



## Cambridge O Level

CANDIDATE  
NAME

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CENTRE  
NUMBER

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NUMBER

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**COMBINED SCIENCE**

**5129/22**

Paper 2

**October/November 2021**

**2 hours 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 100.
- 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 Table 1.1 shows the atomic structure of six different elements **U–Z**.

The letters are not the chemical symbols of the elements.

**Table 1.1**

	<b>U</b>	<b>V</b>	<b>W</b>	<b>X</b>	<b>Y</b>	<b>Z</b>
nucleon number	3	10	14	15	19	23
proton number	2	5	7	7	9	11
total number of electrons	2	5	7	7	9	11

Using the letters in Table 1.1, complete the following sentences.

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

- (a) The element in period 3 of the Periodic Table is ..... [1]
- (b) The element in Group VII of the Periodic Table is ..... [1]
- (c) The element that forms a stable ion with a single negative charge is ..... [1]
- (d) The two atoms that are isotopes of the same element are ..... and ..... [1]
- (e) The atom which does not react with other elements is ..... [1]

[Total: 5]

- 2 Draw **one** straight line to link each part of the male or female reproductive system to the function it carries out.

**part of reproductive system**

**function**

ovary

where fertilisation occurs

uterus

produces sperm

testes

produces liquid to activate sperm

oviduct

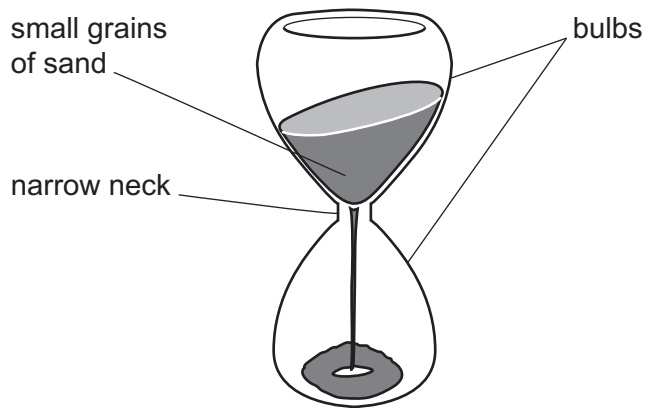
where zygote develops

produces egg cells

[4]

3 Fig. 3.1 shows a piece of apparatus that is used to measure a period of time.

It takes a fixed period of time for all of the grains of sand to fall from the top bulb into the bottom bulb.



**Fig. 3.1**

The grains of sand fall from the top bulb into the bottom bulb through the narrow neck.

(a) Describe how to determine the fixed period of time measured by this apparatus.

.....

.....

.....

..... [3]

(b) The grains of sand have an average diameter of approximately  $6.3 \times 10^{-5}$  m.

Some instruments that can be used to measure length are described in the list:

- a micrometer that measures to the nearest 0.01 mm
- a ruler that measures to the nearest 1 mm
- vernier calipers that measure to the nearest 0.05 mm.

State which instrument from the list is the most suitable to use to measure the diameter of the grains of sand and give a reason for your answer.

instrument .....

reason .....

.....

[2]

[Total: 5]

- 4 Complete the sentences about hydrocarbons and homologous series using words or phrases from the list.

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

**addition**      **chemical**      **carbon dioxide**      **carbon monoxide**  
**double**      **general**      **molecular**      **physical**      **saturated**  
**single**      **substitution**      **unsaturated**

Members of the same homologous series have the same ..... formula and have similar ..... properties.

Alkanes are described as ..... hydrocarbons.

Alkenes undergo ..... reactions because they contain a carbon to carbon ..... bond.

Both alkenes and alkanes burn in a limited supply of oxygen to produce ..... and water.

[6]

- 5 Complete the sentences about dental decay using words from the list.

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

**acid**      **cuticle**      **digestion**      **enamel**  
**ingestion**      **respiration**      **sugar**      **urea**

Dental decay is caused by bacteria in the mouth.

Bacteria use ..... in food as a source of energy.

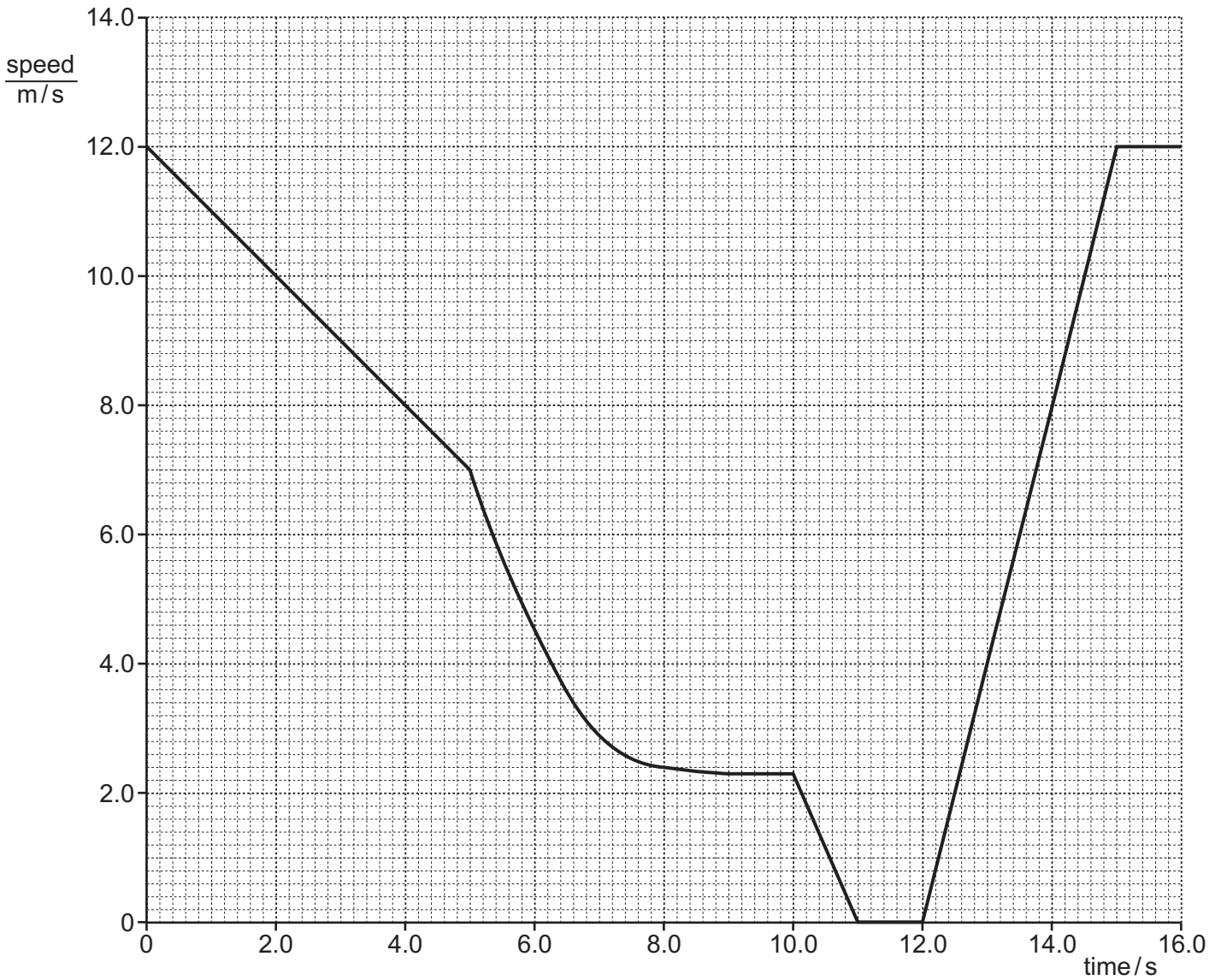
This process is called .....

The bacteria release ..... as a waste product from this process.

This chemical dissolves the ..... of the teeth.

[4]

6 Fig. 6.1 shows the speed–time graph for a car.



**Fig. 6.1**

At 0s, the car is moving at its maximum speed.

The car has a speed of 0m/s between 11.0s and 12.0s.

(a) Use the data in the graph in Fig. 6.1 to describe the change in speed of the car between 0s and 5.0s.

.....  
 ..... [2]

(b) Use Fig. 6.1 to complete these sentences:

Non-constant deceleration occurs between ..... s and ..... s.

The change in speed during this time is ..... m/s.

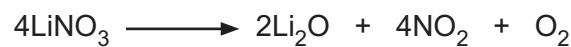
After the car is stationary, it takes ..... s to return to its maximum speed.

[3]

[Total: 5]

7 Lithium nitrate decomposes on heating.

The equation for the reaction is shown.



The relative molecular mass,  $M_r$ , of lithium nitrate is 69.

[ $A_r$ : Li, 7; N, 14; O, 16]

(a) (i) Calculate the relative molecular mass,  $M_r$ , of lithium oxide,  $\text{Li}_2\text{O}$ .

..... [1]

(ii) Complete the following sentences.

276 g of lithium nitrate produces ..... g of lithium oxide

and ..... g of oxygen.

6.9 g of lithium nitrate produces ..... g of lithium oxide.

[3]

(b) Lithium is placed at the top of Group I of the Periodic Table.

(i) Lithium (Li) reacts with chlorine ( $\text{Cl}_2$ ) to produce lithium chloride.

Deduce the balanced equation for the reaction between lithium and chlorine.

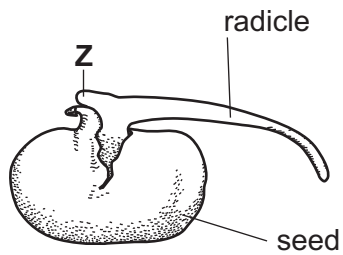
..... [1]

(ii) State the trend in reactivity of the Group I elements with chlorine as the group is descended.

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

[Total: 6]

- 8 Fig. 8.1 shows a seed during the process of germination.  
The young radicle has already emerged.



**Fig. 8.1**

- (a) (i) Name the structure that will develop from **Z** shown on Fig. 8.1.  
..... [1]
- (ii) Name the part of the plant embryo that remains covered by the testa.  
..... [1]
- (b) Seeds need certain environmental conditions before they can germinate.

Some environmental conditions are shown in Table 8.1.

Complete Table 8.1 by placing a tick (✓) against each condition necessary for germination.

**Table 8.1**

environmental condition	necessary for germination
carbon dioxide	
light	
oxygen	
water	

[2]



(c) In an investigation, students examine the effect of pH on the germination of one type of seed.

Their results are shown in Fig. 8.2.

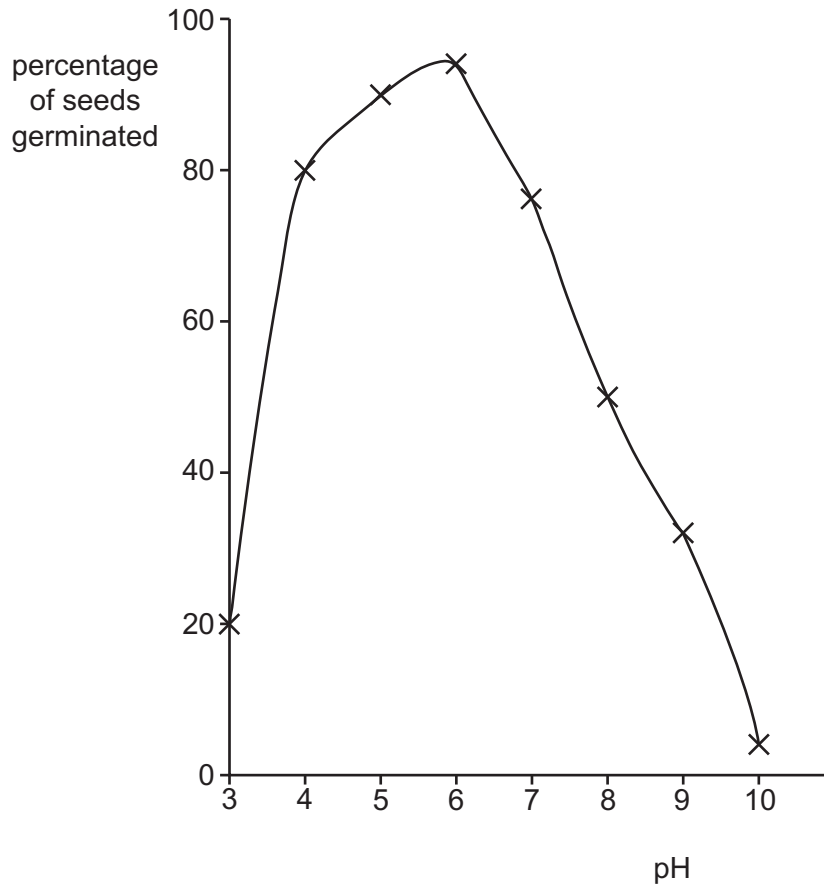


Fig. 8.2

State **two** conclusions that can be drawn from Fig. 8.2 about the effect of pH on the germination of these seeds.

1 .....

.....

2 .....

.....

[2]

(d) Explain why germinated seeds become unhealthy if they cannot obtain nitrogen-containing ions from the soil.

.....

..... [1]

[Total: 7]

9 A mobile is a type of decoration which hangs from a ceiling.

Fig. 9.1 shows part of a mobile.

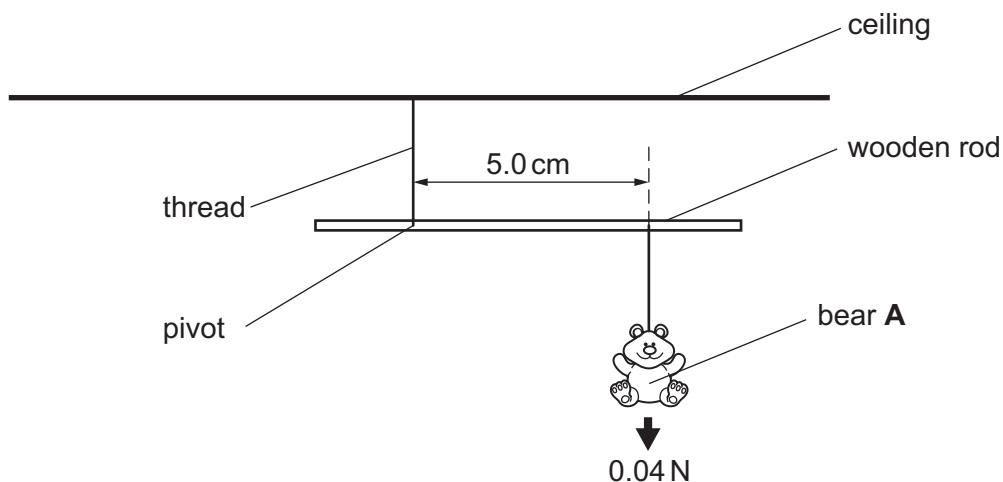


Fig. 9.1

A wooden rod is attached to the ceiling by a piece of thread.

The rod is free to pivot about the point where the thread is attached.

(a) Calculate the moment of bear A about the pivot.

Show your working.

State the unit.

moment = ..... unit ..... [3]

(b) Fig. 9.2 shows the complete mobile.

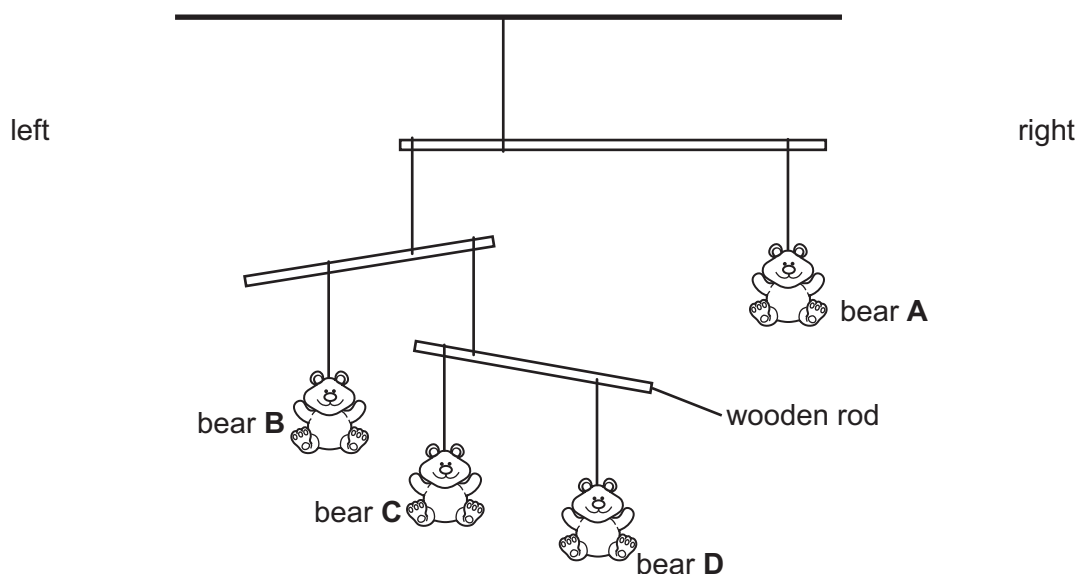


Fig. 9.2

Two of the wooden rods are **not** horizontal.

Put ticks (✓) in Table 9.1 to show which way, if at all, the bears should be moved so that all the wooden rods are horizontal.

**Table 9.1**

bear	stay where it is	move to the left	move to the right
<b>A</b>			
<b>B</b>			
<b>C</b>			
<b>D</b>			

[3]

[Total: 6]

10 Calcium reacts with water to form aqueous calcium hydroxide (limewater).

An aqueous solution of calcium hydroxide has a pH8.

Some reactions of calcium and aqueous calcium hydroxide are shown in Fig. 10.1.

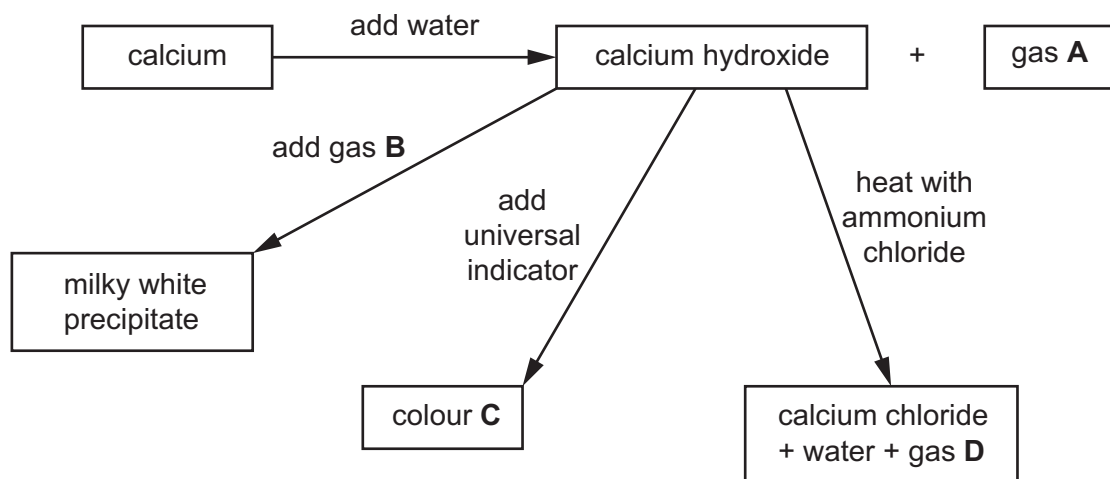


Fig. 10.1

(a) Identify:

gas A .....

gas B .....

colour C .....

gas D. ....

[4]

(b) State the type of bonding in calcium chloride.

Give a reason for your answer.

type of bonding .....

reason .....

.....

[2]

[Total: 6]

11 (a) Table 11.1 contains sentences comparing veins with arteries.

Complete Table 11.1 by placing a tick (✓) in the box next to each sentence which is true.

An example has been done for you.

**Table 11.1**

comparison of veins with arteries	
A vein has less muscle in its wall than an artery.	✓
The lumen (cavity containing blood) is smaller in a vein.	
A vein contains frequent valves.	
Veins carry blood away from the heart.	
Veins usually carry deoxygenated blood.	

[4]

(b) Describe **three** functions of blood capillaries.

- 1 .....
- .....
- 2 .....
- .....
- 3 .....
- .....

[3]

[Total: 7]

12 Table 12.1 shows the resistance of a length of copper wire at different temperatures.

**Table 12.1**

temperature / °C	50	100	150	200
resistance / Ω	1.14	1.37	1.59	1.81

(a) State why a length of copper wire can be used as a thermometer.

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

(b) Estimate the resistance of the wire at 175 °C.

resistance = ..... Ω [1]

(c) The wire is part of an electrical circuit.

State **two** quantities that need to be measured to determine the resistance of the copper wire.

1 .....  
 2 ..... [2]

[Total: 4]

13 The boxes on the left hand side of Fig. 13.1 show some substances.

The boxes on the right hand side show some uses and properties of substances.

Draw **one** line from each substance box to link the substance with its use or property.

substance	use or property
calcium carbonate	contains two elements required for plant growth
copper(II) oxide	used to reduce the acidity of soil
potassium nitrate	reacts with dilute hydrochloric acid to produce a salt and hydrogen only
bromine	turns colourless when reacted with ethene
chlorine	used to make water fit to drink
	reacts with dilute hydrochloric acid to produce a salt and water only

Fig. 13.1

[5]

14 (a) Complete the definition of a drug by inserting appropriate words in the spaces.

A drug is an ..... administered substance which modifies or affects the ..... reactions in the body.

[2]

(b) Alcohol is a drug.

State **two** effects of the long-term excessive consumption of alcohol.

1 .....

.....

2 .....

.....

[2]

(c) The liver is responsible for destroying alcohol in the body.

(i) Suggest how alcohol is transported to the liver.

.....

..... [1]

(ii) State another function carried out by the liver.

.....

..... [1]

[Total: 6]



15 Fig. 15.1 shows the distribution of the positive charges on a metal sphere.

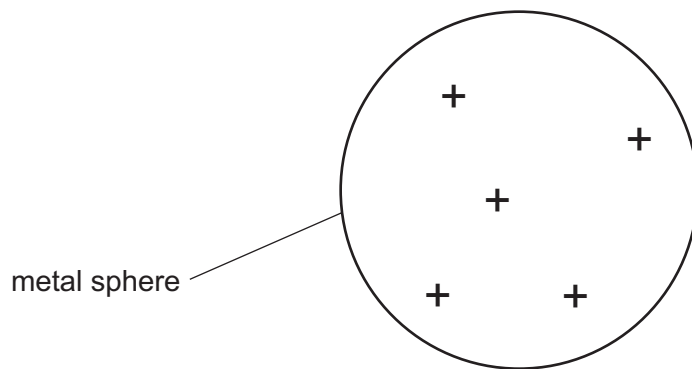


Fig. 15.1

(a) The overall charge on the sphere is neutral.

On Fig. 15.1, draw the negative charges. [2]

(b) A negatively charged rod is placed next to the sphere as shown in Fig. 15.2.

On Fig. 15.2, draw the new arrangement of the negative charges on the sphere. [1]

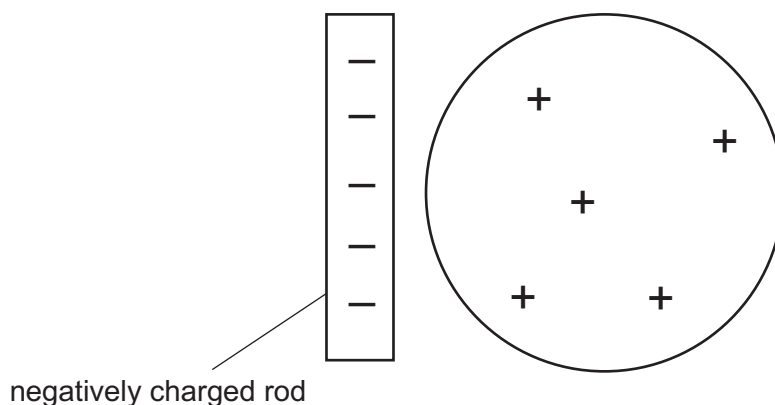


Fig. 15.2

(c) Explain what is meant by the term 'one coulomb per second'.

.....

.....

..... [3]

[Total: 6]

16 The three states of matter are shown in Fig. 16.1.

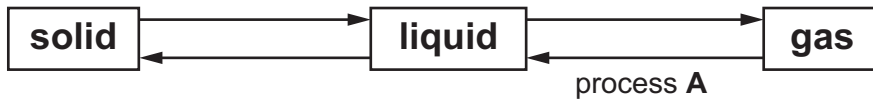


Fig. 16.1

(a) State the name of process A.

..... [1]

(b) Describe how the kinetic energy and the bunching of the particles of a gas change during process A.

.....  
.....  
.....  
..... [2]

[Total: 3]

17 (a) Fig. 17.1 shows a diagram of the alimentary canal.

Name the structures **W**, **X**, **Y** and **Z**.

Write your answers on Fig. 17.1.

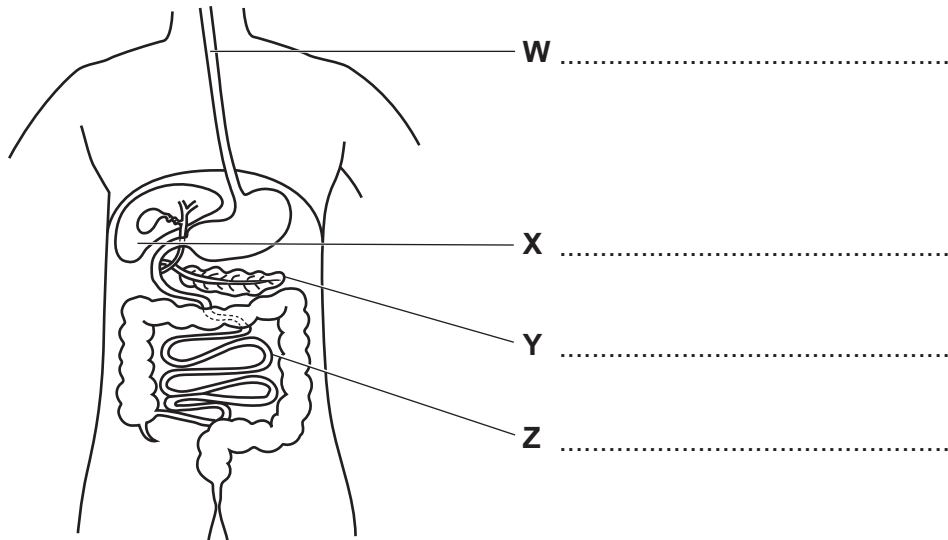


Fig. 17.1

[4]

(b) Describe peristalsis and state its function in digestion.

.....

.....

.....

.....

.....

..... [2]

[Total: 6]

18 The gas carbon dioxide absorbs radiation with a wavelength of  $15 \times 10^{-6} \text{ m}$ .

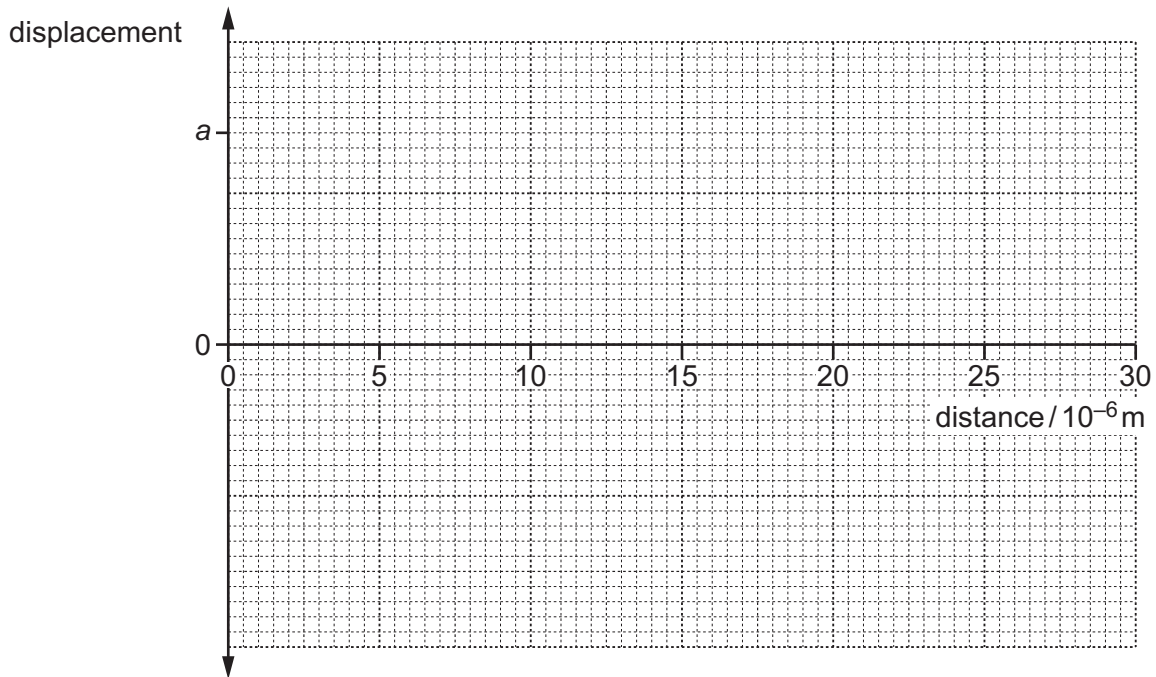


Fig. 18.1

- (a) On Fig. 18.1, draw **one** complete wavelength of this radiation. The amplitude  $a$  is marked for you on the  $y$ -axis. [2]
- (b) Fig. 18.2 shows three types of radiation which make up part of the electromagnetic spectrum.

The range of wavelength of infrared radiation is shown. The regions **P** and **Q** are not drawn to scale.

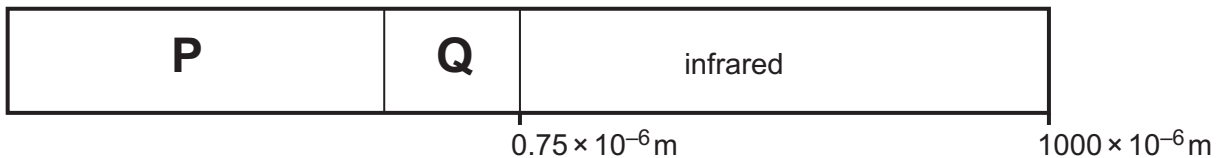


Fig. 18.2

- (i) On Fig. 18.2, draw a vertical line at a wavelength of  $15 \times 10^{-6} \text{ m}$  and label it **W**. [1]
- (ii) Name the type of radiation in regions **P** and **Q**.

**P** .....

**Q** .....

[2]

(c) Suggest the effect on carbon dioxide molecules of absorbing radiation with a wavelength of  $15 \times 10^{-6}$  m.

..... [1]

[Total: 6]

19 The properties of iron can be changed by the controlled use of additives to form different alloys called steels.

Two different types of steel are mild steel and stainless steel.

(a) State **one** use of mild steel.

..... [1]

(b) Stainless steel is used to make cutlery.

Suggest **two** properties of stainless steel that make it better than mild steel for making cutlery.

1 .....

.....

2 .....

.....

[2]

[Total: 3]



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## The Periodic Table of Elements

Group											
I	II	III	IV	V	VI	VII	VIII				
3 <b>Li</b> lithium 7	4 <b>Be</b> beryllium 9	1 <b>H</b> hydrogen 1	5 <b>B</b> boron 11	6 <b>C</b> carbon 12	7 <b>N</b> nitrogen 14	8 <b>O</b> oxygen 16	9 <b>F</b> fluorine 19	10 <b>Ne</b> neon 20			
11 <b>Na</b> sodium 23	12 <b>Mg</b> magnesium 24	<b>Key</b> atomic number atomic symbol name relative atomic mass		13 <b>Al</b> aluminium 27	14 <b>Si</b> silicon 28	15 <b>P</b> phosphorus 31	16 <b>S</b> sulfur 32	17 <b>Cl</b> chlorine 35.5	18 <b>Ar</b> argon 40		
19 <b>K</b> potassium 39	20 <b>Ca</b> calcium 40	25 <b>Mn</b> manganese 55	26 <b>Fe</b> iron 56	27 <b>Co</b> cobalt 59	28 <b>Ni</b> nickel 59	29 <b>Cu</b> copper 64	30 <b>Zn</b> zinc 65	33 <b>As</b> arsenic 75	34 <b>Se</b> selenium 79	35 <b>Br</b> bromine 80	36 <b>Kr</b> krypton 84
37 <b>Rb</b> rubidium 85	38 <b>Sr</b> strontium 88	43 <b>Tc</b> technetium —	44 <b>Ru</b> ruthenium 101	45 <b>Rh</b> rhodium 103	46 <b>Pd</b> palladium 106	47 <b>Ag</b> silver 108	48 <b>Cd</b> cadmium 112	51 <b>Sb</b> antimony 122	52 <b>Te</b> tellurium 128	53 <b>I</b> iodine 127	54 <b>Xe</b> xenon 131
55 <b>Cs</b> caesium 133	56 <b>Ba</b> barium 137	75 <b>Re</b> rhenium 186	76 <b>Os</b> osmium 190	77 <b>Ir</b> iridium 192	78 <b>Pt</b> platinum 195	79 <b>Au</b> gold 197	80 <b>Hg</b> mercury 201	83 <b>Bi</b> bismuth 209	84 <b>Po</b> polonium —	85 <b>At</b> astatine —	86 <b>Rn</b> radon —
87 <b>Fr</b> francium —	88 <b>Ra</b> radium —	107 <b>Bh</b> bohrium —	108 <b>Hs</b> hassium —	109 <b>Mt</b> meitnerium —	110 <b>Ds</b> darmstadtium —	111 <b>Rg</b> roentgenium —	112 <b>Cn</b> copernicium —	114 <b>Fl</b> flerovium —	116 <b>Lv</b> livermorium —	—	—

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

lanthanoids

actinoids

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