Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8162523375

CO-ORDINATED SCIENCES **0654/32**

Paper 3 Theory (Core) **May/June 2023**

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.

[Turn over

1 **(a)** Fig. 1.1 is a diagram of a flower.

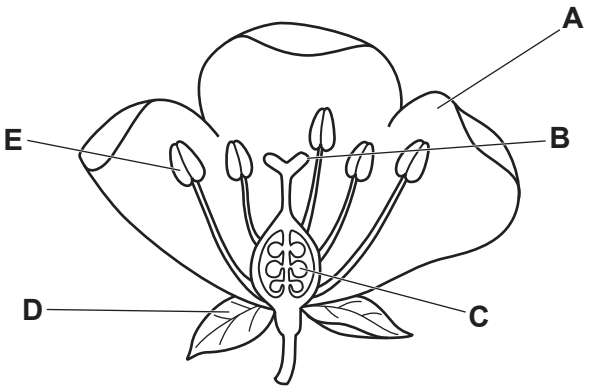


Fig. 1.1

State the letter in Fig. 1.1 that identifies the part:

that attracts insects .....

that produces pollen .....

where fertilisation occurs. .....

[3]

(b) State the name of the part in the human body where fertilisation takes place.

..... [1]

(c) Some plants reproduce both asexually and sexually.

Table 1.1 compares some of the features of asexual reproduction and sexual reproduction.

Place ticks (✓) in the boxes in Table 1.1 to show the correct features of asexual reproduction and sexual reproduction.

Table 1.1

	asexual reproduction	sexual reproduction
involves gametes		
involves inheritance of genetic information		
offspring is genetically identical to the parent		

[2]

(d) Bacteria reproduce by a type of asexual reproduction.

Fig. 1.2 is a diagram of the reproduction of a bacterium.

The original bacterium divides to form two bacteria.

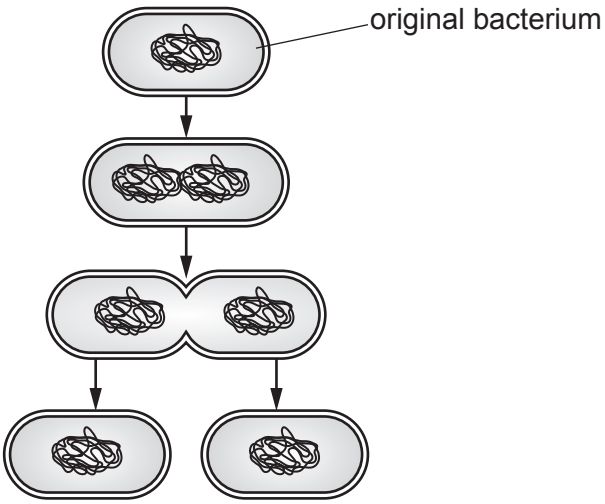


Fig. 1.2

A bacterium can divide every 30 minutes.

Calculate the number of bacteria after 4 hours if you start with one bacterium.

..... [2]

(e) Reproduction is one of the characteristics of living organisms.

State three other characteristics of living organisms.

1 .....

2 .....

3 .....

[3]

[Total: 11]

2 **(a)** The list gives the names of six compounds.

aluminium oxide

ammonium nitrate

carbon dioxide

lead bromide

sodium chloride

sulfur dioxide

Answer the questions about these compounds.

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

State which compound:

(i) has the formula $PbBr_2$.

..... [1]

(ii) is a salt from which ammonia can be displaced.

..... [1]

(iii) is an acidic oxide.

..... [1]

(iv) is a greenhouse gas.

..... [1]

(v) is the main constituent of bauxite.

..... [1]

(b) Aluminium, copper and iron are all solid metals.

State three general **physical** properties of solid metals.

1 .....

2 .....

3 .....

[3]

(c) (i) Duralumin is an alloy of aluminium.

Table 2.1 shows the percentage composition of duralumin.

Table 2.1

metal	percentage by mass in the alloy / %
aluminium	95
copper	4
magnesium	1

Calculate the mass of aluminium in 20 kg of duralumin.

mass of aluminium = ... kg [1]

(ii) Table 2.2 shows the melting points of aluminium, copper, magnesium and duralumin.

Table 2.2

metal	melting point / °C
aluminium	660
copper	1085
magnesium	650
duralumin	550–660

Duralumin does not have a precise melting point but melts over a range of temperatures.

Explain why duralumin does **not** have a precise melting point.

.....

..... [1]

[Total: 10]

3 **(a)** A spacecraft carrying an astronaut travels 384 000 km from the Earth to the Moon in 78 hours.

Calculate the average speed of the spacecraft in km / s.

average speed = ... km / s [3]

(b) The mass of the astronaut on the Earth is 90 kg.

(i) Calculate the weight of the astronaut on the Earth.

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

weight = ... N [2]

(ii) State the mass of the astronaut on the Moon.

mass = ... kg [1]

(c) **(i)** The astronaut communicates with Earth using radio waves.

Fig. 3.1 shows an incomplete electromagnetic spectrum.

Write radio waves in the correct position in Fig. 3.1.

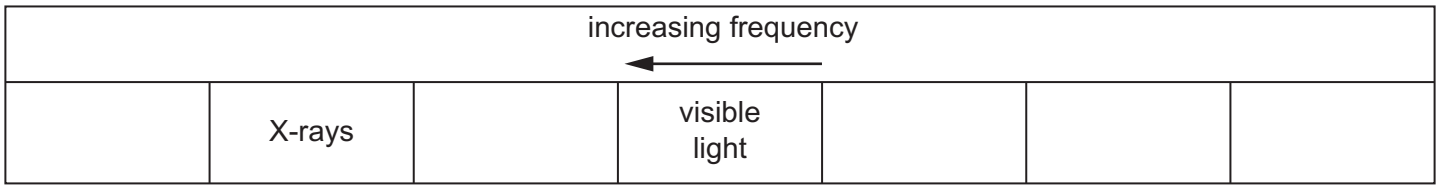


Fig. 3.1

[1]

(ii) Explain why it is **not** possible for the astronaut to communicate with Earth using sound waves.

.....

..... [1]

(d) The astronaut collects a lump of moon rock.

The rock contains iron-60, a radioactive isotope.

(i) State the meaning of the term isotope.

.....

..... [1]

(ii) Iron-60 decays by the emission of β-particles.

Complete the sentences to describe the nature of β-particles.

β-particles are identical in nature to ..... .

β-particles have a single ..... charge.

[2]

[Total: 11]

4 **(a)** The number of new infections of HIV each year in one country is recorded.

Fig. 4.1 is a bar chart of the results.

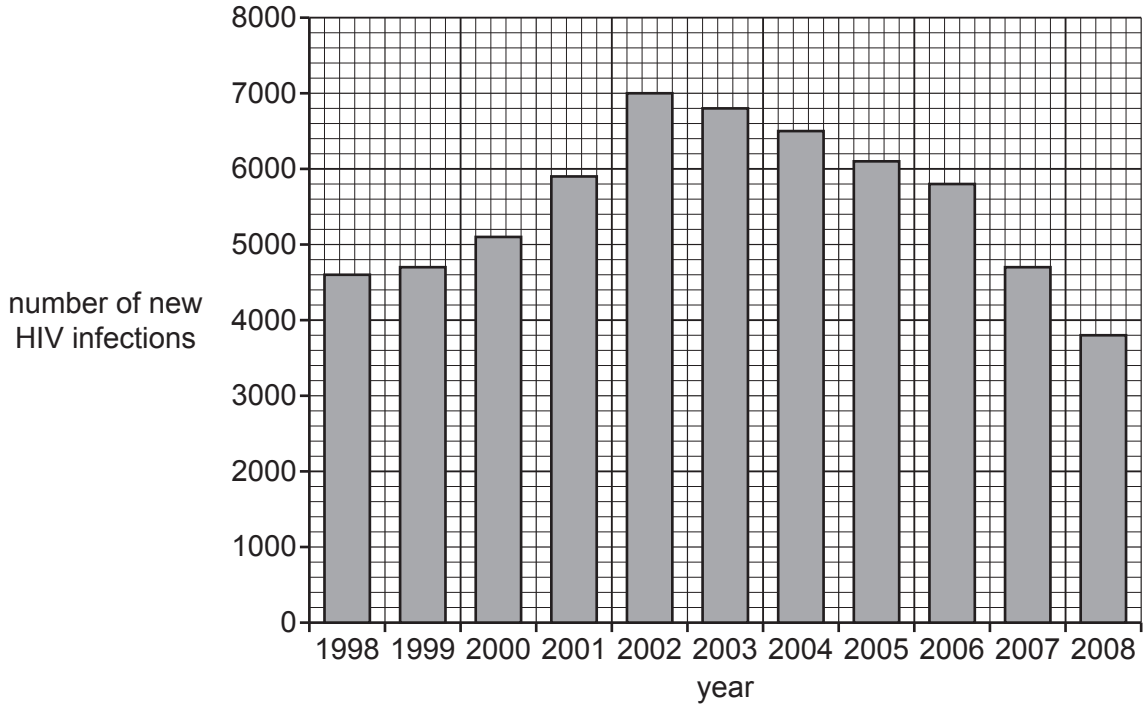


Fig. 4.1

(i) Calculate the percentage increase in cases between 1998 and 2002 shown in Fig. 4.1.

number of new HIV infections in 1998 .....

number of new HIV infections in 2002 .....

percentage increase = ... %

[2]

(ii) Suggest three reasons for the change in the number of new HIV infections between **2002** and **2008** in Fig. 4.1.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

(b) Fig. 4.2 is a photomicrograph of blood.

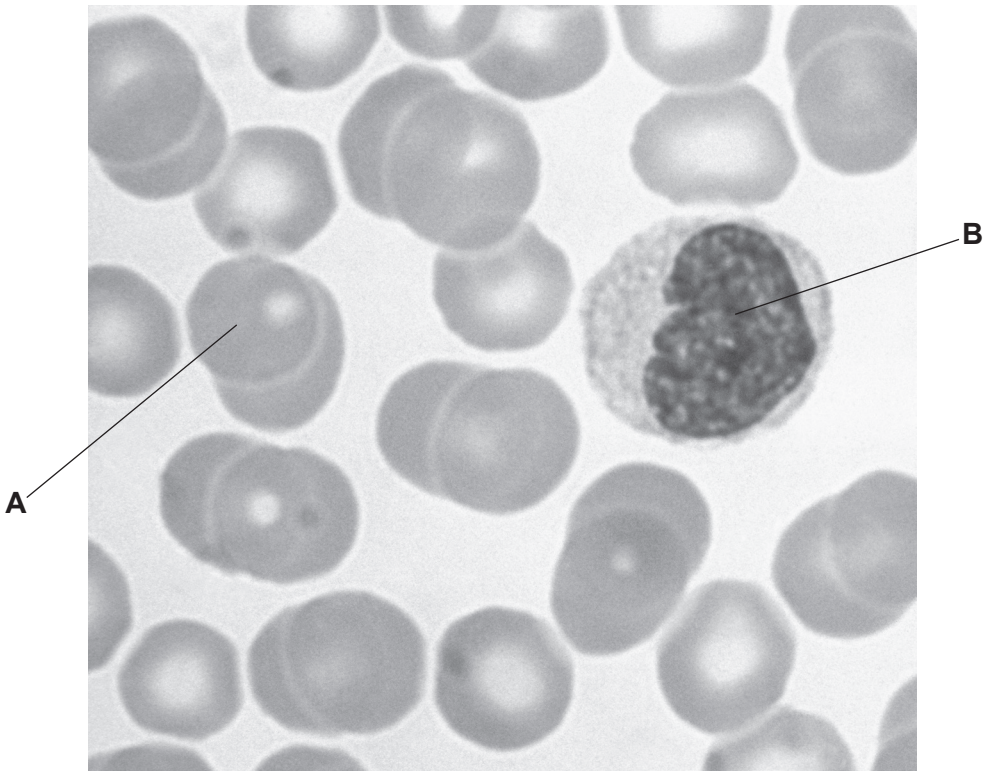


Fig. 4.2

State the names **and** functions of the two types of cells, **A** and **B**, shown in Fig. 4.2.

cell type **A**

name .....

function .....

.....

cell type **B**

name .....

function .....

.....
[4]

(c) State the name of the organ responsible for pumping the blood around the body.

..... [1]

[Total: 10]

5 A sample of clean air is a mixture of oxygen, nitrogen and small quantities of noble gases, water vapour and carbon dioxide.

(a) State the percentage of oxygen gas and nitrogen gas in clean air.

oxygen = ... %

nitrogen = ... %
[2]

(b) State the name of a noble gas and give a use for this noble gas.

name .....

use .....

.....
[2]

(c) Water is made when hydrogen gas reacts with oxygen gas.

Look at the symbol equation for the reaction between hydrogen and oxygen.

This equation is not balanced.

$$H_2 + O_2 \rightarrow H_2O$$

(i) Explain why this equation is **not** balanced.

.....

..... [1]

(ii) Another way that water is made is by the decomposition of hydrogen peroxide, H_2O_2.

Oxygen is also made.

Balance the symbol equation for this reaction.

$$\text{.....}H_2O_2 \rightarrow \text{.....}H_2O + O_2$$
[1]

(iii) Complete the dot-and-cross diagram in Fig. 5.1 to show the bonding in a molecule of water, H_2O.

Show only the outer-shell electrons.

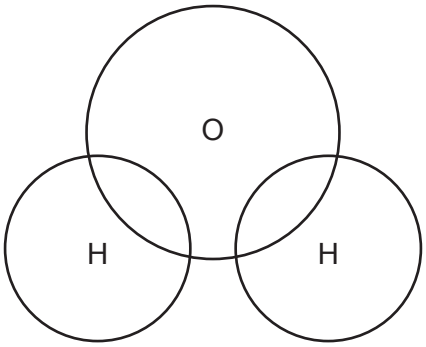


Fig. 5.1

[2]

(iv) Name the type of chemical bonding in a molecule of water.

..... [1]

(v) Describe a chemical test for water and give the positive result.

test .....

positive result .....

.....

[2]

[Total: 11]

6 **(a)** Table 6.1 shows the audible frequency range of five animals.

Table 6.1

animal	highest frequency / Hz	lowest frequency / Hz
bat	200 000	2000
dog	50 000	50
elephant	12 000	5
rat	76 000	200
whale	123 000	1000

(i) State which animal in Table 6.1 can hear a sound with the highest pitch.

..... [1]

(ii) State which animal in Table 6.1 has the smallest audible frequency range.

..... [1]

(iii) State the audible frequency range for a human.

from ..... Hz to ..... Hz [1]

(b) The volume of an elephant is 3.4 m^3.

The average density of the elephant is 1030 kg / m^3.

Calculate the mass of the elephant.

mass = ... kg [2]

(c) The elephant sprays its skin with water and leaves the water to evaporate.

(i) Describe the process of evaporation in terms of water molecules.

.....

.....

..... [2]

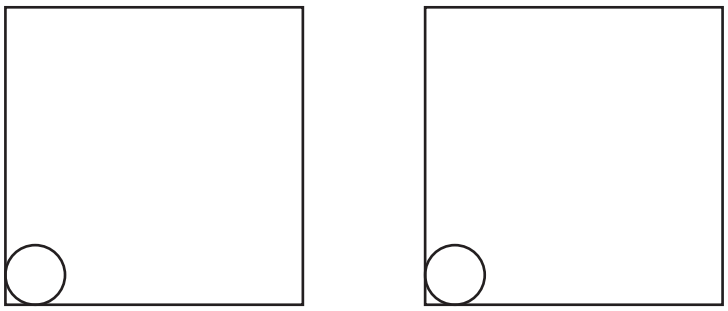
(ii) Suggest why the elephant sprays its skin with water and leaves the water to evaporate.

.....

..... [1]

(iii) During evaporation, liquid water changes state and becomes water vapour, a gas.

Complete the diagrams in Fig. 6.1 to show the arrangement of molecules in liquid water and in water vapour.



liquid water water vapour

Fig. 6.1

[2]

[Total: 10]

7 **(a)** A school investigates variation in one class.

Define the term variation.

.....

..... [1]

(b) A class measures the height of each student.

Table 7.1 shows the results.

Table 7.1

height range / cm	number of students
140.0 – 144.9	2
145.0 – 149.9	5
150.0 – 154.9	8
155.0 – 159.9	6
160.0 – 164.9	3
165.0 – 169.9	1

(i) Identify the **most** frequent height range shown in Table 7.1.

..... cm [1]

(ii) Complete the sentence to describe how Table 7.1 provides evidence that height is an example of continuous variation.

Choose words from the list.

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

genotypes **offspring** **phenotypes**

six **eight** **two**

The results in Table 7.1 show there are a range of .....

between ..... extremes.

[2]

(iii) State **one** example of **discontinuous** variation.

..... [1]

(c) Fig. 7.1 is a photograph of a female lion.

The lion has very sharp, pointed teeth suitable for catching and eating other animals.

Fig. 7.1

(i) State the term used to describe an animal that gets its energy from feeding on other animals.

..... [1]

(ii) Circle the correct words shown in **bold** to complete the sentences to describe how lions may have developed sharp, pointed teeth.

There was a range of different length teeth in the lion population.

The lions with sharp, pointed teeth were better at catching and killing other animals for food.

The lions without sharp, pointed teeth **adapted / died / survived**.

The lions with sharp, pointed teeth passed on their **alleles** / **cells** / **sex** to their offspring.

This occurred over many **days** / **hours** / **generations** until eventually, all the lions had sharp, pointed teeth. [3]

(iii) State the name used to describe the process in **(c)(ii)**.

..... [1]

[Total: 10]

8 **(a)** Fig. 8.1 shows the separation of petroleum into useful fractions.

Only two fractions are shown.

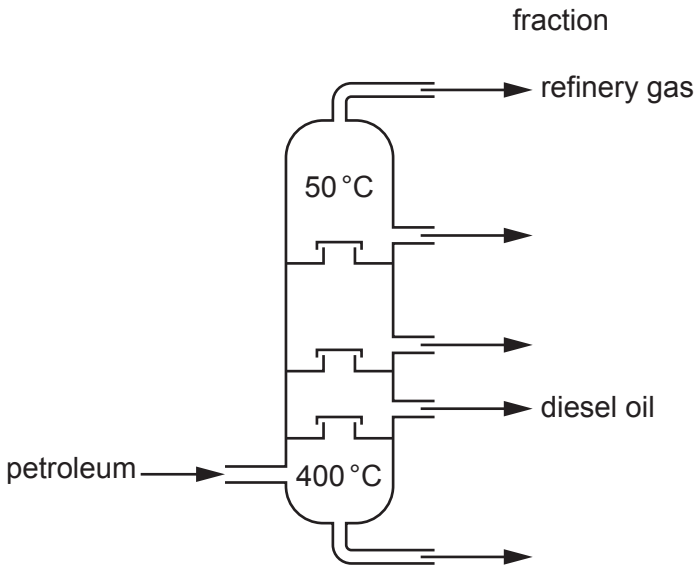


Fig. 8.1

(i) Petroleum is a fossil fuel.

State the name of **one** other fossil fuel.

..... [1]

(ii) State the name of the process shown in Fig. 8.1.

..... [1]

(iii) State the name of **one** fraction **not** shown in Fig. 8.1.

..... [1]

(iv) State **one** use for **each** of the fractions shown in Fig. 8.1.

refinery gas .....

diesel oil .....
[2]

(b) Cracking is a process that produces small alkene molecules from larger alkane molecules.

Ethane is an alkane.

Ethene is an alkene.

Fig. 8.2 shows the structure of ethane, C_2H_6.

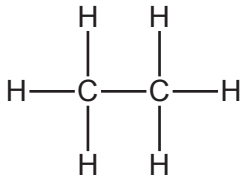


Fig. 8.2

Draw the structure of ethene, C_2H_4.

[2]

(c) Ethene is used to make a polymer.

(i) State the name of the polymer that is made from ethene.

..... [1]

(ii) State the type of polymerisation reaction that makes this polymer from ethene.

..... [1]

[Total: 9]

9 **(a)** Fig. 9.1 shows an electric circuit.

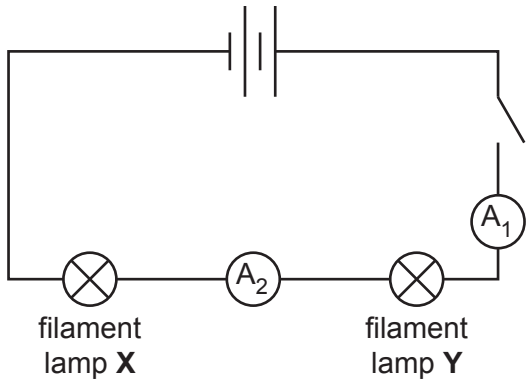


Fig. 9.1

(i) When the switch is closed, ammeter A_2 shows a reading of 0.6A.

State the reading on ammeter A_1.

..... A [1]

(ii) On Fig. 9.1, draw a voltmeter to measure the potential difference across lamp **Y**. [2]

(b) Lamp **X** has a resistance of 2Ω and lamp **Y** has a resistance of 4Ω.

Calculate the potential difference across lamp **Y**.

State the unit of your answer.

potential difference = ... unit ..... [3]

(c) An electric current transfers energy from the battery to the lamps.

(i) State two forms of energy emitted by filament lamps.

1 .....

2 .....
[2]

(ii) State the energy store in the battery (cells) that is decreasing when the circuit is switched on.

..... [1]

[Total: 9]

10 **(a)** Fig. 10.1 is a diagram representing the concentration of oxygen molecules outside and inside a cell.

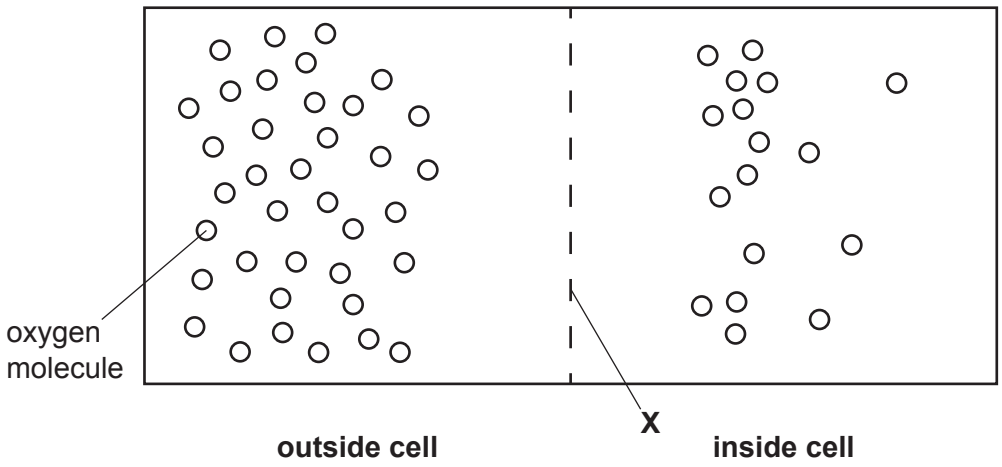


Fig. 10.1

(i) On Fig. 10.1, draw **one** arrow to represent the net movement of oxygen molecules. [1]

(ii) State the name of the part labelled **X** in Fig. 10.1.

..... [1]

(iii) Describe **one** similarity and **one** difference between diffusion and osmosis.

similarity .....

.....

difference .....

.....

[2]

(b) Aerobic respiration requires oxygen and releases energy.

(i) State the two products of aerobic respiration.

1 .....

2 .....

[2]

(ii) Complete these uses of energy in the body of humans.

- ..... contraction
- protein .....
- ..... division

[3]

[Total: 9]

11 (a) (i) An atom of calcium has 20 protons and 20 neutrons.

State the number of electrons in this calcium atom.

..... [1]

(ii) State the number of electrons in one calcium ion, Ca^{2+}.

..... [1]

(b) Limestone (calcium carbonate) and lime (calcium oxide) are both calcium compounds.

Fig. 11.1 shows a limekiln in which calcium carbonate thermally decomposes to make calcium oxide and carbon dioxide.

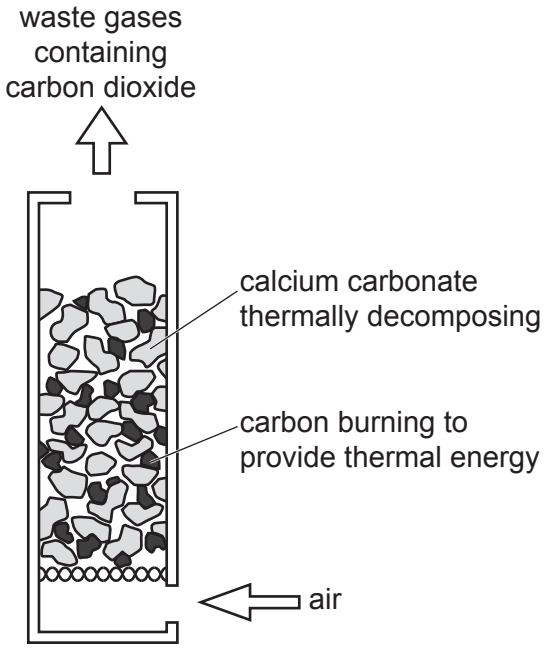


Fig. 11.1

(i) Write the word equation for the thermal decomposition of calcium carbonate.

..... [1]

(ii) The mass of calcium oxide made in this reaction is always less than the mass of calcium carbonate used.

Suggest why.

.....

..... [1]

(iii) The decomposition of calcium carbonate to calcium oxide is an **endothermic** reaction.

State the meaning of the term endothermic.

.....

..... [1]

(iv) One use for limestone is in the production of lime.

State **one** other use of limestone.

.....

..... [1]

(v) Suggest why the calcium carbonate is broken into small pieces before being thermally decomposed.

.....

.....

..... [2]

(c) Calcium carbonate has the formula $CaCO_3$.

(i) State the number of different elements shown in this formula.

..... [1]

(ii) State the total number of atoms shown in this formula.

..... [1]

[Total: 10]

12 (a) An oil tanker is carrying petroleum.

Petroleum is a **non-renewable** energy source.

Identify the energy sources in Table 12.1 as renewable or non-renewable by placing a tick (✓) for each one in the correct column.

One has been done for you.

Table 12.1

energy source	renewable	non-renewable
coal		
hydroelectric (HEP)		
natural gas		
solar	✓	
tidal		

[2]

(b) Fig. 12.1 shows a speed–time graph for the oil tanker.

The graph is divided into sections **P**, **Q**, **R** and **S**.

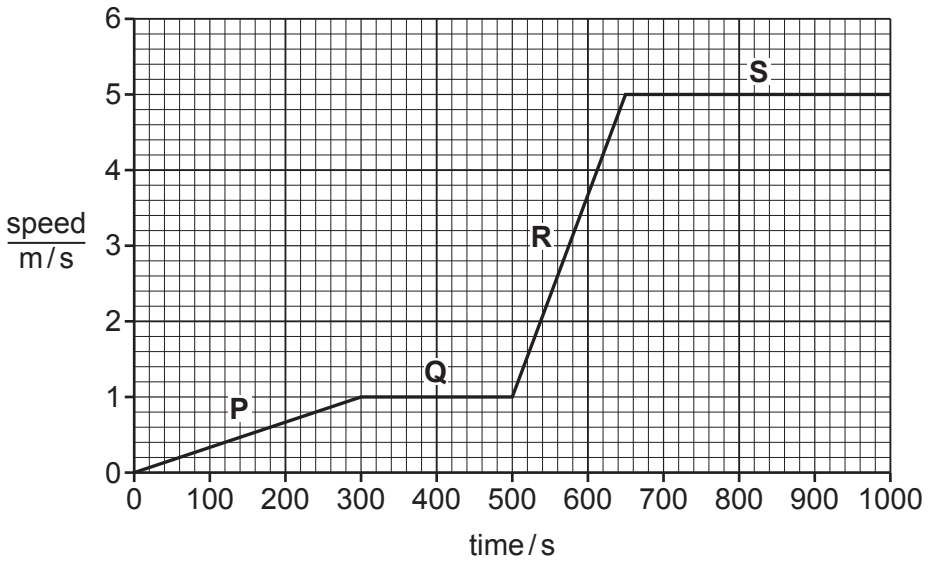


Fig. 12.1

(i) State a section of the graph (**P**, **Q**, **R** or **S**) when the oil tanker is travelling at a constant speed and state this speed.

section .....

speed ..... m/s

[1]

(ii) State the section of the graph (**P**, **Q**, **R** or **S**) when the oil tanker has the greatest acceleration.

Explain your answer.

section .....

explanation .....

.....

[1]

(iii) Calculate the distance travelled by the oil tanker during section **P**.

distance = ... m [2]

(c) The captain of the oil tanker uses a telescope to look at another ship.

The telescope uses a converging lens to focus the light and form an image of the other ship.

Fig. 12.2 shows two parallel light rays passing through a convex lens.

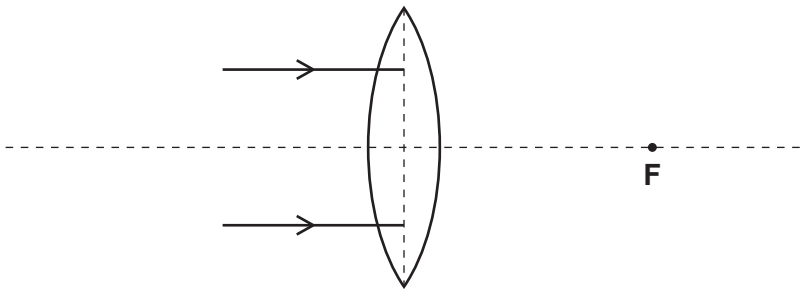


Fig. 12.2

(i) Complete the light rays in Fig. 12.2 to show how the light rays are focused by the lens at point **F**. [1]

(ii) State the name of point **F**.

..... [1]

(d) Fig. 12.3 shows a wave similar to a water wave on the surface of the sea.

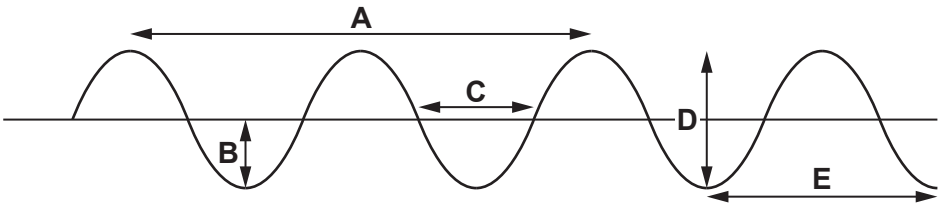


Fig. 12.3

(i) State which letter, **A**, **B**, **C**, **D** or **E**, is the amplitude of the wave.

letter ..... [1]

(ii) State which letter, **A**, **B**, **C**, **D** or **E**, is the wavelength of the wave.

letter ..... [1]

[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.).