Cambridge Assessment International Education

Cambridge IGCSE™(9–1)

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

CO-ORDINATED SCIENCES **0973/41**

Paper 4 Theory (Extended) **May/June 2022**

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 **36** pages. Any blank pages are indicated.
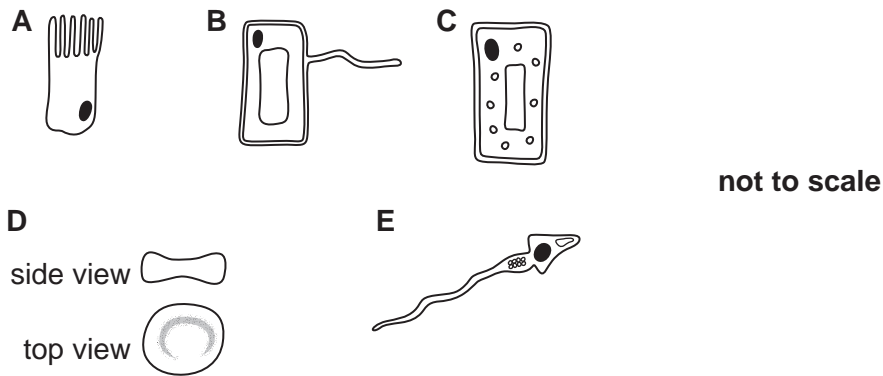
1 **(a)** Fig. 1.1 shows some specialised cells.

not to scale

Fig. 1.1

(i) Identify the names of the cells labelled **B** and **E** in Fig. 1.1.

B ....

E ....
[2]

(ii) Explain how the structure of cell **A** is related to its function.

....

....

.... [2]

(iii) Describe two ways in which cell **D** is adapted for transporting oxygen.

1 ....

2 ....
[2]

(b) Cell **D** is one of the main components of blood.

State two other main components of blood.

1 ....

2 ....
[2]

(c) Blood vessels are adapted to their function.

(i) Explain why arteries have a thick elastic wall.

....

.... [1]

(ii) Explain why veins have valves.

....

.... [1]

(iii) Explain why capillaries have very thin walls.

....

.... [1]

[Total: 11]

4

2 Ethene is a member of a family of hydrocarbons.

Fig. 2.1 shows an ethene molecule.
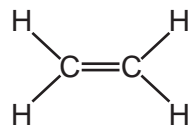
Fig. 2.1

(a) State the family of hydrocarbons that ethene is a member of.

.... [1]

(b) Ethene is made from the **larger** molecules in petroleum.

State the name of this process.

.... [1]

(c) Poly(ethene) can be made from ethene.

Poly(ethene) is a polymer.
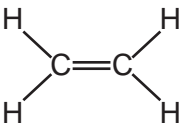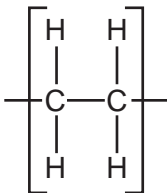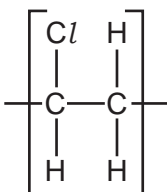
(i) State what is meant by a polymer.

....

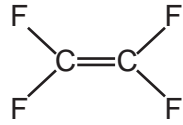.. [2]

(ii) Table 2.1 shows some information about polymers.

Complete Table 2.1.

Table 2.1

molecule used to make polymer	name of polymer	repeat unit of polymer
![ethene structure] H₂C=CH₂	poly(ethene)	repeat unit –[CH₂–CH₂]–
	poly(chloroethene)	repeat unit –[CHCl–CH₂]–
![tetrafluoroethene] F₂C=CF₂	poly(tetrafluoroethene)	

[2]

(d) Ethene can be made into ethane.
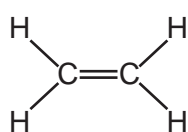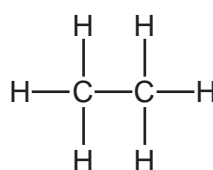
      ethene   **ethane**

State the **formula** of the substance that ethene reacts with to make ethane.

.... [1]

(e) Ethane is a saturated hydrocarbon.

Describe what is meant by a **saturated** hydrocarbon.

....

.... [1]

(f) Ethene undergoes an addition reaction with bromine.

Fig. 2.2 shows the equation for the reaction.

Complete the equation in Fig. 2.2 by drawing the structure of the compound formed.

Fig. 2.2

[1]

[Total: 9]

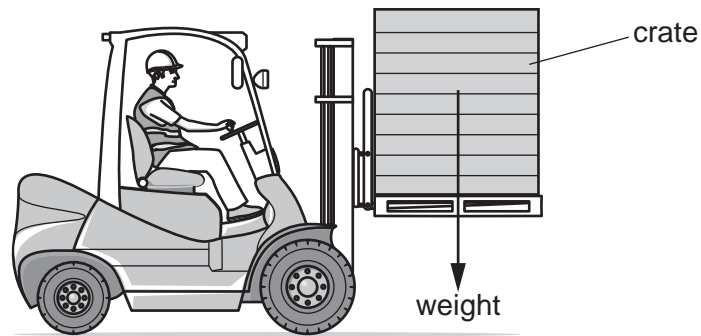**BLANK PAGE**

3 Fig. 3.1 shows a forklift truck lifting a crate.

Fig. 3.1

(a) The crate has a mass of 140 kg.

    (i) Calculate the weight of the crate.

        The gravitational field strength, g, is 10 N/kg.

weight = ... N [1]

    (ii) Calculate the work done on the crate when it is lifted through a height of 1.5 m.

        State the unit for your answer.

work done = ... unit .... [3]

(b) The forklift truck uses an electric motor to lift the crate.

Fig. 3.2 shows the circuit that includes the electric motor.
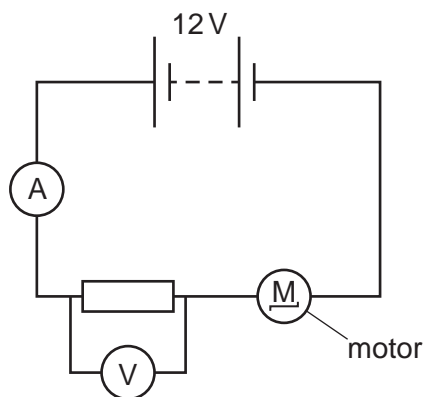
Fig. 3.2

The voltmeter displays a reading of 0.50 V.

(i) Show that the potential difference (p.d.) across the motor is 11.5 V.

[1]

(ii) The current in the circuit is 9.20 A.

Calculate the resistance of the motor.

resistance = ... Ω [2]

[Total: 7]

4 (a) Tay-Sachs disease is a genetic disorder that destroys nerve cells in the brain and spinal cord.

The allele for Tay-Sachs disease is recessive **t**.

The allele for unaffected by Tay-Sachs disease is dominant **T**.

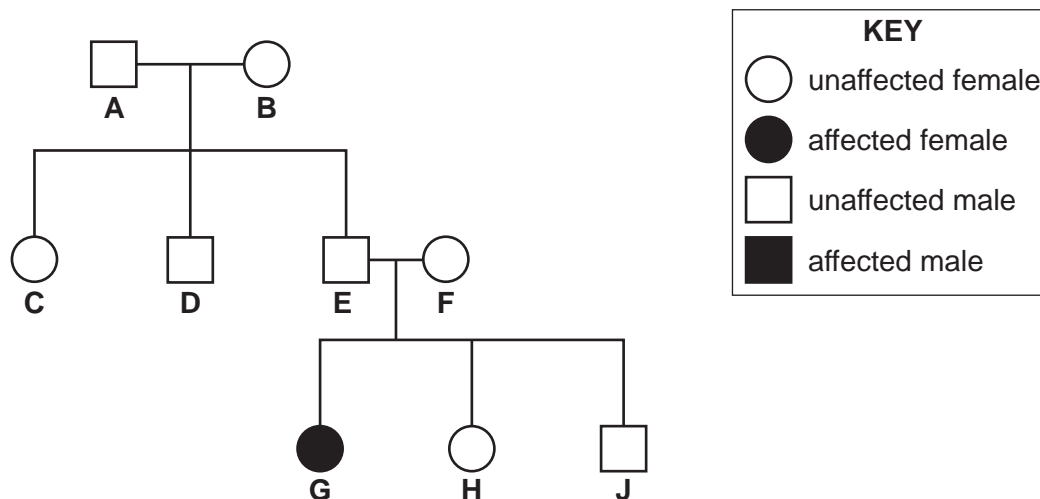Fig. 4.1 is a pedigree diagram showing the inheritance of Tay-Sachs disease.

KEY	
○	unaffected female
●	affected female
□	unaffected male
■	affected male

Fig. 4.1

(i) State the number of males in Fig. 4.1 that are **unaffected** by Tay-Sachs disease.

.... [1]

(ii) Complete the sentences to explain the genotypes of some of the people in Fig. 4.1.

Person **E** and person **F** are .... by Tay-Sachs disease.

Person **E** and person **F** both have the genotype ....

Person **G** has Tay-Sachs disease. They have the genotype ....

Person **G** will have inherited one .... allele from each parent.

[4]

(iii) State the probability of two parents with the genotypes **TT** having a child with Tay-Sachs disease.

.... [1]

(b) Growth of offspring involves mitosis.

The box on the left contains the term mitosis.

The boxes on the right contain some sentence endings.

Draw **three** lines from the word mitosis to the boxes on the right to make **three** correct sentences about mitosis.

occurs after exact duplication of chromosomes.

is involved in the production of gametes.

is reduction division.

Mitosis

produces cells with diploid nuclei.

produces nuclei with paired chromosomes.

produces genetically different cells.

[3]

(c) State the number of chromosomes in a human diploid cell.

.... [1]

(d) State the term given to a change in a gene or chromosome.

.... [1]

[Total: 11]

5   In an experiment, a student adds an alkali to an acid.
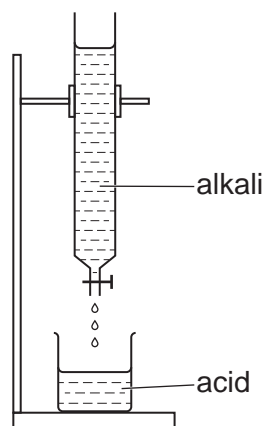
Fig. 5.1 shows the experiment.

Fig. 5.1

(a)   The student slowly adds the alkali to the acid.

   (i)   Describe how the pH of the **acid** changes as the alkali is added.

   .... [1]

   (ii)   Complete the word equation to show the **type** of substance made in the reaction.

   acid + alkali $\rightarrow$ …………………. + water   [1]

   (iii)   Sulfuric acid, H_2SO_4, is an acid.

   Potassium hydroxide, KOH, is an alkali.

   Construct the balanced symbol equation for the reaction of sulfuric acid with potassium hydroxide.

   .... + ... $\rightarrow$ .... + ...   [2]

   (iv)   State the **formula** of the ion which is present in solutions of all acids.

   .... [1]

(b) Ammonium sulfate, $(NH_4)_2SO_4$, is made by reacting an acid with an alkali.

Calculate the relative formula mass, M_r, of ammonium sulfate.
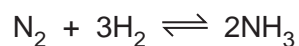
[A_r: H, 1; N, 14; O, 16; S, 32]

relative formula mass = ... [1]

(c) The alkali used to make ammonium sulfate is ammonia, NH_3.

Ammonia is made by the Haber process.

Nitrogen, N_2, and hydrogen, H_2, are the starting materials.

Look at the equation for the reaction.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(i) Describe the Haber process.

You should include:

- the sources of nitrogen and hydrogen gas
- the conditions used.

....

....

....

.... [3]

(ii) Ammonia, NH_3, reacts with nitric acid, HNO_3.

Ammonium nitrate, NH_4NO_3, is made.

Look at the equation for the reaction.

$$NH_3 + HNO_3 \rightarrow NH_4NO_3$$
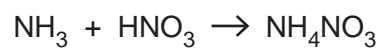
Calculate the mass of ammonium nitrate made from 51 kg of ammonia.

Show your working.

[A_r: H, 1; N, 14; O, 16]

mass = ... kg [2]

[Total: 11]

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[Turn over

6 Fig. 6.1 shows a tidal power station which uses tidal energy to generate electricity.

The moving water turns a turbine which is connected to a generator.
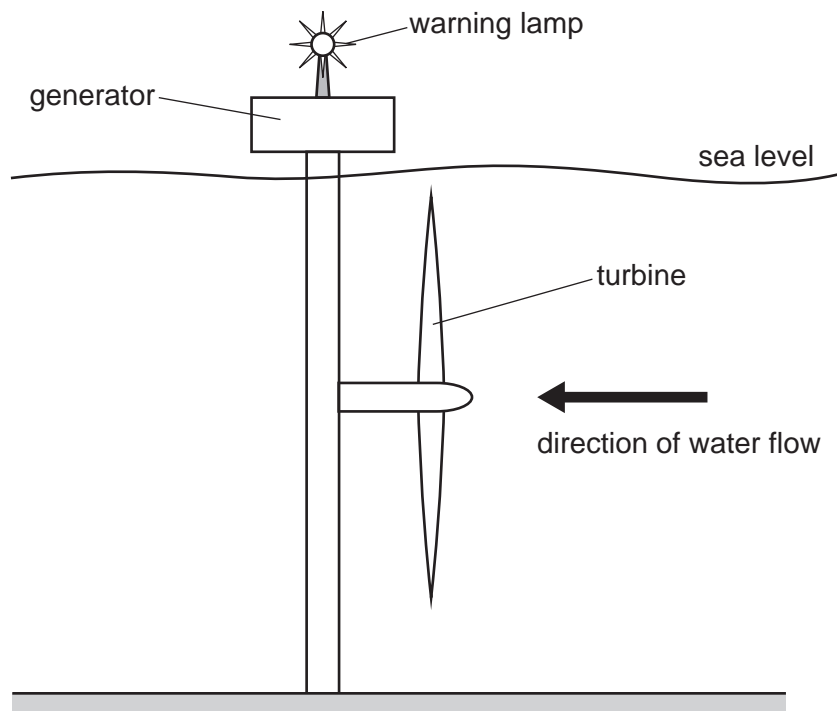
Fig. 6.1

(a) (i) State the source of the energy for the tides.

.... [1]

(ii) Each kilogram of water has 1.62 J of kinetic energy.

Calculate the speed of the water flow.

speed = ... m / s [2]

(b) Fig. 6.2 shows a simple a.c. generator.
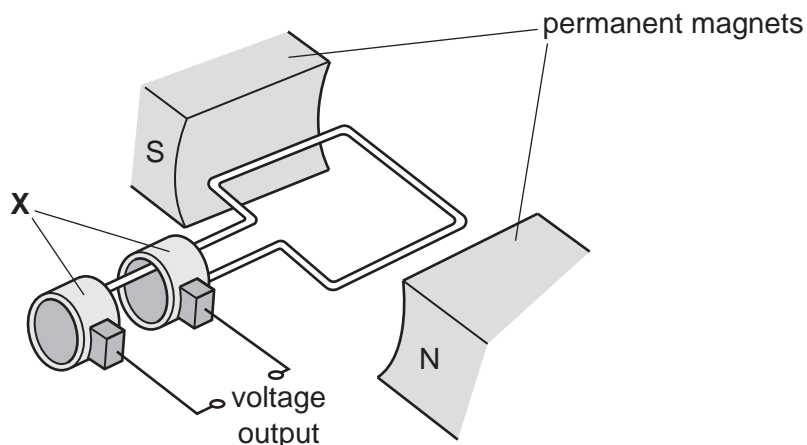
Fig. 6.2

(i) On Fig. 6.2, draw an arrow to show the direction of the magnetic field between the permanent magnets. [1]

(ii) State the name of the components labelled **X** and describe their use.

name ....

use ....

....
[2]

(iii) On Fig. 6.3, sketch a graph of voltage output against time for a simple a.c. generator operating at a constant speed.

Fig. 6.3

[2]
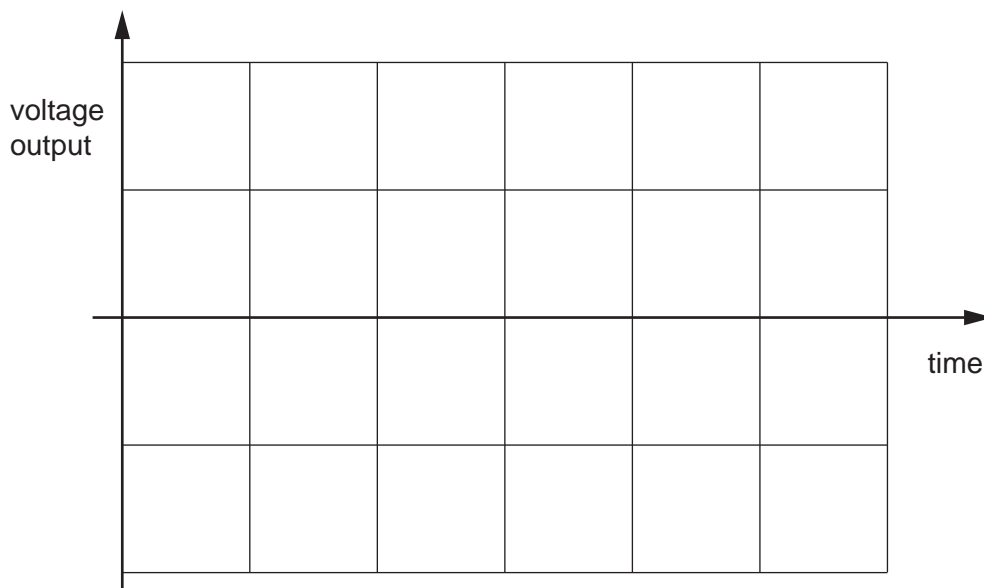
(c) The tidal power station uses a warning lamp to warn passing boats of its location.

The lamp emits light with a wavelength of 4.0×10^{-7} m.

Calculate the frequency of the light.

frequency = ... Hz [3]

[Total: 11]

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 [Turn over

7   (a) Fig. 7.1 is a photograph of a wind-pollinated flower.

A

Fig. 7.1

Identify part **A** in Fig. 7.1.

.... [1]

   (b) Describe **one** way the pollen and petals of insect-pollinated flowers are **different** from wind-pollinated flowers.

pollen ....

petals ....
                                                                                                                            [2]

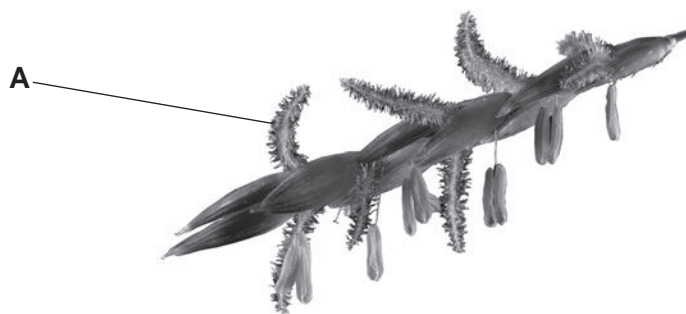   (c) State where fertilisation occurs in a plant.

.... [1]

   (d) Many plants are able to reproduce sexually and asexually.

Describe the **disadvantages** to a plant in the wild of reproducing asexually.

....

....

.... [2]

   (e) State two requirements for germination of plant seeds.

1 ....

2 ....
                                                                                                                            [2]

[Total: 8]

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 [Turn over

8 Table 8.1 gives some information about atoms.

Table 8.1

atom	proton number	nucleon number	electronic structure
sodium	11	23	2.8.1
fluorine	9	19	2.7
chlorine	17	35	2.8.7
chlorine	17	37	2.8.7
argon	....	40	2.8.8
magnesium	12	24	....

(a) Complete Table 8.1. [2]

(b) Chlorine appears twice in Table 8.1.

Each of the atoms is an isotope of chlorine.

(i) Explain what is meant by the word isotope.

....

....

.... [2]

(ii) The two isotopes of chlorine have the same chemical properties.

Explain why.

....

.... [1]

(c) Argon is a noble gas.

Explain why argon is very unreactive.

Use ideas about electronic structure.

....

.... [1]

(d) Sodium is a metal.

Describe the bonding in a metal.

You may draw a diagram to help your answer.

....

....

.... [2]

(e) Magnesium chloride contains the ions Mg^{2+} and Cl^-.

Determine the **formula** of magnesium chloride.

formula = ... [1]

(f) Fluorine, F_2, reacts with sodium chloride, $NaCl$.

Construct the balanced symbol equation for the reaction.

.... [2]

[Total: 11]

9 A student investigates the motion of smoke particles in air using a microscope.

The student shines a bright light on a transparent box containing a mixture of smoke and air and observes the smoke particles as bright dots of light.

(a) The student observes that the smoke particles move in straight lines between random changes of direction.

Fig. 9.1 shows the observed path of one smoke particle.
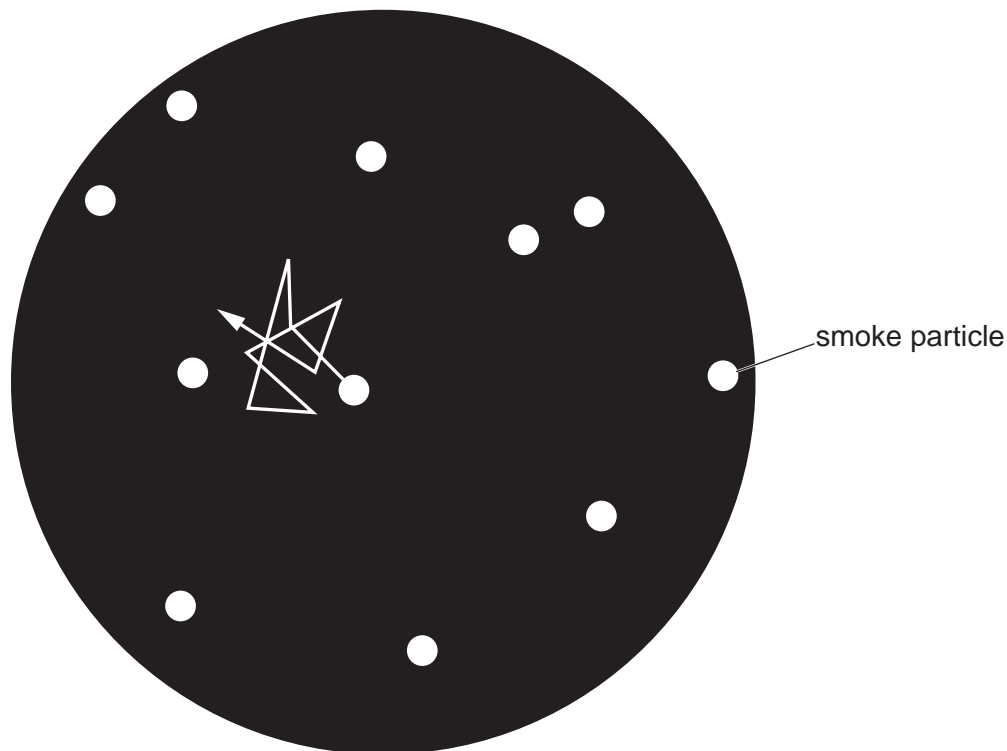
smoke particle

Fig. 9.1

The motion shown in Fig. 9.1 is known as Brownian motion.

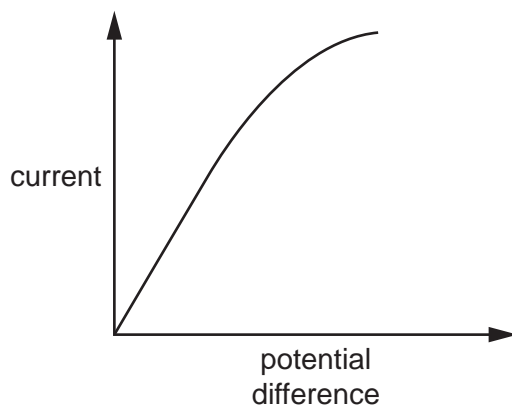Describe what causes the motion of the smoke particles shown in Fig. 9.1.

....

....

....

.... [2]

(b) The microscope uses a filament lamp to illuminate the smoke particles.

Fig. 9.2 shows how current varies with potential difference (p.d.) for the filament lamp.

Fig. 9.2

Use the shape of the graph in Fig. 9.2 to describe **and** explain what happens to the resistance of the filament lamp as the potential difference is increased.

....

....

....

....

....

.... [3]

(c) The microscope uses a thin converging lens to produce an image.
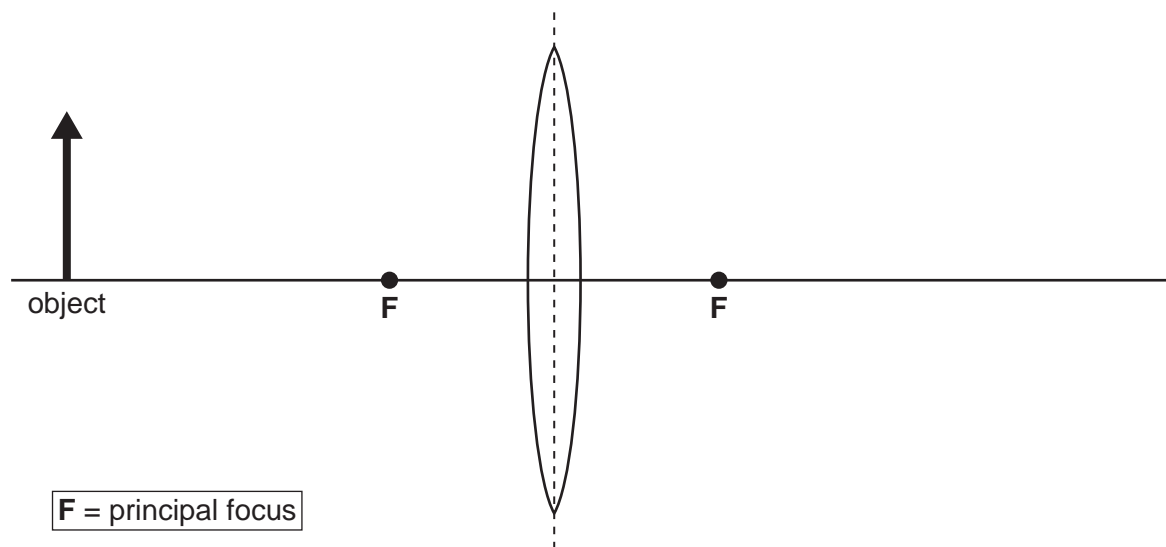
Fig. 9.3 shows a thin converging lens.

object

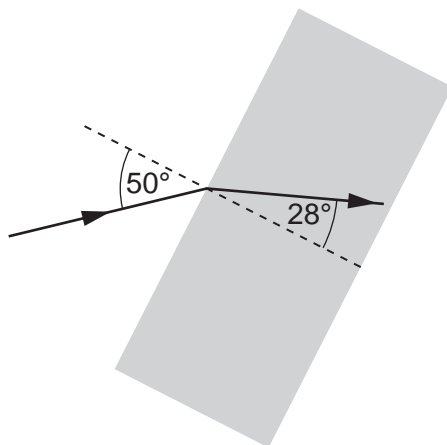**F**

F

F = principal focus

Fig. 9.3

(i) Draw a ray diagram on Fig. 9.3 to show the formation of a real image.

Label the image with the word image. [3]

(ii) Fig. 9.4 shows a single ray of light entering a thin glass block.

Fig. 9.4

Calculate the refractive index of the thin glass block.

refractive index = ... [2]

[Total: 10]

10 The control of blood glucose concentration is an involuntary action by the body.

   (a) Place ticks (✓) in the boxes to show **two** other involuntary actions.

coughing	
cycling	
reading	
sneezing	
talking	

[2]

   (b) State the characteristic of living things that is defined as the ability to respond to a stimulus.

   .... [1]

   (c) Fig. 10.1 is a graph that shows the blood glucose concentration after eating a meal.
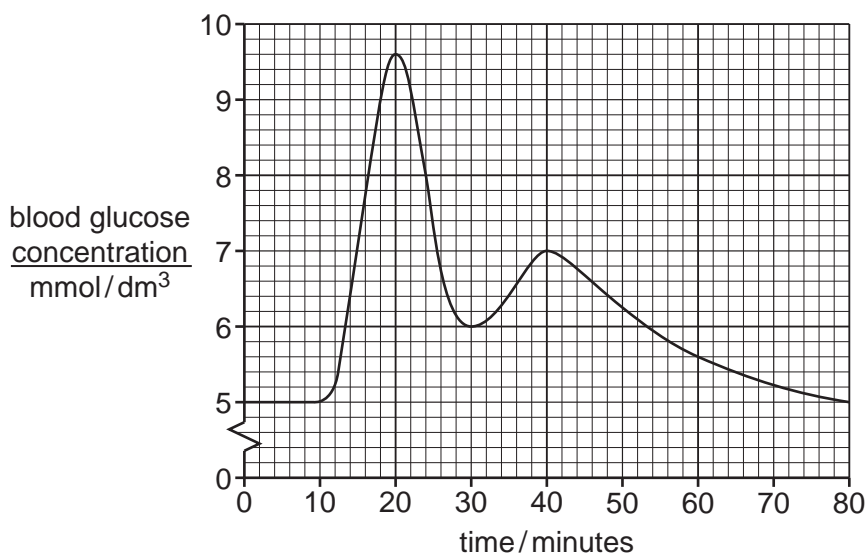

Fig. 10.1

   (i) Calculate the length of time it takes for the blood glucose concentration to return to its starting concentration from its maximum.

   .... minutes [1]

   (ii) Explain the results between **20–30 minutes** in Fig. 10.1.

   ....

   ....

   ....

   ....

   .... [3]

   (iii) State the type of response shown by the control of blood glucose concentration.

   .... [1]

(d) State the names of two hormones that can increase the blood glucose concentration.

   1 ....

   2 ....

[2]

[Total: 10]

11 A student investigates indigestion tablets.

Indigestion tablets neutralise acids.

The student measures $50\,cm^3$ of dilute hydrochloric acid into a beaker.

He adds an indigestion tablet to the acid.

Fig. 11.1 shows the student's experiment.
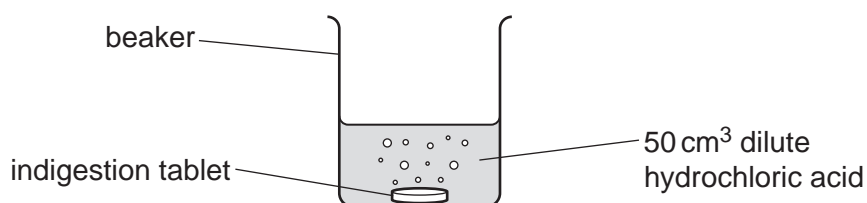
Fig. 11.1

The student measures the time the tablet takes to react completely.

He repeats the experiment but makes one change each time.

Table 11.1 shows his results.

Table 11.1

experiment	volume of acid/cm³	concentration of acid	temperature of acid/°C	time for tablet to react/s
1	50	dilute	20	131
2	50	concentrated	20	66
3	100	concentrated	20	66
4	50	concentrated	30	32

(a) The volume of acid does not affect the rate of reaction.

State which **two** experiments show this.

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

(b) Increasing the temperature of the acid affects the rate of reaction.

Increasing the concentration of the acid also affects the rate of reaction.

For each factor (temperature and concentration):

- describe how the rate of reaction changes
- explain why the rate of reaction changes, using ideas about particles.

temperature

how the rate of reaction changes ....

....

because ....

....

....

concentration

how the rate of reaction changes ....

....

because ....

....

....
[4]

(c) In experiment 1, the student uses dilute hydrochloric acid with a concentration of $0.1\,mol/dm^3$.

Calculate the concentration of the dilute hydrochloric acid in **g/dm^3**.

[A_r: H, 1; Cl, 35.5]

answer = ... g/dm^3 [1]

(d) The reaction between the indigestion tablet and the acid is an exothermic reaction.

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

....

....

....

.... [3]

[Total: 9]

 [Turn over

12 A rocket is used to launch satellites into Earth's orbit.

(a) Fig. 12.1 shows the forces acting on a rocket as it is launched.

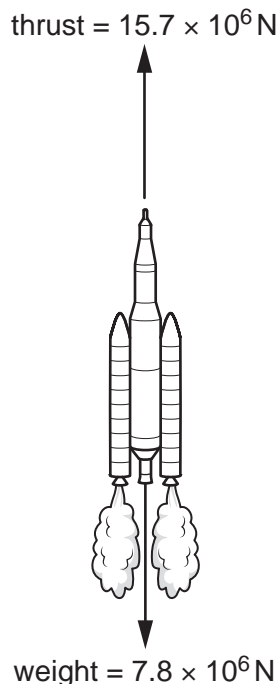thrust = 15.7×10^6 N

weight = 7.8×10^6 N

Fig. 12.1

(i) Calculate the resultant force acting on the rocket as it is launched.

resultant force = ... N [1]

(ii) Describe the motion of the rocket as it is launched.

....

....

....

.... [2]

(iii) Suggest a reason why the weight decreases as the rocket travels further away from Earth.

....

.... [1]

(b) Fig. 12.2 shows a satellite in orbit around the Earth.

The satellite orbits at a height of 2000 km above the surface of the Earth.

The satellite takes 125 minutes to complete one orbit.

The satellite travels at an average speed of 7.1 km/s.
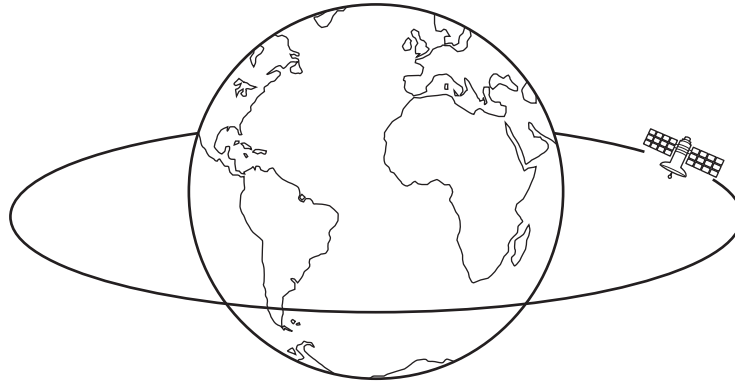
Fig. 12.2

Calculate the radius of the Earth.

radius of the Earth = ... km [4]

(c) When in orbit, satellites are subject to ionising radiation coming from space.

This radiation includes α-particles, β-particles and γ-rays.

(i) State **and** explain which forms of ionising radiation will be deflected by the Earth's magnetic field.

forms of radiation ....

explanation ....

....

....

[2]

(ii) A β-particle is emitted when the radioactive isotope iodine-131 decays into an isotope of xenon.

Use the correct nuclide notation to complete the decay equation for iodine-131.

$$^{131}_{53}I \quad \rightarrow \quad ^{......}_{......}Xe \quad + \quad ^{......}_{......}\beta$$

[2]

[Total: 12]

35

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