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CO-ORDINATED SCIENCES

0654/31

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 **32** pages. Any blank pages are indicated.

1 (a) Fig. 1.1 is a diagram of the alimentary canal and associated organs.

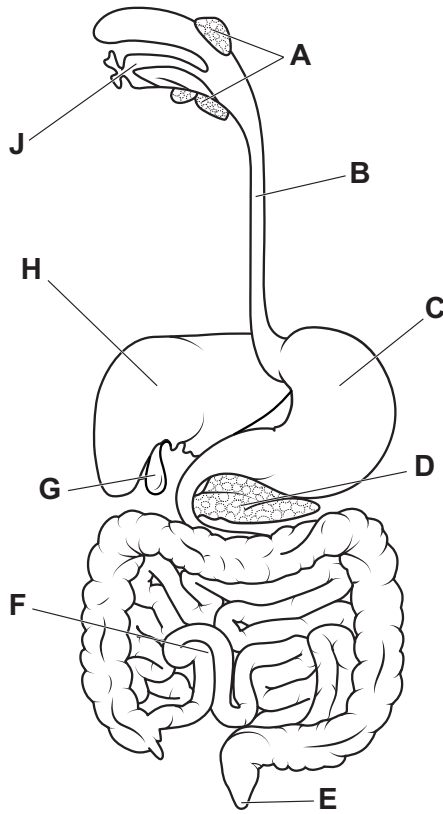


Fig. 1.1

(i) State the letter in Fig. 1.1 that identifies where:

most absorption occurs

egestion occurs

ingestion occurs

saliva is produced.

[4]

(ii) State the names of the parts labelled **D** and **H** in Fig. 1.1.

D

H

[2]

(iii) Complete the sentence to define the term digestion.

Digestion is the of large, insoluble food molecules into small, water-soluble molecules using mechanical and processes.

[2]

(b) The boxes on the left show some nutrients.

The boxes on the right show some principal sources of nutrients.

Draw **one** straight line from each nutrient to its principal source.

nutrient	principal source
carbohydrate	tuna fish
vitamin C	grapefruit
	rice

[2]

(c) Describe the dietary importance of iron.

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

[Total: 11]

2 (a) (i) An iron nail rusts when it is exposed to damp air.

Rusting involves the oxidation of iron.

State what is meant by the term oxidation.

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

(ii) Describe **one** method used to prevent the iron nail from rusting.

Explain how this method prevents the iron nail from rusting.

method

.....

explanation

..... [2]

(b) Complete the sentence.

Metal ores are a finite resource and therefore, metals need to be [1]

(c) Iron is a transition element.

Put a tick (✓) in the boxes next to **all** the correct statements about iron.

- iron acts as a catalyst
- iron forms coloured compounds
- iron has a low density
- iron has a low melting point
- iron is brown in colour

[2]

(d) Steel is an alloy of iron.

(i) Suggest why steel is used for making cars instead of pure iron.

.....
 [1]

(ii) Table 2.1 shows the percentage composition of stainless steel.

Table 2.1

element	percentage by mass in the alloy / %
carbon	1
chromium	18
iron	
manganese	2
molybdenum	2
nickel	12

Calculate the mass of iron contained in 80 kg of stainless steel.

mass of iron = kg [2]

(e) Iron is malleable.

State the meaning of malleable.

.....
 [1]

[Total: 10]

3 (a) (i) Fig. 3.1 shows a skier standing on the snow.



Fig. 3.1

When she stands on the snow without her skis, she sinks into the snow.

When she wears her skis, she can stand on the snow without sinking.

Explain these observations.

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

(ii) The skier makes a sound near a high wall.

The sound travels through the air as a wave.

The skier hears an echo.

State what happens to the sound wave at the high wall to cause an echo to be heard.

..... [1]

- (b) Fig. 3.2 shows the forces acting on the skier on level snow when she is travelling in a snowmobile.

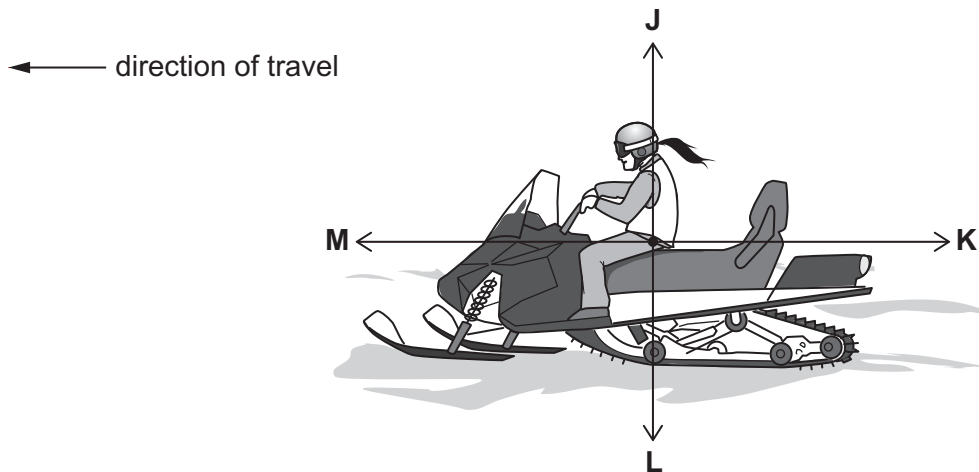


Fig. 3.2

- (i) State which force, **J**, **K**, **L** or **M**, is the weight of the snowmobile and skier.

.....

[1]

- (ii) State which force, **J**, **K**, **L** or **M**, is the friction force acting on the snowmobile.

.....

[1]

(c) Fig. 3.3 shows the speed–time graph for the motion of the skier.

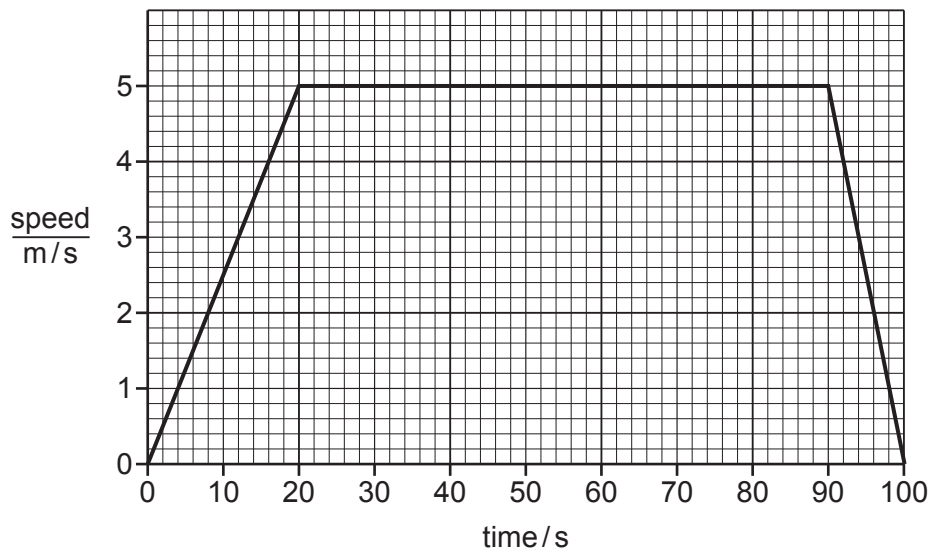


Fig. 3.3

(i) State the maximum speed of the skier.

speed = m/s [1]

(ii) The skier is accelerating during the first 20 s of her journey.

Describe how the graph shows that the skier is accelerating.

.....
 [1]

(iii) Show that the distance travelled by the skier during the first 20 s is 50 m.

[1]

(d) The skier is exposed to ultraviolet radiation from the Sun.

Ultraviolet radiation is a form of ionising radiation.

Describe **one** danger to humans of being exposed to large quantities of ultraviolet radiation.

.....
 [1]

[Total: 9]

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4 (a) Fig. 4.1 shows some different sources of pollution of the water in seas.

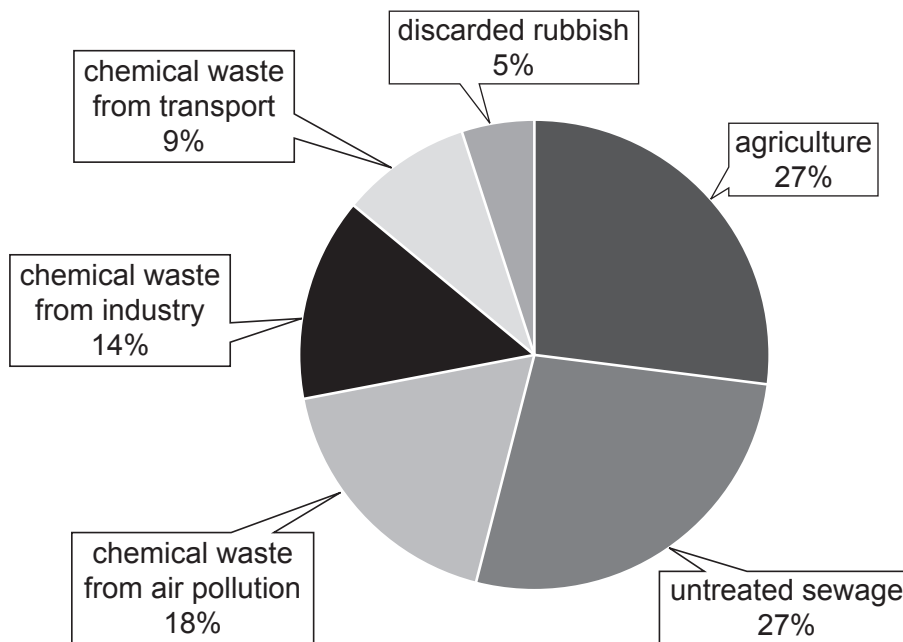


Fig. 4.1

(i) Complete the sentences using information from Fig. 4.1.

The two biggest sources of pollution are and

The total percentage of pollution caused by chemical waste is %.

The percentage of pollution caused by discarded rubbish is %.

[3]

(ii) Suggest **one** negative impact of untreated sewage on humans.

.....

[1]

(b) Polluted water affects the growth of plants.

A scientist measures the height of two pea plants, **A** and **B**, for one month.

Plant **A** is given unpolluted water.

Plant **B** is given polluted water.

Table 4.1 shows the increase in height for each plant.

Table 4.1

plant	type of water	increase in height/cm
A	unpolluted	29
B	polluted	11

(i) Calculate the difference in increase in height between plant **A** and plant **B** from Table 4.1.

..... cm [1]

(ii) Water is needed for germination of seeds.

State two other environmental conditions required for germination.

1

2

[2]

[Total: 7]

5 (a) Substances are separated from mixtures of substances using different methods.

Draw **one** straight line from each substance to the correct method of separating it from the mixture.

One line has been drawn for you.

substance separated from the mixture

method of separation

blue dye from black ink	chromatography
gas oil from petroleum	crystallisation
salt from salt water	distillation
sand from sand and water	filtration
water from salt water	fractional distillation

[3]

(b) One reason for separating mixtures is to purify substances.

Explain the importance of purity in the manufacture of substances used in food additives.

.....
 [1]

(c) The element lead is obtained from the compound lead(II) bromide by electrolysis.

(i) Describe the difference between an element and a compound.

.....
 [1]

(ii) Complete the sentences to describe the electrolysis of lead(II) bromide.

Electrolysis is the breakdown of molten lead(II) bromide

by the passage of

The gas released at the positive electrode is and

..... is formed at the negative electrode.

The negative electrode is called the

[3]

(d) A student reacts dilute hydrochloric acid with four metals.


The student's observations are shown in Table 5.1.

Table 5.1

metal	observation
calcium	reacts very quickly
copper	does not react
lead	reacts very slowly
magnesium	reacts quickly

Place the four metals in order of their reactivity from the most reactive to the least reactive.

..... most reactive
.....
.....
..... least reactive



[2]

[Total: 10]

- 6 (a) (i) Complete the sentences to describe the energy changes that occur during the generation of electricity in a nuclear power station.

Nuclear fission releases energy which heats up water in a boiler.

When the turbine and generator are turning, they have energy.

The generator produces energy. [3]

- (ii) Nuclear fission occurs in the nuclear power station.

State what happens to the nucleus of an atom during nuclear fission.
 [1]

- (b) The radioactive decay of plutonium-239 produces an isotope of uranium, uranium-235.



- (i) State the charge on an α -particle.
 [1]

- (ii) Describe how the numbers of protons and neutrons change in the nucleus of a plutonium-239 atom when it emits an α -particle.

protons
 neutrons [2]

- (iii) The half-life of plutonium-239 is 24 000 years.

A sample of nuclear fuel contains 6.0g of plutonium-239.

Calculate the mass of plutonium-239 remaining after 72 000 years.

mass = g [3]

[Total: 10]

7 (a) Fig. 7.1 is a drawing of a cross-section of a leaf.

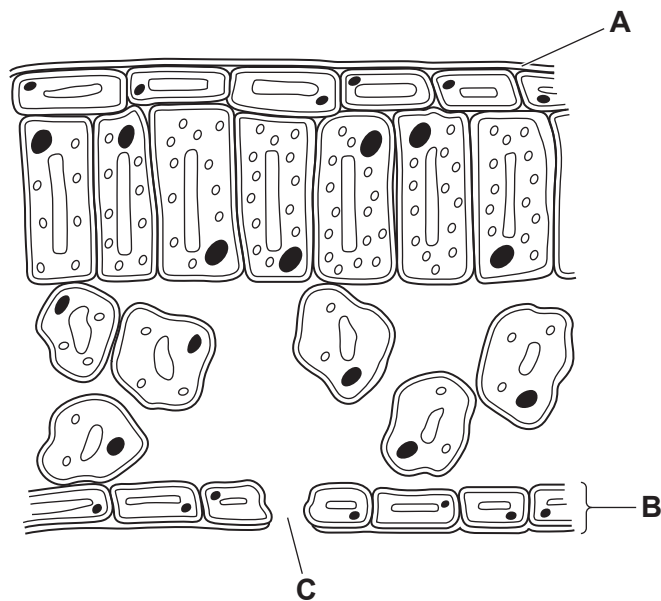


Fig. 7.1

State the names of the parts labelled **A**, **B** and **C** in Fig. 7.1.

- A
- B
- C

[3]

(b) Fig. 7.2 is a cell from the palisade mesophyll layer of the leaf.

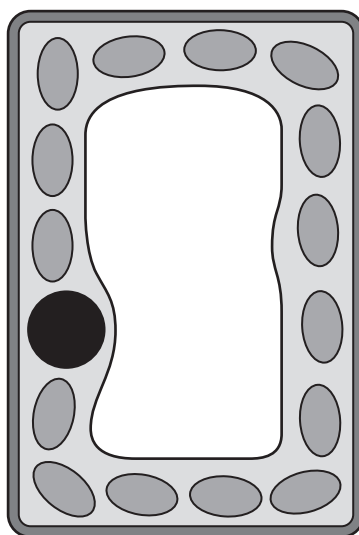


Fig. 7.2

On Fig. 7.2:

- Identify the part where photosynthesis takes place with a label line and the correct name.
- Identify the part that contains the genetic material with a label line and the letter **X**.

[3]

(c) Describe the process of photosynthesis.

.....
.....
.....
.....
..... [3]

(d) Plants need nitrate ions to make an important substance.

Circle the name of this substance.

- amino acid fatty acid starch
- glycogen glycerol

[1]

(e) State the name of the cell that absorbs mineral ions in a plant.

..... [1]

(f) State the name of the vessels that transport mineral ions in the stem.

..... [1]

[Total: 12]

- 8 (a) (i) Complete the dot-and-cross diagram in Fig. 8.1 to show the bonding in a molecule of methane, CH₄.

Show only the outer-shell electrons.

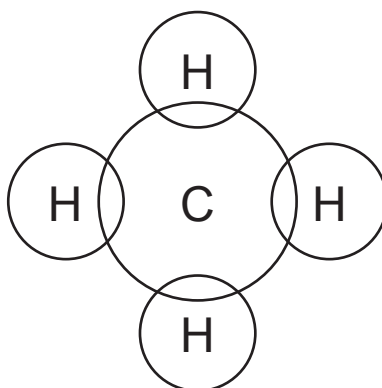


Fig. 8.1

[2]

- (ii) State the name of the type of chemical bonding present in a molecule of methane.

Explain your answer.

type of chemical bonding

explanation

.....

[2]

- (b) Complete the word equation for the complete combustion of methane.

methane + → + [2]

- (c) (i) State the name of the pollutant gas produced during the **incomplete** combustion of methane.

..... [1]

- (ii) State **one** adverse effect of the gas you have named in (c)(i) on the health of humans.

..... [1]

[Total: 8]

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9 Fig. 9.1 shows a washing machine.

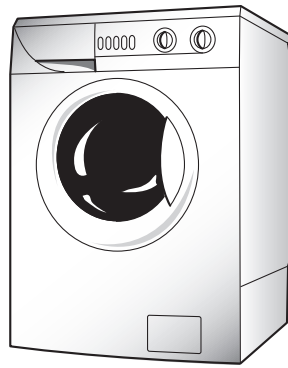



Fig. 9.1

(a) (i) The washing machine uses:

- a heater to heat the water
- a motor to pump the hot water through the machine.

The motor and the heater are connected in a parallel circuit.

The motor and the heater are each operated by separate switches.

The circuit symbol for a heater is 


The circuit symbol for a motor is 

Fig. 9.2 shows an incomplete circuit diagram for the washing machine.

Complete the circuit diagram on Fig. 9.2.

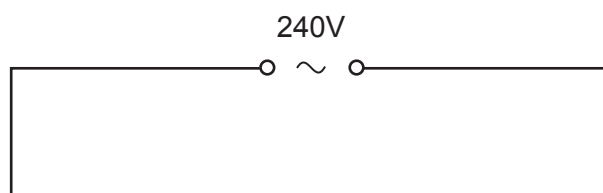


Fig. 9.2

[3]

- (ii) The resistance of the heater is $20\ \Omega$.

The resistance of the motor is $80\ \Omega$.

Identify from the list the most likely value for the combined resistance of the heater and motor connected in parallel.

Explain your answer.

16 Ω 20 Ω 50 Ω 80 Ω 100 Ω

combined resistance = Ω

explanation

..... [2]

- (iii) The current in the wires of the electrical circuit is a flow of charged particles.

State the name of the particles that flow in the wires of the electrical circuit.

..... [1]

- (iv) The current-carrying coil in the motor experiences a turning effect.

This turning effect can be increased by increasing the number of turns on the coil.

State two other ways to **increase** this turning effect.

1

2

[2]

(b) Inside the washing machine, some of the water evaporates.

During evaporation, water changes state from a liquid to a gas.

(i) Complete the diagrams in Fig. 9.3 to show the arrangement and separation of molecules in a liquid and in a gas.

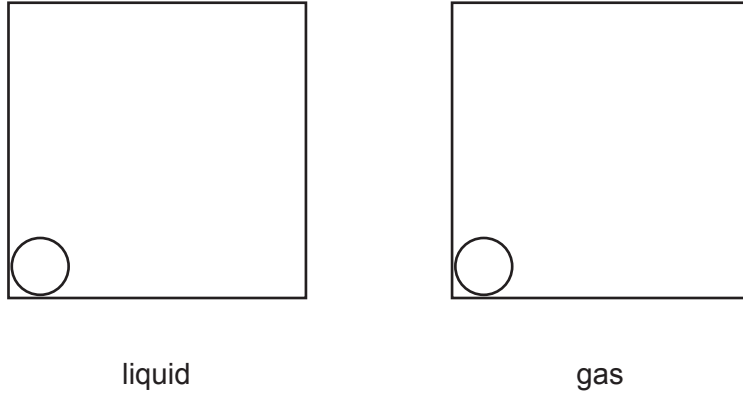


Fig. 9.3

[2]

(ii) During evaporation, the water does not boil.

State the boiling point of water.

..... °C [1]

[Total: 11]

10 (a) A person touches a hot pan and instantly removes their hand.

This is a reflex action.

The reflex arc is shown in Fig. 10.1.

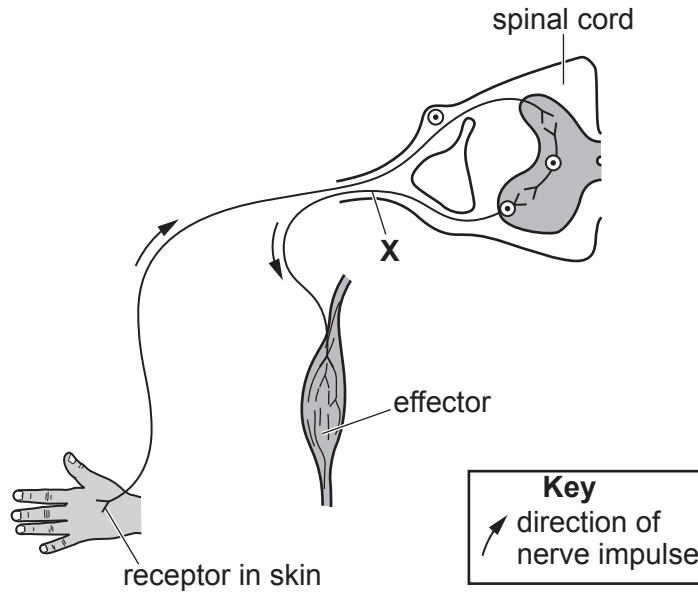


Fig. 10.1

(i) State the names of the stimulus and the effector in this reflex arc.

stimulus

effector

[2]

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

..... [1]

(iii) The spinal cord is one part of the central nervous system.

State the name of the other part of the central nervous system.

..... [1]

(b) Neurones are the longest cells in the body.

One neurone measures 1.5 m in length.

One plant cell measures 0.1 mm in length.

Calculate how many times longer the neurone is than the plant cell.

..... [2]

(c) Hormones and nerve impulses both carry information around the body.

Identify if each statement is about **hormones** or **nerve impulses**.

They are carried in the blood.

They are produced by glands.

They are electrical signals.

[2]

(d) Adrenaline is a hormone released in 'fight or flight' situations.

Describe two effects of adrenaline on the body.

1

2

[2]

[Total: 10]

11 (a) Limestone is insoluble in water.

Limestone is mixed with water and poured through filter paper.

(i) Explain how filter paper separates limestone from water.

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

(ii) The filtrate is tested to find its pH number.

One way of finding the pH number is to use a pH meter.

Describe **one** other way to find the pH number of the filtrate.

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

(b) Limestone is sometimes added to soil to reduce soil acidity.

Limestone is mainly calcium carbonate which reacts with acid.

(i) This soil treatment adds carbon dioxide to the atmosphere.

State **one** other reason why the amount of carbon dioxide in the atmosphere is increasing.

..... [1]

(ii) Describe how an increase in carbon dioxide in the atmosphere affects the environment.

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

- (c) A student investigates the rate of reaction between excess dilute hydrochloric acid and a piece of limestone.

Fig. 11.1 shows the apparatus used.

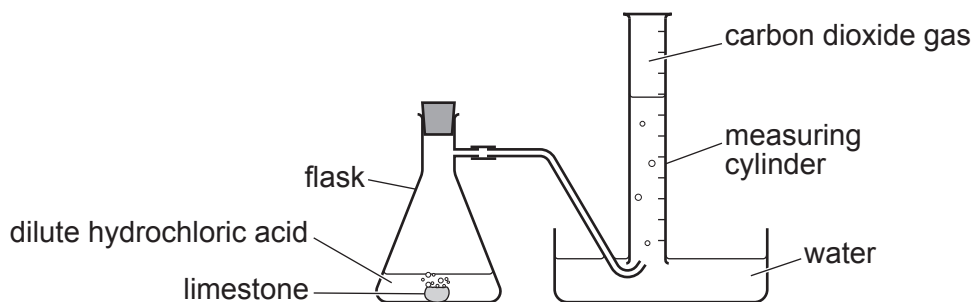


Fig. 11.1

The student measures the volume of carbon dioxide in the measuring cylinder every 20 seconds for 280 seconds.

A graph of the student's results is shown in Fig. 11.2.

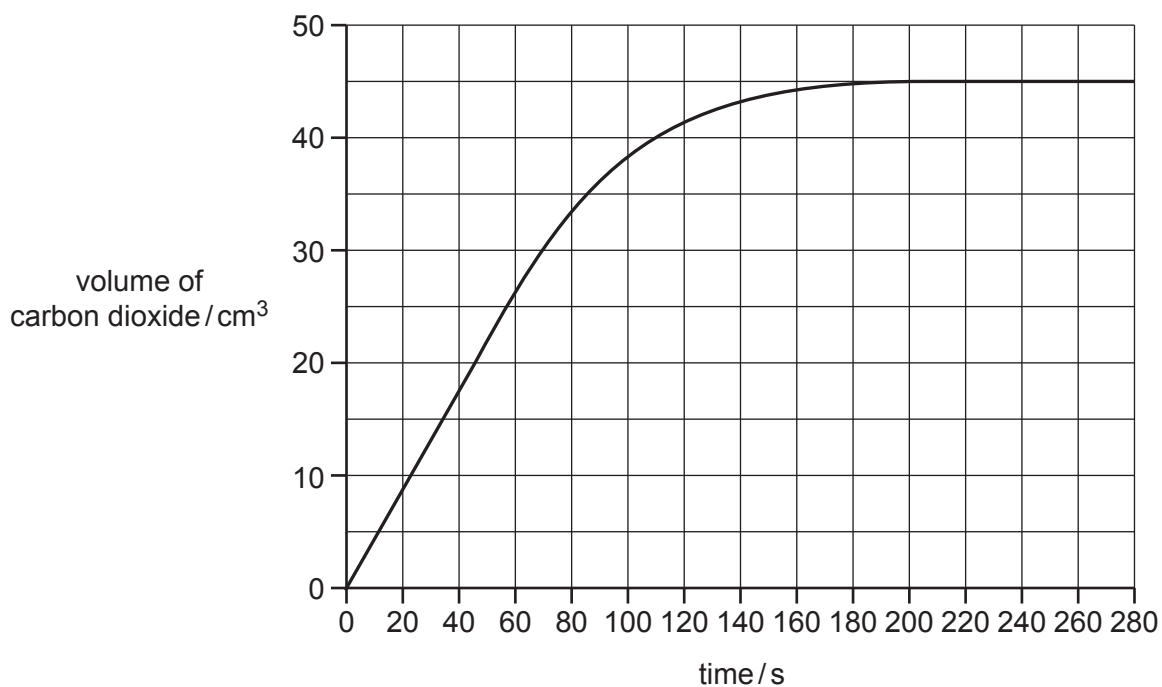


Fig. 11.2

- (i) Use Fig. 11.2 to find the total volume of carbon dioxide released.

volume = cm³ [1]

- (ii) Use Fig. 11.2 to find the time when the reaction finished.

time = s [1]

- (iii) The student repeats the experiment at a **higher** temperature.

On Fig. 11.2, sketch a line to show the results.

[2]

(iv) Increasing the temperature increases the rate of reaction.

State two other ways the student can increase the rate of the reaction.

1

2

[2]

[Total: 12]

12 (a) The mass of the Sun is 1.97×10^{30} kg.

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

Calculate the volume of the Sun.

volume = m^3 [2]

(b) The Sun is made of very hot gas.

(i) Suggest the main method of thermal energy transfer from the inside of the Sun to the surface of the Sun.

..... [1]

(ii) State the main method of energy transfer that occurs when infrared waves travel from the Sun to the Earth through space.

..... [1]

(iii) Sound energy is produced by the Sun.

Explain why we are unable to hear this sound on Earth.

.....
 [1]

(c) (i) Fig. 12.1 shows an incomplete electromagnetic spectrum.

Write infrared radiation in its correct place.

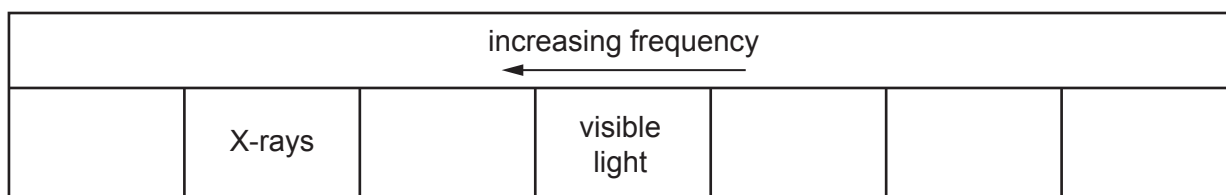


Fig. 12.1

[1]

(ii) State the electromagnetic radiation which has the highest frequency.

..... [1]

(iii) Explain why it takes the same time for infrared and visible light to travel from the Sun to the Earth.

..... [1]

(d) Fig. 12.2 shows a sound wave.

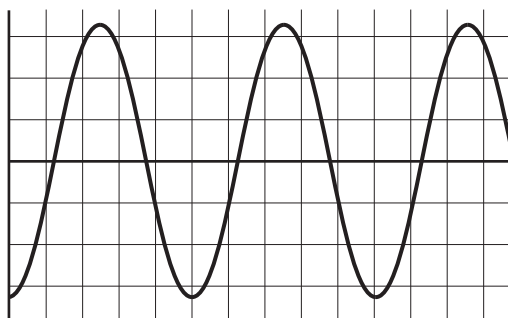


Fig. 12.2

- (i) On Fig. 12.2, label the amplitude of the wave with a double-headed arrow (\leftrightarrow) or (\updownarrow) and the letter **A**. [1]
- (ii) On Fig. 12.2, label the wavelength of one wave with a double-headed arrow (\leftrightarrow) or (\updownarrow) and the letter **W**. [1]

[Total: 10]

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The Periodic Table of Elements

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11 Na sodium 23	12 Mg magnesium 24																	1 H hydrogen 1	5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20	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 —	113 Nh nihonium —	114 Fl flerovium —	115 Mc moscovium —	116 Lv livermorium —	117 Ts tennessine —	118 Og oganeson —	119 Uu ununium —	120 Uub ununium —	121 Uut ununium —	122 Uuq ununium —	123 Uuq ununium —	124 Uub ununium —	125 Uut ununium —	126 Uuq ununium —	127 Uub ununium —	128 Uut ununium —	129 Uuq ununium —	130 Uub ununium —	131 Uut ununium —	132 Uuq ununium —	133 Uub ununium —	134 Uut ununium —	135 Uuq ununium —	136 Uub ununium —	137 Uut ununium —	138 Uuq ununium —	139 Uub ununium —	140 Uut ununium —	141 Uuq ununium —	142 Uub ununium —	143 Uut ununium —	144 Uuq ununium —	145 Uub ununium —	146 Uut ununium —	147 Uuq ununium —	148 Uub ununium —	149 Uut ununium —	150 Uuq ununium —	151 Uub ununium —	152 Uut ununium —	153 Uuq ununium —	154 Uub ununium —	155 Uut ununium —	156 Uuq ununium —	157 Uub ununium —	158 Uut ununium —	159 Uuq ununium —	160 Uub ununium —	161 Uut ununium —	162 Uuq ununium —	163 Uub ununium —	164 Uut ununium —	165 Uuq ununium —	166 Uub ununium —	167 Uut ununium —	168 Uuq ununium —	169 Uub ununium —	170 Uut ununium —	171 Uuq ununium —	172 Uub ununium —	173 Uut ununium —	174 Uuq ununium —	175 Uub ununium —	176 Uut ununium —	177 Uuq ununium —	178 Uub ununium —	179 Uut ununium —	180 Uuq ununium —	181 Uub ununium —	182 Uut ununium —	183 Uuq ununium —	184 Uub ununium —	185 Uut ununium —	186 Uuq ununium —	187 Uub ununium —	188 Uut ununium —	189 Uuq ununium —	190 Uub ununium —	191 Uut ununium —	192 Uuq ununium —	193 Uub ununium —	194 Uut ununium —	195 Uuq ununium —	196 Uub ununium —	197 Uut ununium —	198 Uuq ununium —	199 Uub ununium —	200 Uut ununium —	201 Uuq ununium —	202 Uub ununium —	203 Uut ununium —	204 Uuq ununium —	205 Uub ununium —	206 Uut ununium —	207 Uuq ununium —	208 Uub ununium —	209 Uut ununium —	210 Uuq ununium —	211 Uub ununium —	212 Uut ununium —	213 Uuq ununium —	214 Uub ununium —	215 Uut ununium —	216 Uuq ununium —	217 Uub ununium —	218 Uut ununium —	219 Uuq ununium —	220 Uub ununium —	221 Uut ununium —	222 Uuq ununium —	223 Uub ununium —	224 Uut ununium —	225 Uuq ununium —	226 Uub ununium —	227 Uut ununium —	228 Uuq ununium —	229 Uub ununium —	230 Uut ununium —	231 Uuq ununium —	232 Uub ununium —	233 Uut ununium —	234 Uuq ununium —	235 Uub ununium —	236 Uut ununium —	237 Uuq ununium —	238 Uub ununium —	239 Uut ununium —	240 Uuq ununium —	241 Uub ununium —	242 Uut ununium —	243 Uuq ununium —	244 Uub ununium —	245 Uut ununium —	246 Uuq ununium —	247 Uub ununium —	248 Uut ununium —	249 Uuq ununium —	250 Uub ununium —	251 Uut ununium —	252 Uuq ununium —	253 Uub ununium —	254 Uut ununium —	255 Uuq ununium —	256 Uub ununium —	257 Uut ununium —	258 Uuq ununium —	259 Uub ununium —	260 Uut ununium —	261 Uuq ununium —	262 Uub ununium —	263 Uut ununium —	264 Uuq ununium —	265 Uub ununium —	266 Uut ununium —	267 Uuq ununium —	268 Uub ununium —	269 Uut ununium —	270 Uuq ununium —	271 Uub ununium —	272 Uut ununium —	273 Uuq ununium —	274 Uub ununium —	275 Uut ununium —	276 Uuq ununium —	277 Uub ununium —	278 Uut ununium —	279 Uuq ununium —	280 Uub ununium —	281 Uut ununium —	282 Uuq ununium —	283 Uub ununium —	284 Uut ununium —	285 Uuq ununium —	286 Uub ununium —	287 Uut ununium —	288 Uuq ununium —	289 Uub ununium —	290 Uut ununium —	291 Uuq ununium —	292 Uub ununium —	293 Uut ununium —	294 Uuq ununium —	295 Uub ununium —	296 Uut ununium —	297 Uuq ununium —	298 Uub ununium —	299 Uut ununium —	300 Uuq ununium —	301 Uub ununium —	302 Uut ununium —	303 Uuq ununium —	304 Uub ununium —	305 Uut ununium —	306 Uuq ununium —	307 Uub ununium —	308 Uut ununium —	309 Uuq ununium —	310 Uub ununium —	311 Uut ununium —	312 Uuq ununium —	313 Uub ununium —	314 Uut ununium —	315 Uuq ununium —	316 Uub ununium —	317 Uut ununium —	318 Uuq ununium —	319 Uub ununium —	320 Uut ununium —	321 Uuq ununium —	322 Uub ununium —	323 Uut ununium —	324 Uuq ununium —	325 Uub ununium —	326 Uut ununium —	327 Uuq ununium —	328 Uub ununium —	329 Uut ununium —	330 Uuq ununium —	331 Uub ununium —	332 Uut ununium —	333 Uuq ununium —	334 Uub ununium —	335 Uut ununium —	336 Uuq ununium —	337 Uub ununium —	338 Uut ununium —	339 Uuq ununium —	340 Uub ununium —	341 Uut ununium —	342 Uuq ununium —	343 Uub ununium —	344 Uut ununium —	345 Uuq ununium —	346 Uub ununium —	347 Uut ununium —	348 Uuq ununium —	349 Uub ununium —	350 Uut ununium —	351 Uuq ununium —	352 Uub ununium —	353 Uut ununium —	354 Uuq ununium —	355 Uub ununium —	356 Uut ununium —	357 Uuq ununium —	358 Uub ununium —	359 Uut ununium —	360 Uuq ununium —	361 Uub ununium —	362 Uut ununium —	363 Uuq ununium —	364 Uub ununium —	365 Uut ununium —	366 Uuq ununium —	367 Uub ununium —	368 Uut ununium —	369 Uuq ununium —	370 Uub ununium —	371 Uut ununium —	372 Uuq ununium —	373 Uub ununium —	374 Uut ununium —	375 Uuq ununium —	376 Uub ununium —	377 Uut ununium —	378 Uuq ununium —	379 Uub ununium —	380 Uut ununium —	381 Uuq ununium —	382 Uub ununium —	383 Uut ununium —	384 Uuq ununium —	385 Uub ununium —	386 Uut ununium —	387 Uuq ununium —	388 Uub ununium —	389 Uut ununium —	390 Uuq ununium —	391 Uub ununium —	392 Uut ununium —	393 Uuq ununium —	394 Uub ununium —	395 Uut ununium —	396 Uuq ununium —	397 Uub ununium —	398 Uut ununium —	399 Uuq ununium —	400 Uub ununium —	401 Uut ununium —	402 Uuq ununium —	403 Uub ununium —	404 Uut ununium —	405 Uuq ununium —	406 Uub ununium —	407 Uut ununium —	408 Uuq ununium —	409 Uub ununium —	410 Uut ununium —	411 Uuq ununium —	412 Uub ununium —	413 Uut ununium —	414 Uuq ununium —	415 Uub ununium —	416 Uut ununium —	417 Uuq ununium —	418 Uub ununium —	419 Uut ununium —	420 Uuq ununium —	421 Uub ununium —	422 Uut ununium —	423 Uuq ununium —	424 Uub ununium —	425 Uut ununium —	426 Uuq ununium —	427 Uub ununium —	428 Uut ununium —	429 Uuq ununium —	430 Uub ununium —	431 Uut ununium —	432 Uuq ununium —	433 Uub ununium —	434 Uut ununium —	435 Uuq ununium —	436 Uub ununium —	437 Uut ununium —	438 Uuq ununium —	439 Uub ununium —	440 Uut ununium —	441 Uuq ununium —	442 Uub ununium —	443 Uut ununium —	444 Uuq ununium —	445 Uub ununium —	446 Uut ununium —	447 Uuq ununium —	448 Uub ununium —	449 Uut ununium —	450 Uuq ununium —	451 Uub ununium —	452 Uut ununium —	453 Uuq ununium —	454 Uub ununium —	455 Uut ununium —	456 Uuq ununium —	457 Uub ununium —	458 Uut ununium —	459 Uuq ununium —	460 Uub ununium —	461 Uut ununium —	462 Uuq ununium —	463 Uub ununium —	464 Uut ununium —	465 Uuq ununium —	466 Uub ununium —	467 Uut ununium —	468 Uuq ununium —	469 Uub ununium —	470 Uut ununium —	471 Uuq ununium —	472 Uub ununium —	473 Uut ununium —	474 Uuq ununium —	475 Uub ununium —	476 Uut ununium —	477 Uuq ununium —	478 Uub ununium —	479 Uut ununium —	480 Uuq ununium —	481 Uub ununium —	482 Uut ununium —	483 Uuq ununium —	484 Uub ununium —

lanthanoids

actinoids

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).