn over

4 **(a)** Fig. 4.1 is a diagram of the alimentary canal and associated organs.

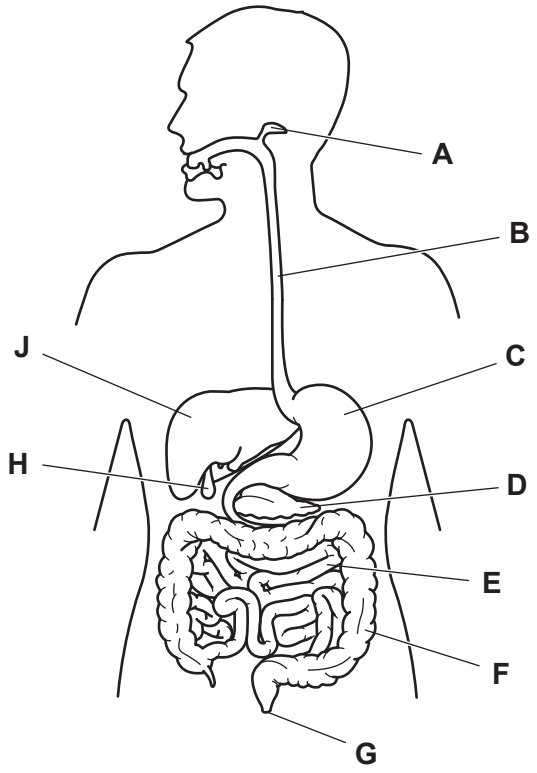


Fig. 4.1

Table 4.1 shows the functions of some parts shown in Fig. 4.1.

Complete Table 4.1.

Table 4.1

name of part	letter in Fig. 4.1	function
salivary gland		produces salivary amylase
gall bladder		
	D	produces lipase, protease and amylase
		produces bile

[4]

(b) Explain why gastric juice in the stomach contains hydrochloric acid.

.....

.....

.....

.....

.....

..... [3]

(c) Name the part of the alimentary canal where these processes occur:

- absorption of water .....
- egestion .....
- ingestion. .....

[3]

[Total: 10]

5 The alkenes are a homologous series.

The general formula for the alkenes is C_nH_{2n}.

The alkanes are another homologous series.

(a) State the **general formula** for the alkanes.

..... [1]

(b) Propene, C_3H_6, is an alkene.

Complete Fig. 5.1 to show the structure of a propene molecule.

Show all of the atoms and all of the covalent bonds.

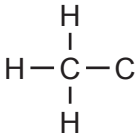
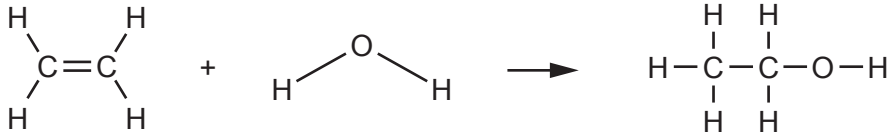


Fig. 5.1

[1]

(c) Ethene is also an alkene.

Ethene reacts with steam to form ethanol.



This reaction is **exothermic**.

Explain why. Use ideas about bond breaking and bond making.

.....

.....

.....

..... [3]

(d) Ethanol is an alcohol.

Describe how ethanol is made by fermentation.

.....

.....

.....

.....

..... [3]

[Total: 8]

6 **(a)** The volume of the Sun is $1.4 \times 10^{27}\,m^3$.

The average density of the Sun is $1410\,kg/m^3$.

Calculate the mass of the Sun.

mass = ... kg [2]

(b) Explain why the Sun transfers energy to the Earth mainly by radiation and not by conduction or convection.

.....

..... [1]

(c) The Sun emits γ-radiation and visible light. Both of these radiations are part of the electromagnetic spectrum.

(i) Place γ-radiation and visible light in their correct places in the incomplete electromagnetic spectrum shown in Fig. 6.1.

radio waves		infrared		ultraviolet		

[1]

Fig. 6.1

(ii) State why both these radiations take the same time to travel from the Sun to the Earth.

.....

.....

..... [1]

(d) Visible light from the Sun can be reflected, refracted and diffracted.

Describe what happens to a wave when it is:

reflected .....

.....

refracted .....

.....

diffracted. .....

.....

[3]

[Total: 8]

7 **(a)** Fig. 7.1 is a photomicrograph of a human eye.

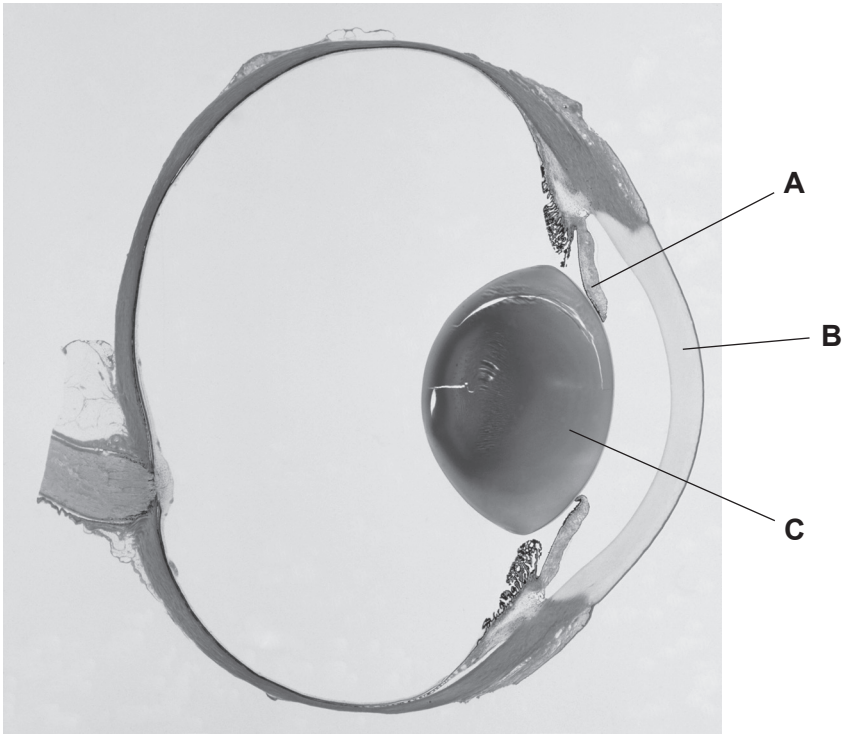


Fig. 7.1

(i) Identify parts labelled **A**, **B** and **C** in Fig. 7.1.

A .....

B .....

C .....

[3]

(ii) Draw an **X** on Fig. 7.1 to show the position of the blind spot. [1]

(iii) Describe the changes that occur in the eye when changing focus to view a distant object.

.....

.....

.....

.....

.....

..... [3]

(b) The list shows examples of involuntary and voluntary responses.

Place ticks (✓) to show **all** the examples of involuntary responses.

breathing	
heart beating	
reading	
running	
sweating	
writing	

[2]

(c) Sense organs form part of the peripheral nervous system.

State the two parts that form the central nervous system.

1 .....

2 .....

[2]

[Total: 11]

8 Iron is a transition metal.

(a) State two properties of transition metals that are **not** properties of all metals.

1 .....

2 .....
[2]

(b) Describe the metallic bonding in a metal.

You may draw a labelled diagram to help your answer.

.....

.....

..... [2]

(c) Hematite contains iron oxide, Fe_2O_3.

Iron is extracted from iron oxide in a blast furnace.

(i) Describe how iron is extracted from iron oxide.

Do **not** describe how impurities are removed.

You can use **balanced symbol** equations in your answer.

.....

.....

.....

.....

..... [3]

(ii) Silicon dioxide, SiO_2, is an impurity that needs to be removed from the blast furnace.

The silicon dioxide reacts with calcium oxide, CaO.

$$CaO + SiO_2 \rightarrow CaSiO_3$$

Calculate the mass of calcium oxide needed to remove 21 kg of silicon dioxide, SiO_2.

[A_r: Ca, 40; O, 16; Si, 28]

mass of calcium oxide = ... kg [2]

(d) A blast furnace works at a very high temperature.

Reactions are faster at higher temperatures.

Explain why reactions are faster at higher temperatures.

Use ideas about collisions between particles.

.....

.....

.....

..... [3]

[Total: 12]

9 **(a)** Astatine 211 (At-211) decays by the emission of α-particles.

The α-particles emitted by At-211 are used to destroy cancer cells.

Small quantities of At-211 are injected directly into the site of the cancer.

(i) Explain why At-211 is only effective when injected directly into the cancer.

.....

..... [1]

(ii) At-211 decays by α-particle emission to produce an isotope of bismuth.

Use nuclide notation to complete a symbol equation for this decay process.

$$^{211}_{85}\text{At} \rightarrow {}^{\cdots\cdots}_{\cdots\cdots}\text{Bi} + {}^{\cdots\cdots}_{\cdots\cdots}\cdots\cdots$$

[2]

(b) X-rays and ultrasound waves are used by doctors in hospitals.

(i) X-rays are transverse waves and ultrasound waves are longitudinal waves.

Describe the difference between a transverse wave and a longitudinal wave.

.....

.....

..... [1]

(ii) X-rays have a wavelength of 1.1×10^{-9} m and travel at 3.0×10^{8} m/s.

Calculate the frequency of X-rays.

frequency = ... Hz [2]

(iii) Ultrasound waves are used to scan unborn babies.

Ultrasound waves have a frequency too high to be heard by a healthy human ear.

Using your knowledge of the range of audible frequencies for a healthy human ear, suggest a frequency for ultrasound waves.

Explain your answer.

frequency = ... Hz

explanation .....

.....

[1]

(iv) Suggest a reason why it is **not** safe to scan unborn babies with X-rays.

.....

.....

..... [1]

[Total: 8]

10 **(a)** Fig. 10.1 is a sketch graph showing the effect of humidity on the rate of transpiration.

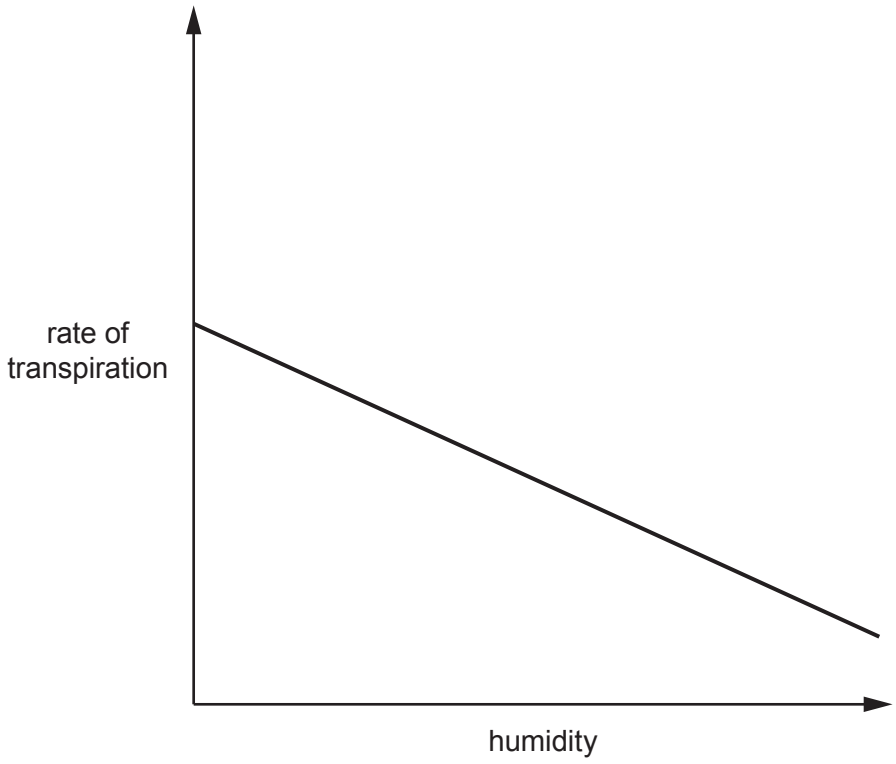


Fig. 10.1

(i) Explain the change in rate of transpiration shown in Fig. 10.1.

.....

.....

.....

.....

.....

..... [3]

(ii) State **one other** factor that affects the rate of transpiration.

..... [1]

(b) Transpiration pull moves water through xylem vessels.

State how water molecules are held together.

..... [1]

(c) Xylem is a specialised tissue in plants.

The palisade mesophyll layer is another specialised tissue in plants.

(i) Describe two ways the palisade mesophyll cells are adapted for photosynthesis.

1 .....

.....

2 .....

.....

[2]

(ii) State the raw materials required for photosynthesis.

..... [1]

(iii) State the source of energy needed for the process of photosynthesis.

..... [1]

[Total: 9]

11 Fig. 11.1 shows part of the Periodic Table.

Group																	
I	II											III	IV	V	VI	VII	VIII
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											A*l*	Si	P	S	C*l*	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

Fig. 11.1

(a) Describe the relationship between the Group number and the number of electrons in the outer shell.

.....

..... [1]

(b) Magnesium, Mg, is in Group II.

Magnesium has a proton number of 12.

State the electronic structure of a magnesium atom.

..... [1]

(c) Sodium forms bonds with chlorine.

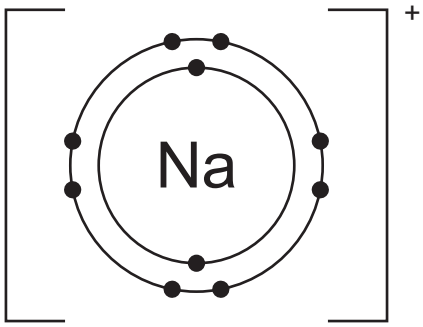
Sodium is in Group I.

Chlorine is in Group VII.

(i) Sodium chloride is an ionic compound.

Fig. 11.2 shows a sodium ion.

Complete Fig. 11.2 to show a chloride ion.



sodium ion chloride ion

Fig. 11.2

[2]

(ii) Ionic compounds, such as sodium chloride, have a **lattice structure**.

Describe the lattice structure of sodium chloride.

You may draw a labelled diagram to help you.

.....

.....

..... [2]

(d) Table 11.1 shows some information about the Group VII elements.

Table 11.1

element	state at room temperature	melting point / °C	boiling point / °C
fluorine	gas	–220	–188
chlorine	gas		–35
bromine	liquid	–7	
iodine		114	184
astatine	solid	302	337

(i) Identify the state of iodine at room temperature.

..... [1]

(ii) Suggest the melting point of chlorine and the boiling point of bromine.

Use ideas about trends down a Group to help you.

melting point of chlorine ..... °C

boiling point of bromine ..... °C
[2]

(e) Chlorine has a relative atomic mass of 35.5.

Define *relative atomic mass*.

.....

.....

..... [2]

[Total: 11]

12 **(a)** Fig. 12.1 shows the speed–time graph for part of a train journey.

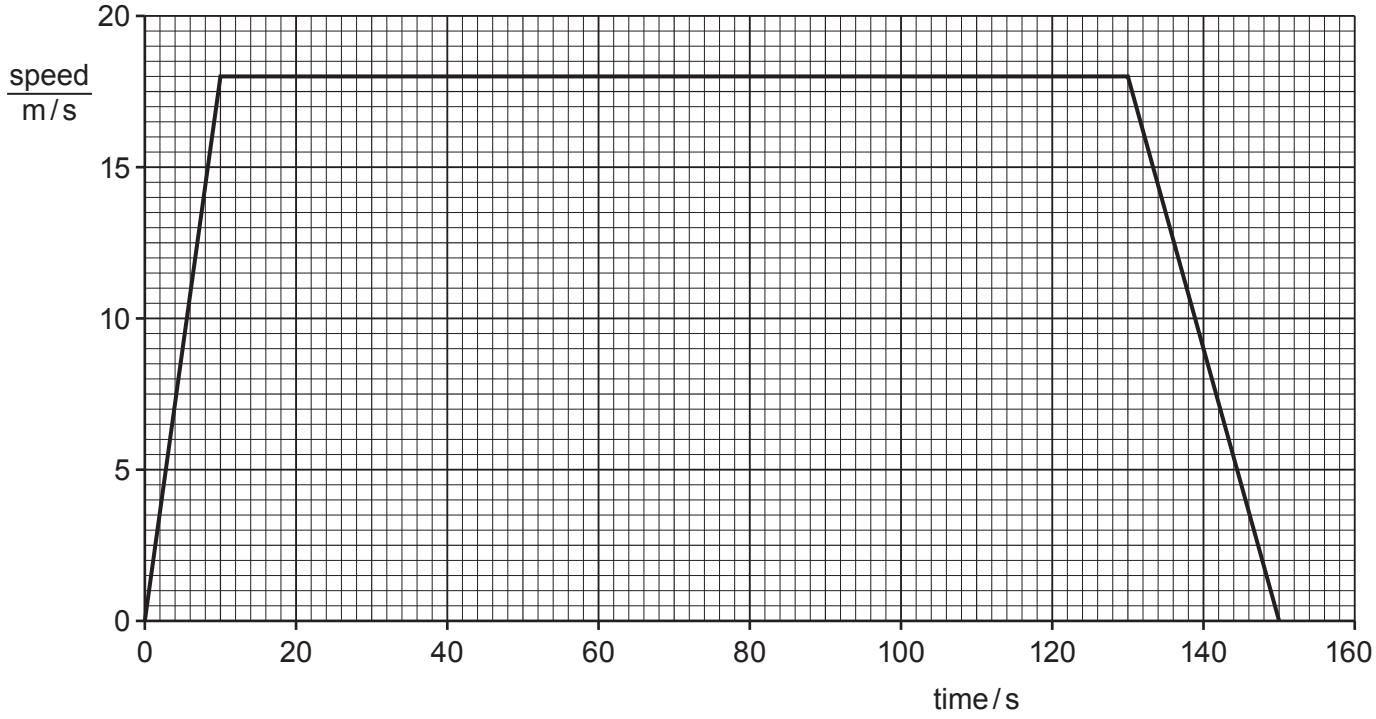


Fig. 12.1

Calculate the acceleration of the train at 5 s.

acceleration = ... m/s^2 [2]

(b) The train has two large headlamps connected in parallel. The lamps have a power rating of 360 W and are operated with a potential difference of 80 V.

(i) Show that the resistance of each lamp is 18 Ω.

[3]

(ii) Calculate the combined resistance of the two lamps connected together in parallel.

resistance = ... Ω [2]

(c) The electricity for the lamps is produced by a generator.

Fig. 12.2 shows a simple generator.

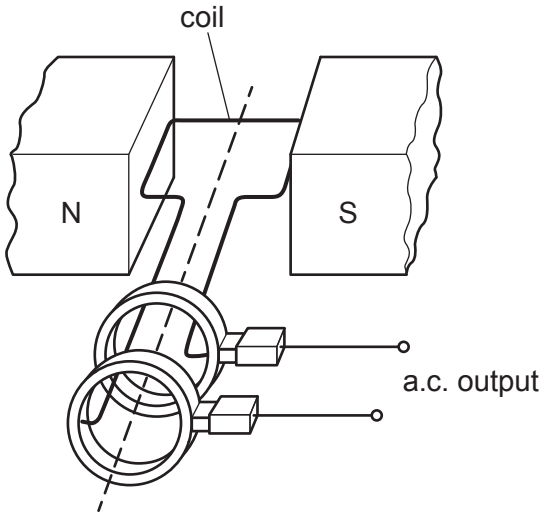


Fig. 12.2

(i) Describe how rotating the coil at constant speed induces an alternating voltage.

.....

.....

.....

..... [2]

(ii) On the grid in Fig. 12.3, sketch a graph of voltage output against time for the generator when the coil rotates at constant speed.

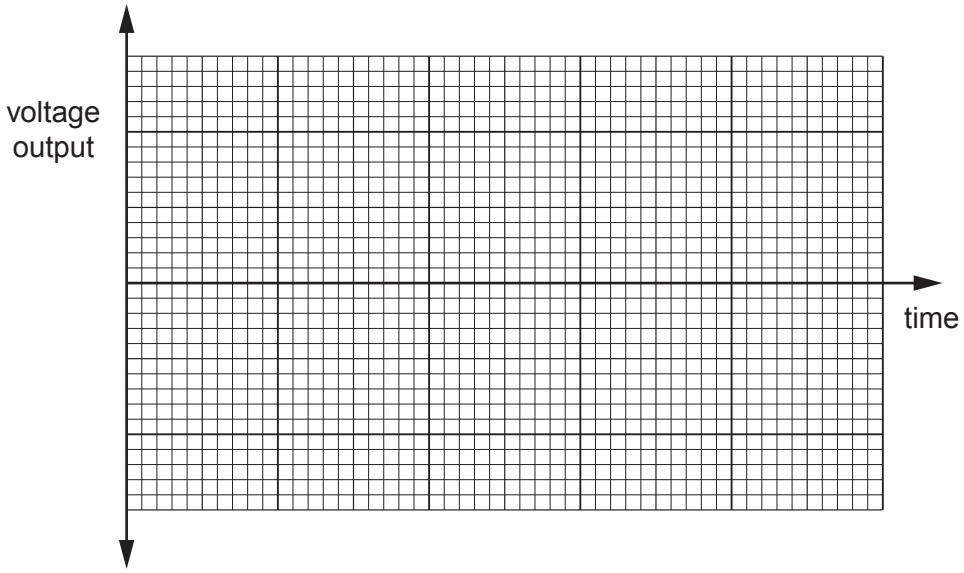


Fig. 12.3

[2]

(iii) The coil is rotated faster.

Suggest two effects this will have on the alternating voltage output.

1 .....

2 .....

[2]

(iv) The permanent magnets in the generator shown in Fig. 12.2 are made from steel rather than iron.

Suggest why the magnets are made from steel rather than iron.

.....

..... [1]

[Total: 14]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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