Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6493574332

CO-ORDINATED SCIENCES **0654/43**

Paper 4 Theory (Extended) **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.

[Turn over

1 **(a)** Fig. 1.1 is a diagram of parts of a tooth.

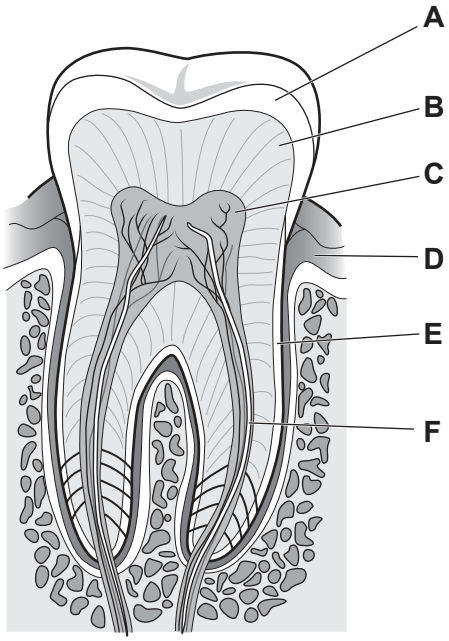


Fig. 1.1

(i) State the letters from Fig. 1.1 that identify **two** parts that are dissolved by acid during dental decay.

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

(ii) State the letter from Fig. 1.1 that identifies part of the nervous system.

..... [1]

(iii) State the type of organism that causes dental decay.

..... [1]

(iv) State the names of two different types of human teeth.

1 .....

2 .....
[2]

(b) Table 1.1 shows some information about deficiency of some of the components in the diet.

Complete Table 1.1.

Table 1.1

component	effect of deficiency in the diet
protein	causes the disease .....
.....	causes the disease scurvy
fibre	causes .....
.....	develop weak bones or rickets

[4]

(c) One risk factor for coronary heart disease is an unhealthy diet.

State two other risk factors for coronary heart disease.

1 .....

2 .....

[2]

[Total: 12]

2 A student investigates the reaction between calcium carbonate, $CaCO_3$, and dilute hydrochloric acid, HCl.

Calcium chloride, $CaCl_2$, water and carbon dioxide are made.

(a) Construct the balanced symbol equation for this reaction.

..... [2]

(b) Describe the test for carbon dioxide. Include the observation for a positive result.

test .....

result .....
[2]

(c) Fig. 2.1 shows the apparatus used.

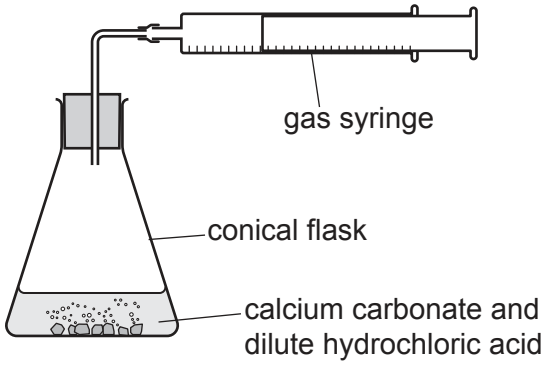


Fig. 2.1

The student does the experiment at five different temperatures.

Table 2.1 shows the results of the experiment.

Table 2.1

temperature / °C	21	32	40	48	59
time to collect 50 cm^3 of gas / s	131	66	42	24	13

(i) State the temperature when the reaction is **fastest**.

temperature = ... °C [1]

(ii) Describe the relationship between the temperature and the **rate** of the reaction.

.....

..... [1]

(d) The student does the experiment again at 21 °C.

They use the same amounts of calcium carbonate and dilute hydrochloric acid.

This time they use hydrochloric acid that is **more concentrated**.

The reaction is faster than when using dilute hydrochloric acid.

Explain why.

Use ideas about collisions between particles in your answer.

.....

.....

..... [2]

(e) Fig. 2.2 shows the energy level diagrams for two different reactions, **A** and **B**.

Reaction **A** and reaction **B** are done under the same conditions.

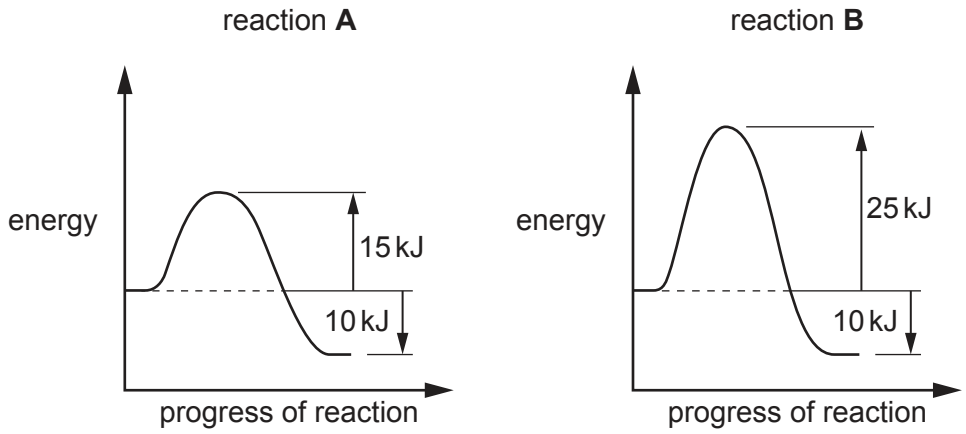


Fig. 2.2

Reaction **A** happens faster than reaction **B**.

Explain why.

Use information from Fig. 2.2 in your answer.

.....

.....

..... [2]

[Total: 10]

3 Fig. 3.1 shows an iceberg floating in the sea.

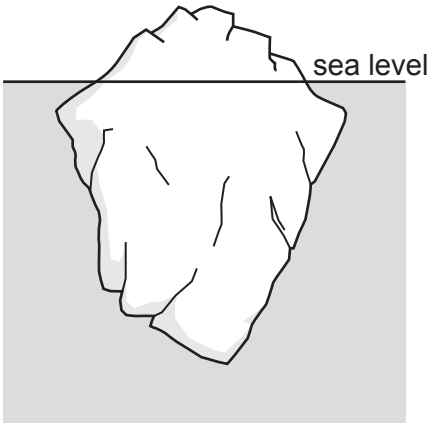


Fig. 3.1

(a) The density of the iceberg is 920 kg / m^3 and the volume of the iceberg is 2×10^5 m^3.

Calculate the mass of the iceberg.

mass = ... kg [2]

(b) **(i)** Some samples of ice are taken from the iceberg so that a scientist can study what happens when the samples melt.

The scientist records the masses of three pieces of ice.

The pieces of ice are placed on top of blocks made of different materials.

The blocks are the same shape and size and are placed in a warm room so that they are all at the same temperature.

Fig. 3.2 shows the materials used.

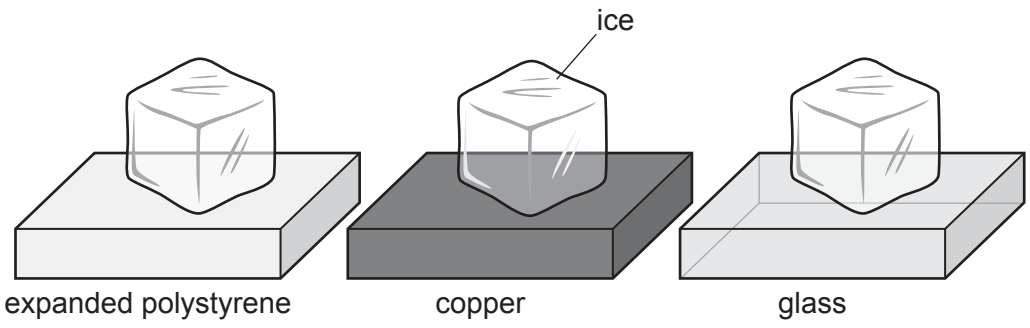


Fig. 3.2

After 5 minutes, the mass of each piece of solid ice remaining is measured.

Table 3.1 shows the scientist's results.

Table 3.1

material used	initial mass / g	mass after 5 minutes / g
expanded polystyrene	8.18	6.14
copper	8.20	4.08
glass	8.17	4.82

Use Fig. 3.2 and Table 3.1 to describe **and** explain the results of the scientist's investigation.

description

.....

.....

.....

explanation

.....

.....

.....

.....

[3]

(ii) Liquid water can be boiled to produce steam.

Describe the process of boiling in terms of the:

- forces between molecules
- distances between molecules
- motion of molecules.

forces between molecules

.....

.....

distances between molecules

.....

.....

motion of molecules

.....

.....

[3]

[Total: 8]

4 **(a)** Fig. 4.1 is a graph showing the effect of temperature on the rate of transpiration in one leaf.

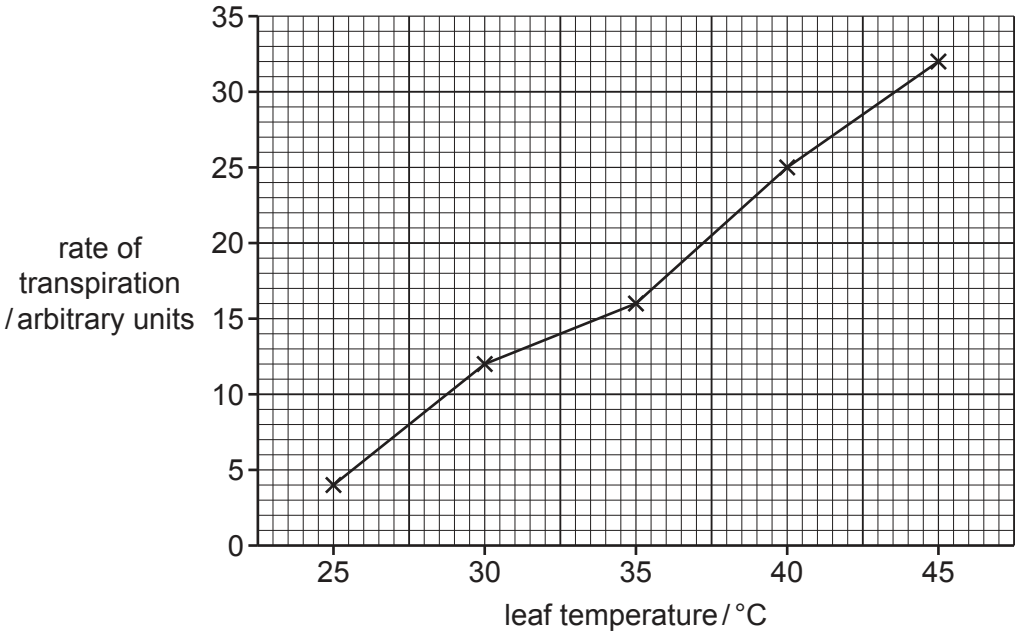


Fig. 4.1

(i) Complete the sentences to describe **and** explain the results shown in Fig. 4.1.

As the leaf temperature increases, the rate of transpiration increases.

Higher leaf temperatures result in increased ..... of water at the surfaces of the mesophyll cells.

This causes an increase in the rate water vapour ..... out of the leaf.

Water vapour is lost from the leaf through ..... in the lower epidermis.

[3]

(ii) The investigation is repeated at a greater humidity.

Draw a line on Fig. 4.1 to show the effect of greater humidity on the results. [1]

(b) Xylem vessels transport water to the leaves.

(i) Explain the mechanism that causes the movement of water up the xylem.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) State **one** other function of xylem apart from transport.

..... [1]

(c) State the names of two substances that are **only** transported in phloem.

1 .....

2 .....
[2]

[Total: 10]

5 Lithium, sodium and potassium are metals in Group I of the Periodic Table.

(a) Describe the trend in reactivity of the Group I elements **down** the group.

..... [1]

(b) Table 5.1 shows some information about Group I elements.

Complete Table 5.1 by predicting the melting point of potassium and the density of rubidium.

Use ideas about trends down the group to help you.

Table 5.1

element	melting point / °C	density / g / cm^3
lithium	181	0.53
sodium	98	0.97
potassium	.....	0.89
rubidium	39	.....
caesium	28	1.93

[2]

(c) State the colour of the flame when sodium burns in oxygen.

Tick (✓) **one** box.

blue ☐

lilac ☐

red ☐

yellow ☐

[1]

(d) Potassium reacts with water.

Potassium hydroxide solution and hydrogen are made.

Complete the balanced equation for the reaction.

Include state symbols.

$2K(s) + 2H_2O(l) \rightarrow$ ..... (.....) + ... (.....) [3]

(e) Chlorine and bromine are elements in Group VII of the Periodic Table.

Chlorine displaces bromine from aqueous sodium bromide.

$$Cl_2 + 2NaBr \rightarrow Br_2 + 2NaCl$$

Explain why this is an example of a **redox** reaction.

.....

.....

..... [2]

(f) State which of the following is the electronic structure of an element in Group VIII (Group 0).

Tick (✓) **one** box.

2.2 ☐

2.8.2 ☐

2.8.4 ☐

2.8.8 ☐

[1]

[Total: 10]

6 Fig. 6.1 shows wind turbines used to generate electricity.

Fig. 6.1

(a) Fig. 6.2 shows how the power output of one wind turbine changes with wind speed.

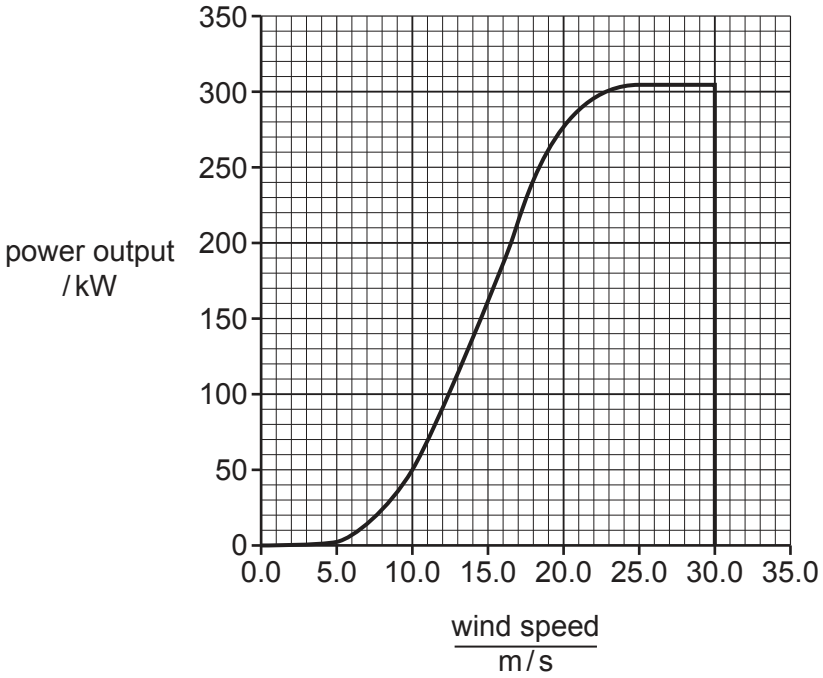


Fig. 6.2

On one particular day, the wind speed is 10 m / s.

Calculate the energy generated by one wind turbine in 1 hour (3600 seconds).

energy = ... J [3]

(b) The wind turbine uses a generator to produce electricity.

Fig. 6.3 shows a simple a.c. generator.

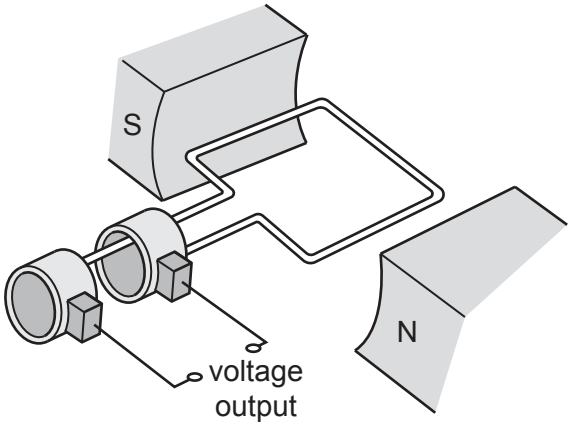


Fig. 6.3

(i) Describe how a simple a.c. generator produces a voltage output.

.....

.....

.....

.....

.....

..... [3]

(ii) On Fig. 6.4, sketch a graph of voltage output against time for a simple a.c. generator rotating with a constant speed.

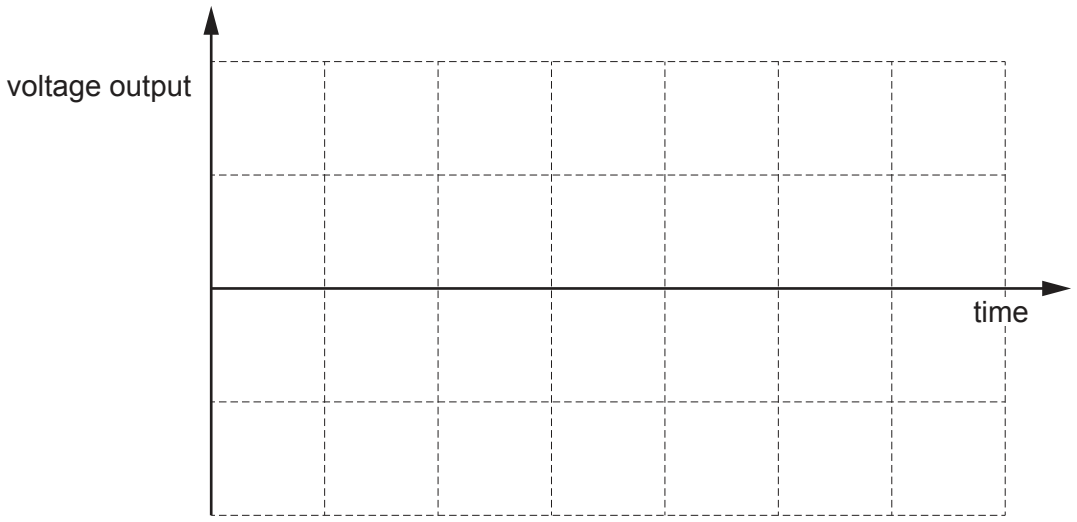


Fig. 6.4

[2]

(c) Turbines and generators can also be used to convert the kinetic energy of tidal water into electrical energy.

(i) The efficiency of a tidal generator is 80% when the tidal water moves at 5.0 m / s.

Calculate the mass of water which would need to pass through the tidal generator to produce 1400 J of electrical energy from kinetic energy.

mass = ... kg [3]

(ii) State **one** advantage of using tidal generators to produce electricity instead of traditional fossil fuel power stations.

.....

..... [1]

[Total: 12]

7 **(a)** Albinism is an inherited condition that results in no pigments being made in the skin.

The allele for albinism is recessive **a**.

The allele for no albinism is dominant **A**.

Fig. 7.1 is a pedigree chart diagram of albinism in one family.

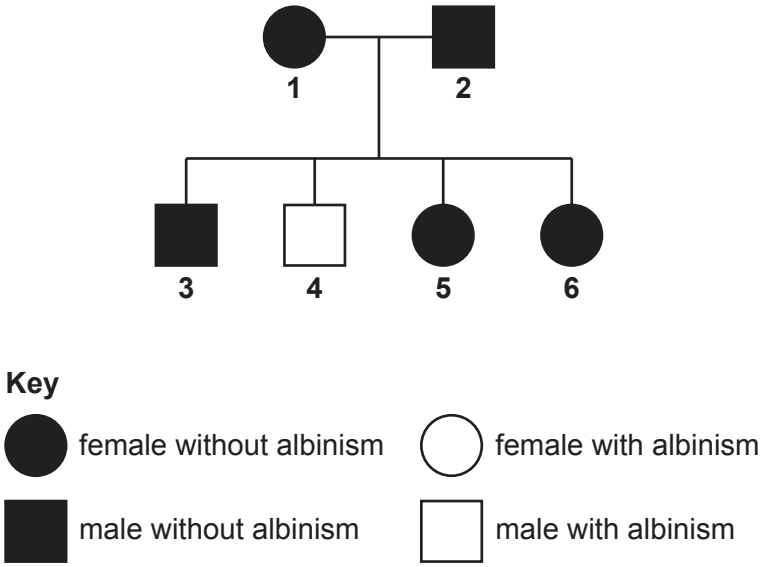


Fig. 7.1

(i) Use the information in Fig. 7.1 to state:

the genotype of person **4** .....

the genotype of person **1** .....

the sex chromosomes of person **5**. .....

[3]

(ii) A couple without albinism decides to have a child.

Complete the genetic diagram in Fig. 7.2 to calculate the percentage chance of having a child with albinism.

		parental gametes	
		A	**a**
parental gametes	**A**		
	a		

Fig. 7.2

percentage chance of child having albinism = ...% [2]

(b) Mitosis and meiosis are two forms of cell division.

(i) State two roles of **mitosis**.

1 .....

2 .....
[2]

(ii) State the name of **one** organ in the human body where **meiosis** occurs.

..... [1]

(iii) An organism has 32 chromosomes.

State the number of chromosomes in a cell formed by **meiosis** in this organism.

..... [1]

[Total: 9]

8 **(a)** Petroleum is separated into different fractions.

Fig. 8.1 shows the percentage composition of fractions from a sample of petroleum.

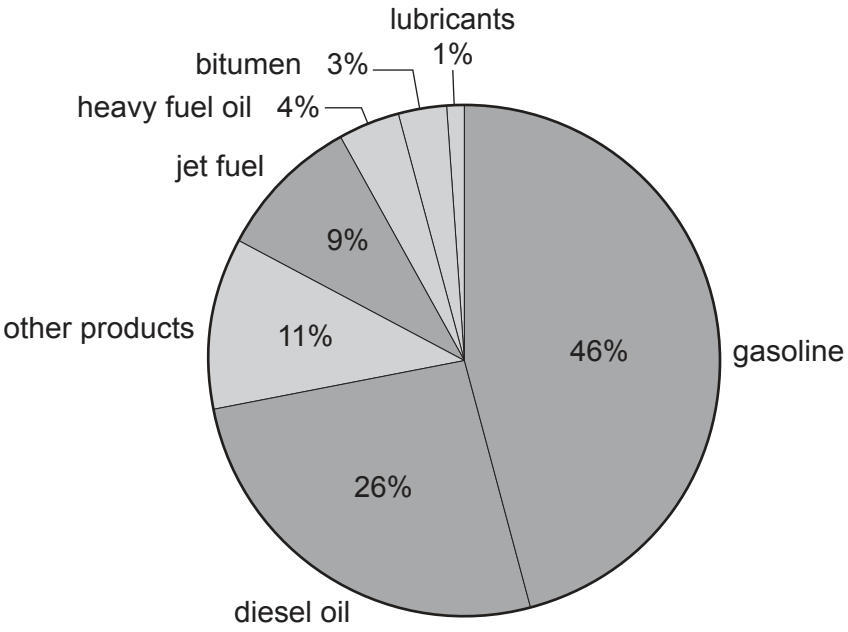


Fig. 8.1

(i) State **one** use of bitumen.

..... [1]

(ii) 225 kg of the sample of petroleum is placed into a barrel.

Calculate the mass of diesel oil, in kilograms, in this barrel.

mass of diesel oil = ... kg [2]

(b) Petroleum is separated into different fractions by fractional distillation.

Describe how petroleum is separated by fractional distillation.

.....

.....

.....

.....

..... [3]

(c) Diesel oil, gasoline and other fuels made from petroleum naturally contain some sulfur impurities.

Suggest why sulfur impurities are removed from these fuels before the fuels are used.

.....

..... [1]

(d) Gasoline used in cars causes air pollution by producing oxides of nitrogen such as nitrogen monoxide, NO.

Describe how a catalytic converter removes nitrogen monoxide from exhaust emissions.

Include a balanced symbol equation in your answer.

.....

.....

.....

.....

..... [3]

[Total: 10]

9 **(a)** Fig. 9.1 shows a butterfly resting on a leaf attached to the branch of a tree.

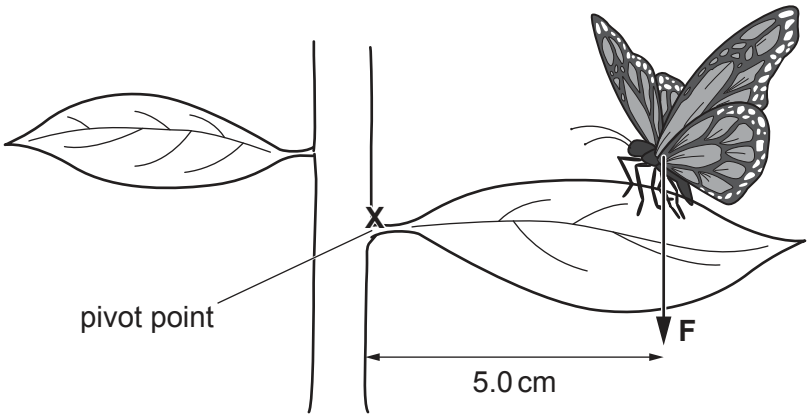


Fig. 9.1

(i) State the name of the force labelled **F**.

..... [1]

(ii) The leaf will break off the branch if the moment about the pivot point **X** is greater than 0.14 N cm.

The leaf does not break off the branch when the butterfly rests on it.

Calculate the maximum mass of the butterfly.

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

maximum mass = ... kg [3]

(b) A scientist captures the butterfly in a plastic container to study it more closely.

The scientist places a converging lens across the top of the plastic container.

Fig. 9.2 shows the butterfly in the container.

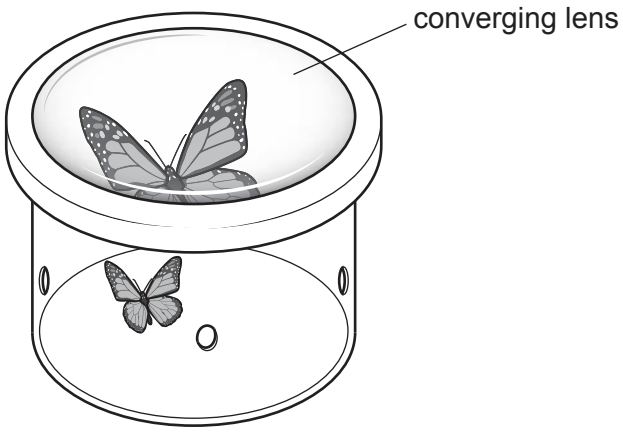


Fig. 9.2

Complete Fig. 9.3 to show how a thin converging lens forms a real image.

Label the image with the word *image*.

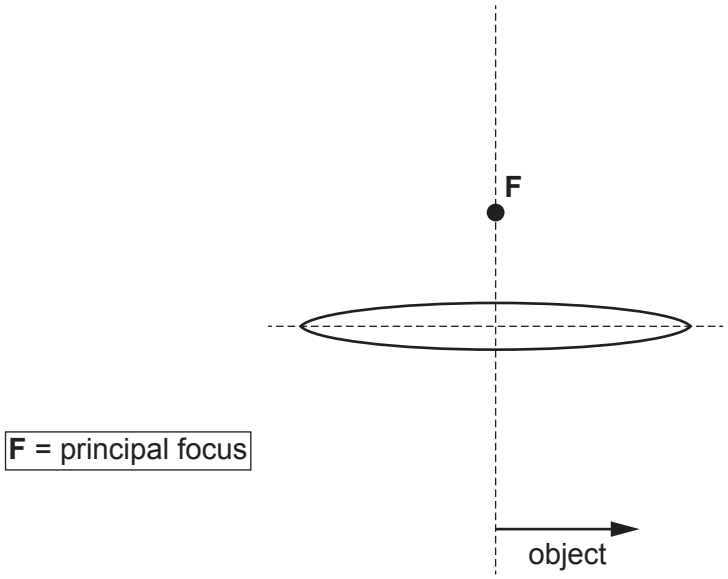


Fig. 9.3

[3]

(c) The scientist uses a filament lamp to illuminate the butterfly while she is studying it.

(i) The filament lamp is in a series circuit with a cell and a switch.

Complete Fig. 9.4 to show this circuit.

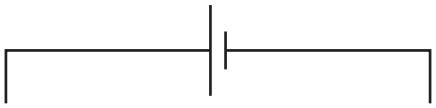


Fig. 9.4

[2]

(ii) Fig. 9.5 shows the current–voltage characteristic of a filament lamp.

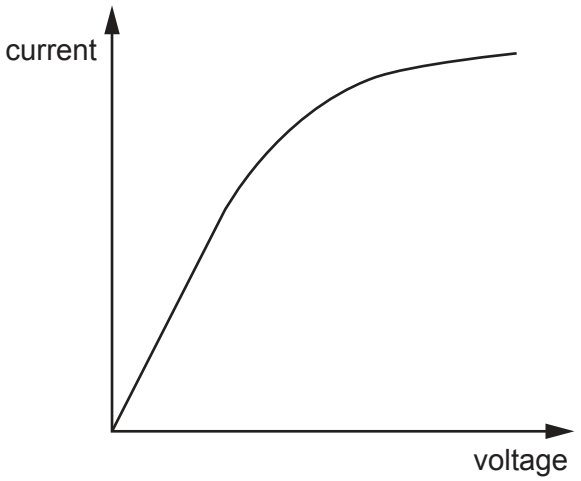


Fig. 9.5

Use Fig. 9.5 to explain how the resistance of the filament lamp changes as the voltage across it is increased.

.....

.....

.....

.....

.....

..... [3]

[Total: 12]

10 **(a)** The pH of the fluid in muscles changes during vigorous exercise due to the changing concentrations of lactic acid.

Table 10.1 shows the difference in pH before and immediately after vigorous exercise.

Table 10.1

measurement taken	pH
before exercise	7.08
immediately after exercise	6.58

(i) Calculate the decrease in pH shown in Table 10.1.

..... [1]

(ii) Explain why there was a decrease in pH of the muscles during vigorous exercise.

.....

.....

.....

.....

..... [3]

(b) Muscle cells are adapted for movement as they are able to contract.

(i) Define the term movement.

.....

.....

..... [2]

(ii) State the name of the cell adapted for:

antibody production .....

movement of mucus .....

photosynthesis. .....

[3]

[Total: 9]

11 (a) Element **X** is found in Group II of the Periodic Table.

State the formula of the ion formed by element **X**.

Tick (✓) **one** box.

X^{2-} ☐

X^{6-} ☐

X^{2+} ☐

X^{6+} ☐

[1]

(b) Determine the **formula** of the compound formed by NH_4^+ and CO_3^{2-} ions.

formula = ... [1]

(c) The number of subatomic particles in an ion is different from the number in a neutral atom.

Table 11.1 shows information about two different **ions**.

Complete Table 11.1.

Table 11.1

ion	proton (atomic) number	nucleon (mass) number	protons	neutrons	electrons
Al^{3+}	13	27	13	.....	10
F^-	9	19	9	10	.....

[2]

(d) Carbon has the electronic structure 2.4.

Oxygen has the electronic structure 2.6.

Carbon reacts with oxygen to make carbon dioxide, CO_2.

Complete the dot-and-cross diagram in Fig. 11.1 to show the bonding in carbon dioxide.

Only show the outer-shell electrons.

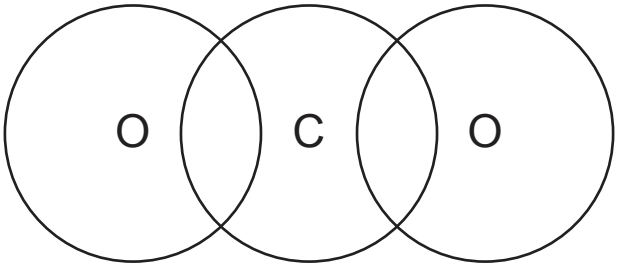


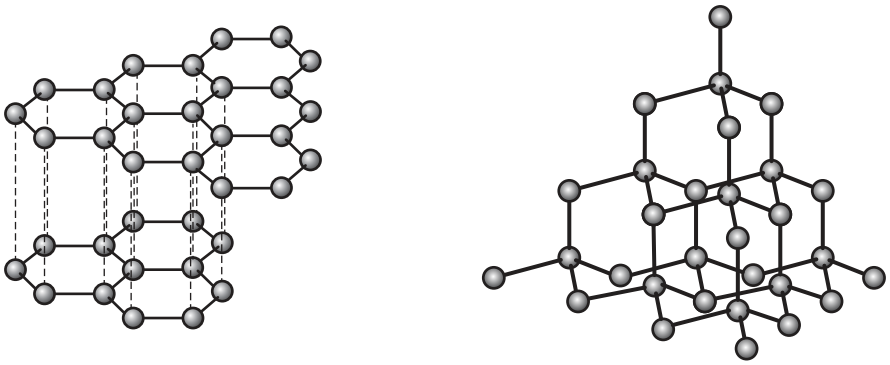
Fig. 11.1

[2]

(e) Carbon exists in several different forms.

Graphite and diamond are two of these forms.

Fig. 11.2 shows the structures of graphite and diamond.



graphite diamond

Fig. 11.2

(i) Explain why the structure of graphite makes it suitable for use as a lubricant.

.....

.....

..... [2]

(ii) Explain why the structure of diamond makes it suitable for use in cutting tools.

.....

.....

..... [2]

[Total: 10]

12 X-rays are part of the electromagnetic spectrum.

Hospitals use X-rays for medical imaging.

(a) (i) State the speed of X-rays.

..... m/s [1]

(ii) An X-ray machine in a hospital uses X-rays with a wavelength of 2.0×10^{-11} m.

Calculate the frequency of these X-rays.

frequency = ... Hz [2]

(b) Hospitals also use ultrasound waves for medical imaging.

(i) Ultrasound waves are high frequency sound waves which are longitudinal.

X-rays are transverse waves.

Complete the sentences to describe the nature of longitudinal and transverse waves.

Longitudinal waves are produced by vibrations that are

..... to the direction of energy transfer.

Transverse waves are produced by vibrations that are

..... to the direction of energy transfer.

[1]

(ii) During an ultrasound scan, ultrasound waves travel through gaseous air, solid bone and liquid blood.

Sound waves, including ultrasound waves, travel at different speeds in gases, solids and liquids.

Place the speed of sound in a **gas**, a **solid** and a **liquid** in order from fastest to slowest.

fastest .....

.....

slowest .....

[1]

(c) Hospitals use radioactive tracers such as technetium-99 ($^{99}_{43}$Tc) for medical imaging.

(i) $^{99}_{43}$Tc has a half-life of 6 hours.

Calculate the percentage of $^{99}_{43}$Tc remaining in a sample after 24 hours.

percentage remaining = ...% [2]

(ii) $^{99}_{43}$Tc is produced in hospitals from molybdenum-99 ($^{99}_{42}$Mo).

Use the correct nuclide notation to complete the decay equation for molybdenum-99.

$$^{99}_{42}\text{Mo} \rightarrow {}^{99}_{43}\text{Tc} + {}^{\ldots\ldots}_{\ldots\ldots}\ldots\ldots$$ [1]

[Total: 8]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).