Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

0207246791

CO-ORDINATED SCIENCES **0654/42**

Paper 4 Theory (Extended) **February/March 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 **28** pages. Any blank pages are indicated.

1 **(a)** Sensitivity is one of the characteristics of living organisms.

Define the term sensitivity.

.....

.....

..... [2]

(b) Fig. 1.1 is a diagram of a human eye.

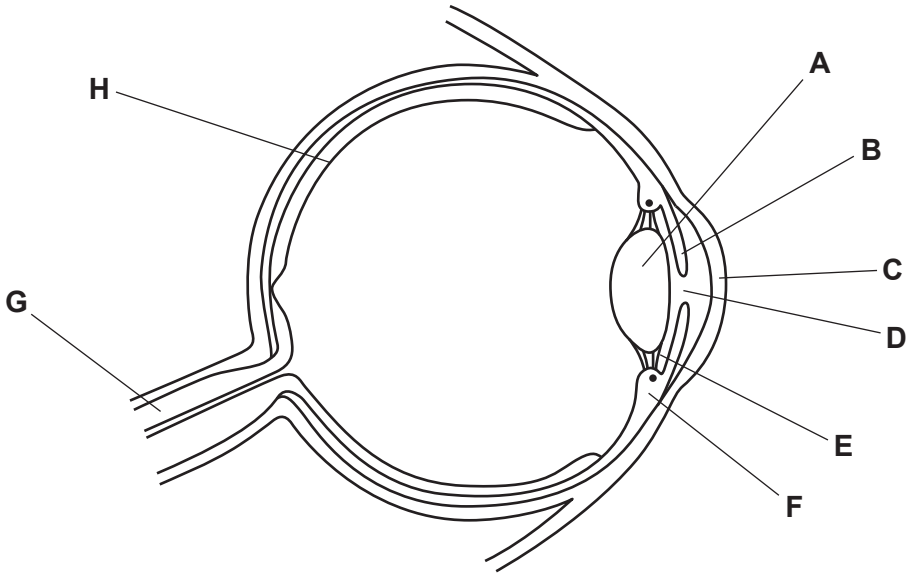


Fig. 1.1

(i) Draw an **X** on Fig. 1.1 to identify the position of the blind spot. [1]

(ii) Identify the letter from Fig. 1.1 that shows the part that:

contains receptor cells .....

controls the amount of light entering the eye .....

refracts light. .....

[3]

(iii) A person changes their focus from a near object to a distant object.

Describe the changes that occur to the parts labelled **A**, **E** and **F** in Fig. 1.1 when focusing on a distant object.

A .....

E .....

F .....

[3]

(c) The eye forms part of the peripheral nervous system.

Name the two parts of the **central** nervous system.

1 .....

2 .....
[2]

[Total: 11]

2 Potassium is in Group I of the Periodic Table.

(a) Potassium-39 is an isotope of potassium.

(i) Explain what is meant by an isotope.

.....

.....

..... [2]

(ii) Potassium-39 has a proton number (atomic number) of 19 and a nucleon number (mass number) of 39.

Complete Table 2.1 to give the number of particles in:

- a potassium atom
- a potassium ion.

Table 2.1

	potassium atom, K	potassium ion, K^+
number of protons		
number of electrons		
number of neutrons		

[3]

(b) Sodium is another element in Group I.

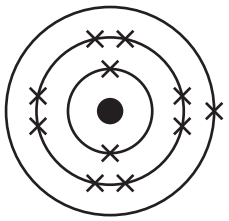
Sodium reacts with water.

Sodium hydroxide, NaOH, and hydrogen are made.

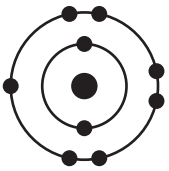
Construct the balanced symbol equation for this reaction.

..... [2]

(c) Fig. 2.1 is a dot-and-cross diagram which shows the electronic structure of a sodium atom and a fluorine atom.



sodium atom



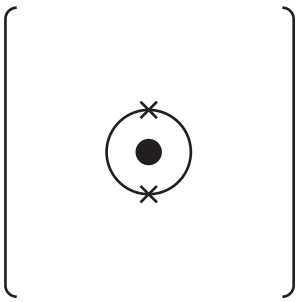
fluorine atom

Fig. 2.1

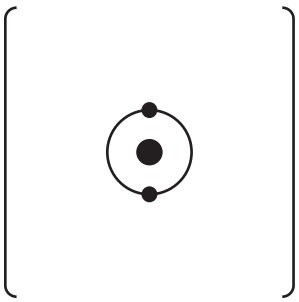
A sodium ion and a fluoride ion are formed when sodium reacts with fluorine.

Complete the dot-and-cross diagram in Fig. 2.2 to show the electronic structure of a sodium ion and a fluoride ion.

Include the charges on the ions.



sodium ion



fluoride ion

Fig. 2.2

[2]

(d) A student wants to identify a metal halide, compound **X**.

(i) The student does a flame test, as shown in Fig. 2.3.

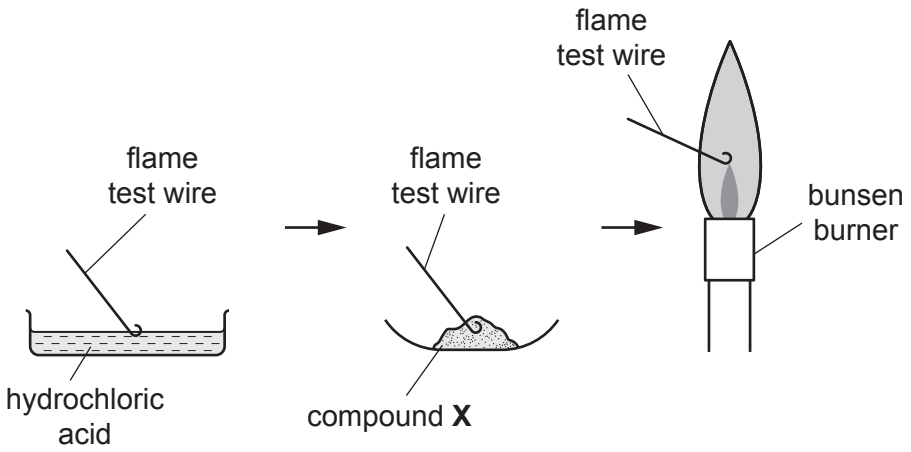


Fig. 2.3

The flame colour turns from blue to **yellow**.

State the name of the metal ion in compound **X**.

metal ion ..... [1]

(ii) The student dissolves compound **X** in distilled water.

The student then adds a little dilute nitric acid followed by a few drops of aqueous silver nitrate. A **white** precipitate is formed.

Suggest which halide ion is in compound **X**.

Choose from the list.

bromide

chloride

iodide

halide ion ..... [1]

[Total: 11]

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3 Fig. 3.1 shows an electric train.

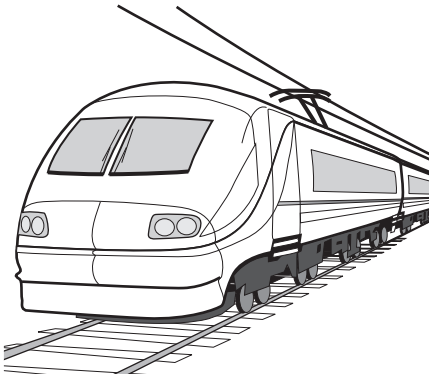


Fig. 3.1

(a) The train has a total mass of 680 000 kg.

During one journey, the train travels 180 km in 1 hour.

(i) Show that the average speed of the train during this journey is 50 m / s.

[1]

(ii) Calculate the average kinetic energy of the train during this journey.

kinetic energy = ... J [2]

(b) When the train passes through a station, the driver sounds a horn.

(i) In air, the frequency of the sound from the horn is 250 Hz and the wavelength is 1.32 m.

Calculate the speed of sound in air.

speed of sound in air = ... m / s [2]

(ii) Describe how the sound wave travels through the air.

.....

.....

.....

..... [2]

(c) The rails for the track are made of steel which has a density of 8100 kg / m^3.

(i) A length of rail has a mass of 324 kg.

Calculate the volume of each length of rail.

volume = ... m^3 [2]

(ii) Fig. 3.2 shows two lengths of train track.

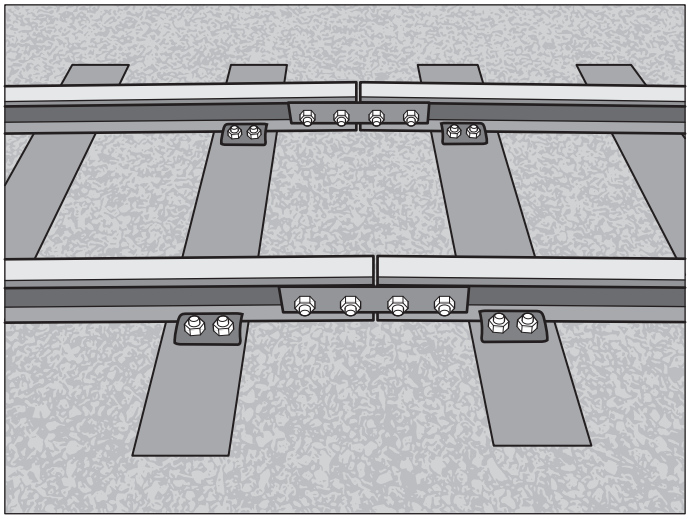


Fig. 3.2

Explain why the lengths of train track are laid with small gaps between them.

.....

.....

.....

.....

.....

..... [2]

[Total: 11]

4 **(a)** A student investigates the effect of bile and lipase on the digestion of fat in milk.

Fat is digested into fatty acids and glycerol.

The student:

- sets up three test-tubes, as shown in Table 4.1
- uses an indicator which turns pink when fatty acid is present
- records how long it takes the indicator to turn pink in each test-tube.

Table 4.1

test-tube	volume of **milk** / cm^3	volume of **bile solution** / cm^3	volume of **boiled lipase solution** / cm^3	volume of **lipase solution** / cm^3	time taken for **indicator** to turn pink / seconds
1	5	0	0	1	378
2	5	1	1	0	never turns pink
3	5	1	0	1	196

(i) Explain the results for test-tube **2**.

.....

.....

.....

.....

..... [3]

(ii) Calculate the difference in time taken for the indicator to turn pink between test-tubes **1** and **3**.

..... seconds [1]

(iii) Explain the difference between the results for test-tube **1** and **3**.

.....

.....

.....

.....

..... [2]

(b) State the name of the organ that produces bile.

..... [1]

(c) After food has been digested, it is absorbed.

(i) Explain how villi increase the rate of absorption of digested food.

.....

..... [1]

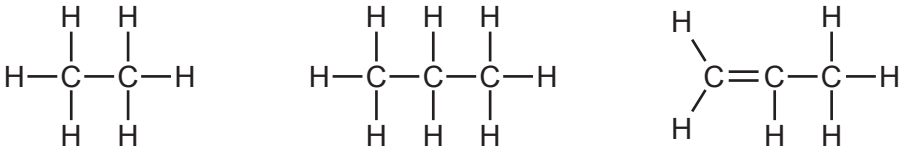
(ii) State the part of the alimentary canal where villi are found.

..... [1]

[Total: 9]

5 This question is about hydrocarbons.

Fig. 5.1 shows the displayed formulae of three hydrocarbons.



ethane **propane** **propene**

Fig. 5.1

(a) The molecular formula of ethane is C_2H_6.

Write down the molecular formula of **propene**.

molecular formula = ... [1]

(b) Ethane and propane are members of the same group of hydrocarbons called the alkanes.

State which group of hydrocarbons **propene** belongs to.

..... [1]

(c) Propene is an unsaturated hydrocarbon.

State what is meant by the word unsaturated.

.....

..... [1]

(d) Propene can be changed into propane by reaction with hydrogen, as shown in Fig. 5.2.

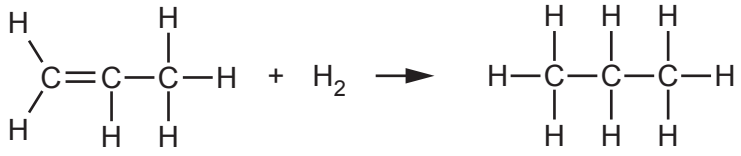


Fig. 5.2

State the name of this **type** of reaction.

..... [1]

(e) Aqueous bromine is used to tell the difference between propene and propane.

State what you would see when aqueous bromine is added to propene and propane.

propene .....

propane .....

[2]

(f) **(i)** Propene can be used as a monomer.

Propene can be converted into a polymer, poly(propene), in an addition polymerisation reaction.

Complete Fig. 5.3 to show the structure of poly(propene).

Fig. 5.3

[2]

(ii) Nylon is another polymer.

Nylon is made in a condensation polymerisation reaction.

Describe the differences between **addition** polymerisation and **condensation** polymerisation.

.....

.....

.....

..... [2]

[Total: 10]

6 Fig. 6.1 shows a child's slide. The slide is made from plastic and is 1.8 m high.

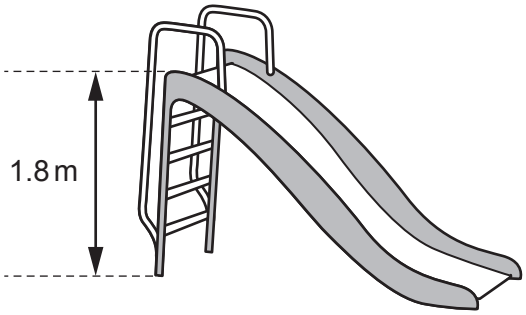


Fig. 6.1

(a) Calculate the work done in lifting a 15 kg child to the top of the slide.

State the unit for your answer.

The gravitational field strength g is 10 N / kg.

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

(b) Fig. 6.2 shows how the speed of the child changes as they slide down the plastic slide.

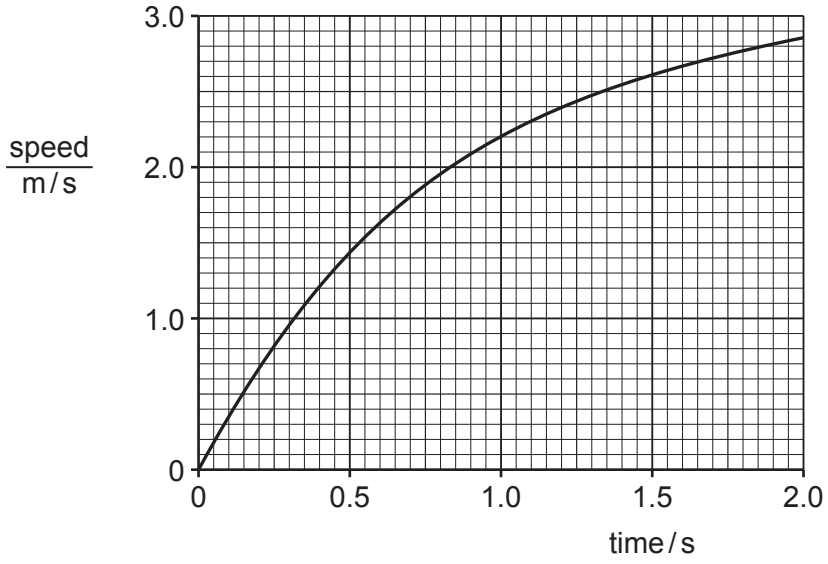


Fig. 6.2

Describe how the motion of the child changes as they slide down the plastic slide.

.....

.....

.....

.....

..... [2]

(c) As the child slides down the plastic slide, they become positively charged.

Describe how the child becomes positively charged.

.....

.....

.....

.....

.....

..... [3]

(d) A plastic slide is made from either black plastic or white plastic.

Complete the sentences below using the words **more** or **less**.

A white plastic slide will absorb infrared radiation ..... than a black plastic slide.

A white plastic slide will reflect infrared radiation ..... than a black plastic slide.

On a sunny day, a white plastic slide will heat up ..... than a black plastic slide.

[1]

[Total: 9]

7 **(a)** Fig. 7.1 is a marine food web.

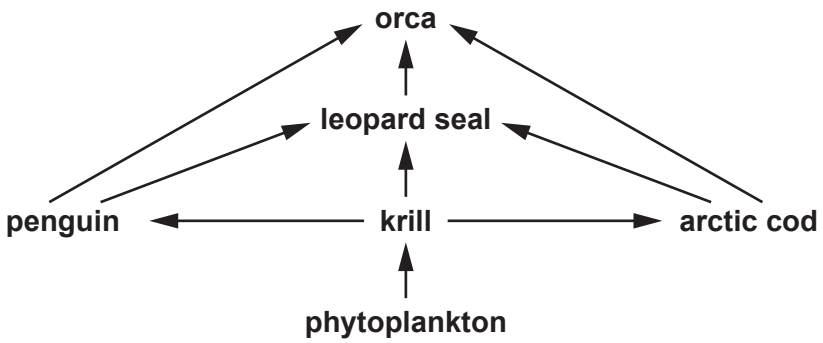


Fig. 7.1

Table 7.1 shows some of the terms that can be used to describe the organisms in Fig. 7.1.

Put ticks (✓) in Table 7.1 to show **all** the terms used to describe each organism.

One has been done for you.

Table 7.1

organism	producer	herbivore	carnivore	quaternary consumer
arctic cod				
krill		✓		
orca				
phytoplankton				

[3]

(b) Describe how producers are able to make their own carbohydrates.

.....

.....

.....

..... [2]

(c) Describe **three** ways energy is lost between trophic levels.

1 .....

2 .....

3 .....

[3]

(d) Marine organisms have developed adaptations such as gills.

(i) Complete the sentences to describe the process of adaptation.

Adaptation results from the process of natural ..... .

Some organisms are better adapted to the ..... than others.

These organisms survive and breed, passing on their ..... .

This process takes many ..... .

[4]

(ii) Gills are the gas exchange surface in fish.

List **two** features of gas exchange surfaces.

1 .....

2 .....

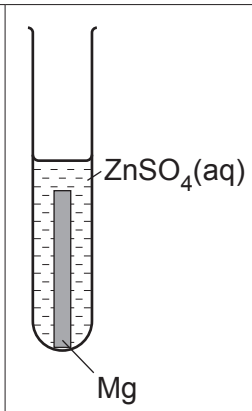
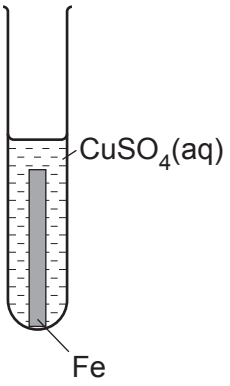
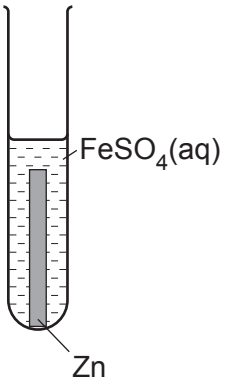
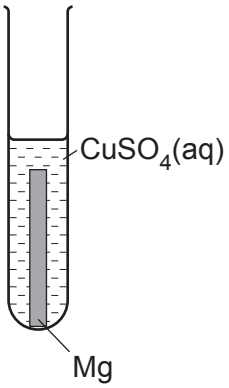
[2]

[Total: 14]

8 A student investigates how metals react with different solutions.

Table 8.1 shows the student's experiments and some of the results.

Table 8.1

diagram of experiment				
colour of metal at start	silver coloured	dark grey	light grey	
colour of solution at start	colourless	pale blue	pale green	pale blue
appearance of metal at end	light grey		dark grey	pink / brown
colour of solution at end	colourless	pale green	colourless	

The order of reactivity of the metals is shown.

magnesium — **most reactive**

zinc

iron

copper — **least reactive**

(a) Use the order of reactivity and the information in Table 8.1 to predict the missing results.

Write your answers in the boxes in Table 8.1.

[3]

(b) Zinc reacts with a solution of iron sulfate, $FeSO_4$.

Iron and zinc sulfate are made.

Construct the balanced symbol equation for the reaction.

Include the state symbols.

..... [2]

(c) In the reaction between magnesium and zinc sulfate, magnesium ions, Mg^{2+}, are formed from magnesium atoms.

Construct the balanced ionic half-equation for this reaction.

Use the symbol e^- for an electron.

..... [2]

(d) Magnesium reacts with hydrochloric acid.

Magnesium chloride, $MgCl_2$, and hydrogen gas are made.

$$Mg + 2HCl \longrightarrow MgCl_2 + H_2$$

(i) Calculate the maximum mass of magnesium chloride that can be made from 0.48 g of magnesium.

Show your working.

[A_r: Cl, 35.5; Mg, 24]

mass = ... g [2]

(ii) State the test for hydrogen gas and give the observation for a positive result.

test .....

observation .....
[2]

[Total: 11]

9 A student investigates the spring constant of three springs, **A**, **B**, and **C**, using Hooke's law and the equipment shown in Fig. 9.1.

The student:
- measures the unloaded lengths of each spring
- hangs identical masses from each spring and measures the extended lengths.

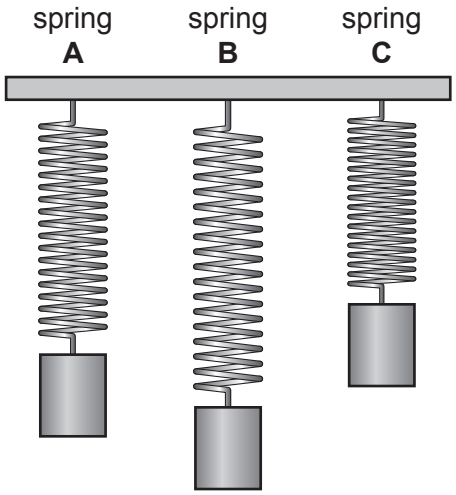


Fig. 9.1

(a) Table 9.1 shows the results.

Table 9.1

	unloaded length / cm	extended length / cm
spring **A**	2.2	3.4
spring **B**	4.0	4.3
spring **C**	1.8	2.6

(i) Spring **A** has a spring constant of 0.50 N / cm.

Calculate the weight of the mass hanging from spring **A**.

weight = ... N [3]

(ii) In the investigation, the student hangs identical masses from each spring.

State and explain which of the three springs has the largest spring constant.

spring .....

explanation .....

.....

.....

[2]

(b) The springs are all made of metals and conduct electricity.

The student sets up a circuit to determine the electrical resistance of one of the springs.

Fig. 9.2 shows the circuit used.

The ammeter reads 0.75 A and the voltmeter reads 7.5 V.

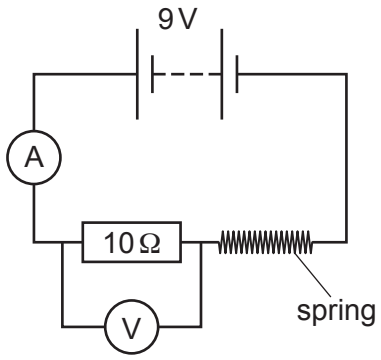


Fig. 9.2

(i) Calculate the resistance of the metal spring.

resistance = ... Ω [3]

(ii) The spring acts like a solenoid when there is a current in it.

Draw on Fig. 9.3 to show the shape, and direction, of the magnetic field due to the current in the solenoid.

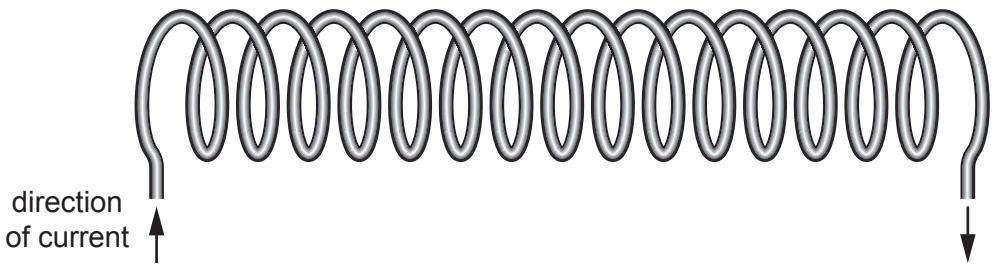


Fig. 9.3

[2]

[Total: 10]

10 **(a)** Fig. 10.1 shows a photomicrograph of some plant cells.

Fig. 10.2 shows a photomicrograph of the same plant cells immersed in a concentrated glucose solution.

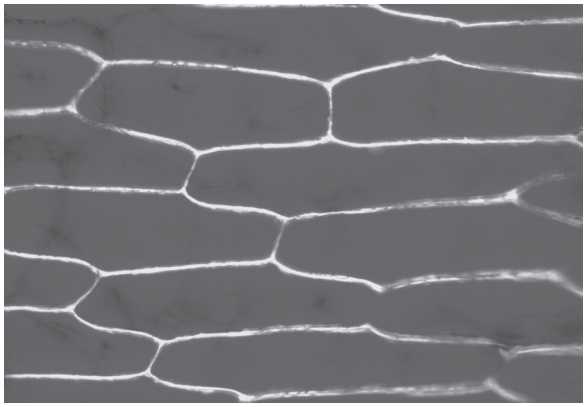


Fig. 10.1

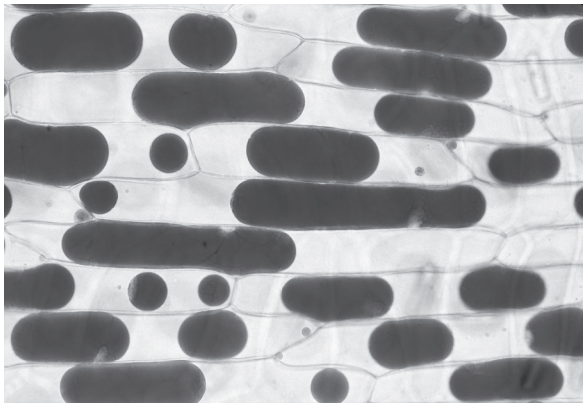


Fig. 10.2

(i) State the name of the effect shown by the change in appearance of the cells.

..... [1]

(ii) Explain the process that causes the cells in Fig. 10.1 to change appearance when immersed in concentrated glucose solution.

.....

.....

.....

.....

..... [3]

(b) Phloem cells in plants are responsible for translocation.

State the **two** main substances transported during translocation.

1 .....

2 .....
[2]

[Total: 6]

11 Diamond and graphite are two forms of carbon shown in Fig. 11.1.

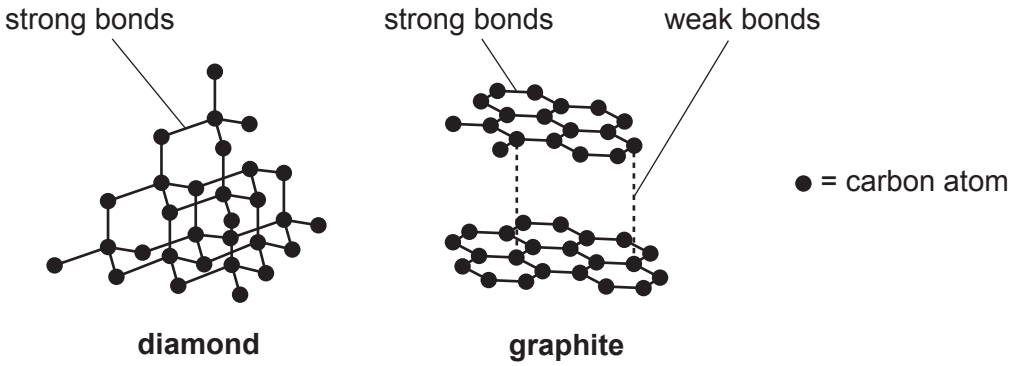


Fig. 11.1

(a) Diamond is used in cutting tools.

State one **property** of diamond that makes it suitable for this use.

..... [1]

(b) Graphite is soft and slippery. It is also a good conductor of electricity.

State a use for graphite.

..... [1]

(c) Explain how graphite conducts electricity.

.....

..... [2]

(d) There are strong bonds between the carbon atoms in diamond.

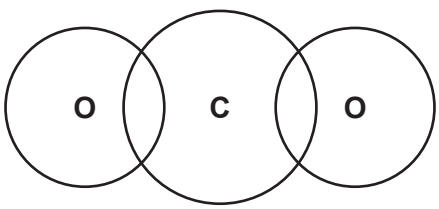
State the name of this type of bond.

..... [1]

(e) Carbon bonds to oxygen in carbon dioxide, CO_2.

Complete the dot-and-cross diagram to show the bonding in carbon dioxide.

Show only the outer shell electrons.



[3]

[Total: 8]

12 **(a)** Fig. 12.1 shows an incomplete electromagnetic spectrum.

radio waves	**P**	**Q**	visible light	**R**	X-rays	γ-rays

Fig. 12.1

State the names of the forms of radiation labelled **P**, **Q** and **R**.

P .....

Q .....

R .....
[2]

(b) Visible light can be used to demonstrate refraction.

Fig. 12.2 shows refraction of visible light through a glass block.

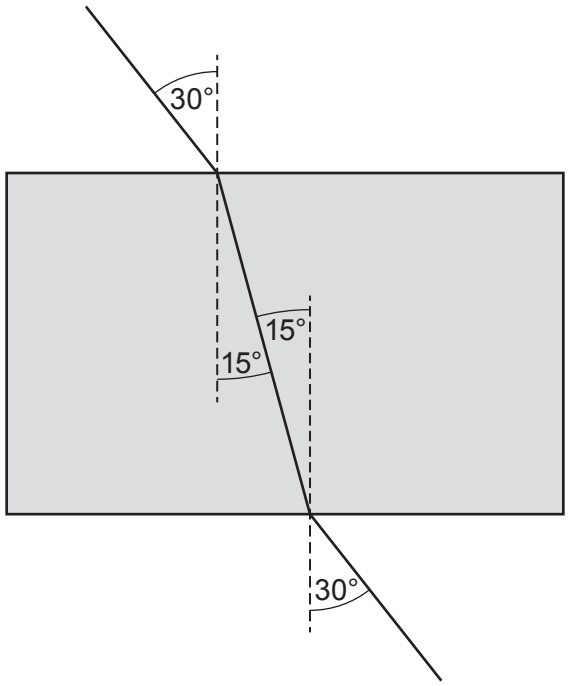


Fig. 12.2

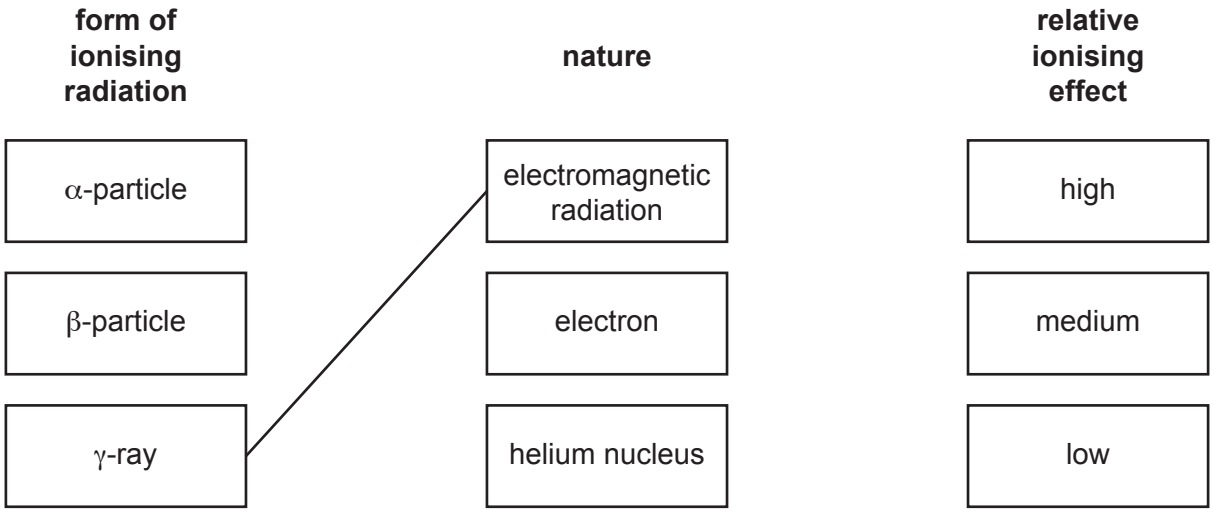
Calculate the refractive index of the glass block.

refractive index = ... [2]

(c) γ-rays are a form of ionising radiation emitted during radioactive decay.

(i) Draw lines to match each form of ionising radiation with its nature and relative ionising effect.

One line has been drawn as an example.



[2]

(ii) Lead-210 ($^{210}_{82}Pb$) will decay to form an isotope of bismuth.

Use the correct nuclide notation to complete the decay equation for lead-210.

$$^{210}_{82}Pb \longrightarrow {}^{\cdots\cdots}_{83}Bi + {}^{\cdots\cdots}_{\cdots\cdots}\cdots\cdots$$

[2]

(iii) Fig. 12.3 shows the activity of a sample of lead-210.

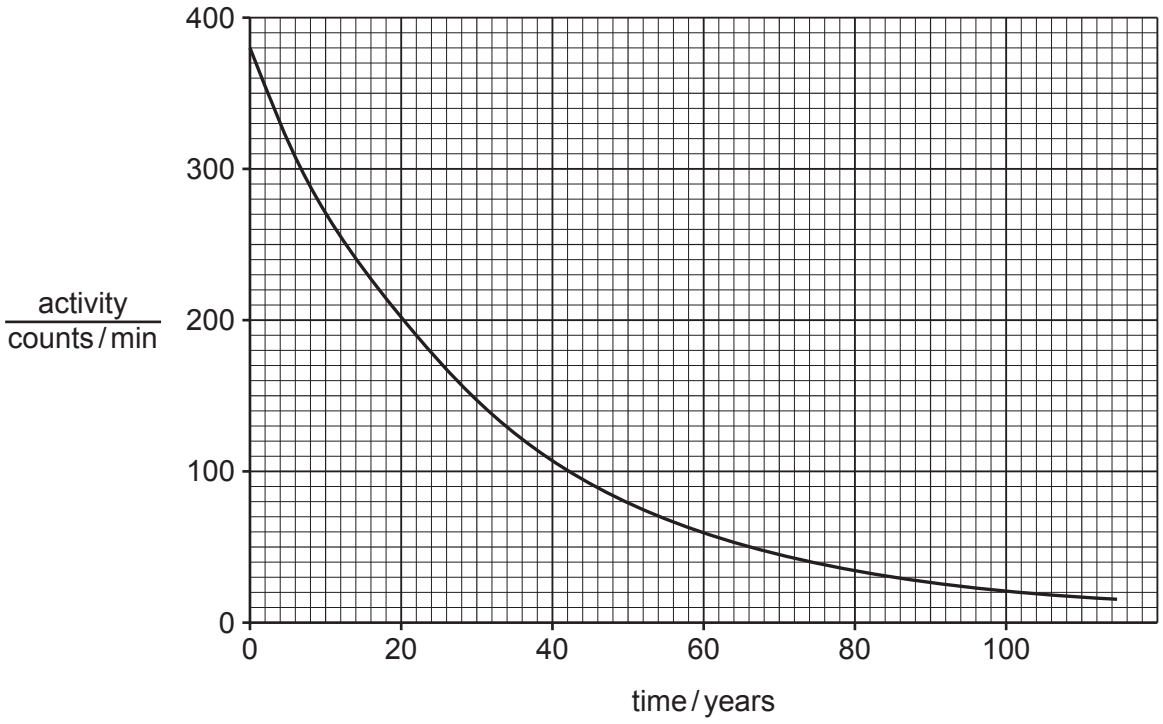


Fig. 12.3

Use Fig. 12.3 to determine the half-life of lead-210.

half-life = ... years [2]

[Total: 10]

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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 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.).