



CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

0654/42

February/March 2024

2 hours

No additional materials are needed.

- 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.

- 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 male reproductive system in humans.

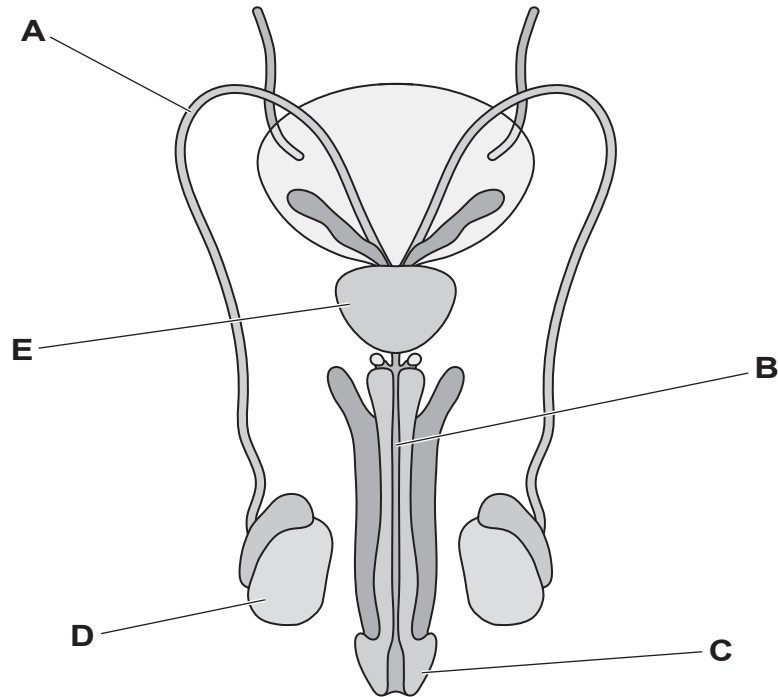


Fig. 1.1

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

that is a tube transporting excretory products

that secretes fluid for the formation of semen

where meiosis occurs.

[3]

(b) Fig. 1.2 is a diagram of a sperm cell.

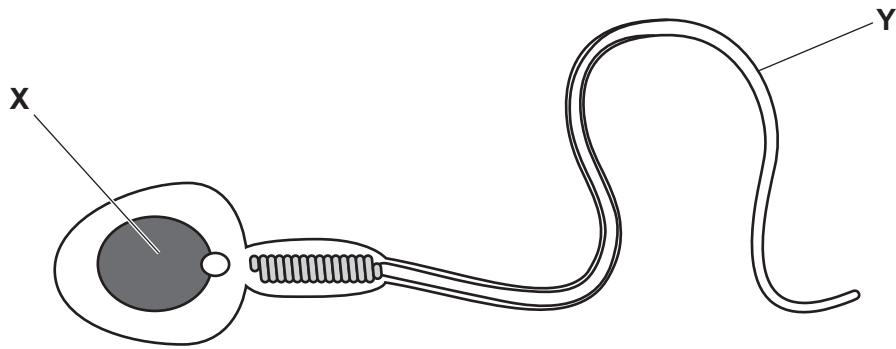


Fig. 1.2

- (i) State how the arrangement of the chromosomes in the part labelled **X** in Fig. 1.2 is different to that of a human body cell.

.....
 [1]

- (ii) State the name and function of the adaptive feature labelled **Y** in Fig. 1.2.

name

function

..... [2]

(c) The list shows the names of some specialised cells.

ciliated cell

egg cell

palisade mesophyll cell

red blood cell

root hair cell

white blood cell

Choose **one** cell from the list that:

contains a haploid nucleus

does not contain a nucleus

is found in the bronchi

is responsible for phagocytosis.

[4]

(d) Red blood cells and white blood cells are components of blood.

State the name of one other major component of blood.

..... [1]

[Total: 11]

BLANK PAGE

- 2 (a) A teacher investigates the reactions of the Group I metals, lithium, potassium and sodium, with water.

Table 2.1 shows their results.

Table 2.1

metal	observations
lithium	fizzes, moves across the surface of the water
potassium	fizzes violently, moves very quickly across the surface of the water, flame seen
sodium	fizzes strongly, moves very quickly across the surface of the water

- (i) Deduce the order of reactivity of the metals.

..... most reactive

.....

..... least reactive

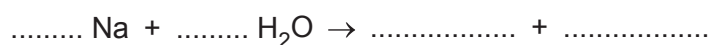
[2]

- (ii) When potassium reacts with water a flame is seen.

State the colour of the flame.

..... [1]

- (iii) Complete and balance the symbol equation for the reaction between sodium and water.



[2]

- (b) Sodium reacts with chlorine to make the **ionic compound** sodium chloride.

Fig. 2.1 shows the electronic structures of a sodium atom and a chlorine atom.

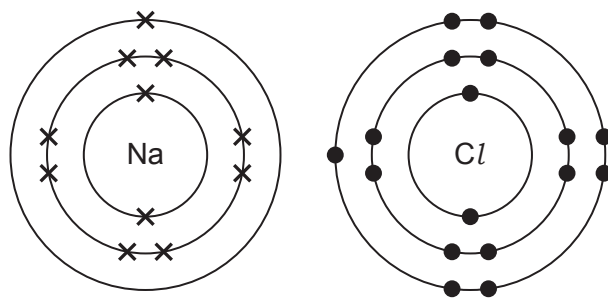


Fig. 2.1

- (i) Draw the electronic structures of the sodium ion and chloride ion in the ionic compound sodium chloride. Show the charges on the ions.

[2]

- (ii) Describe the structure of sodium chloride.

.....

 [2]

- (iii) Explain why **molten** sodium chloride conducts electricity, but **solid** sodium chloride does not conduct electricity.

.....
 [1]

[Total: 10]

3 A student investigates a spring.

The student adds slotted masses to the spring to increase the force applied to the spring as shown in Fig. 3.1.

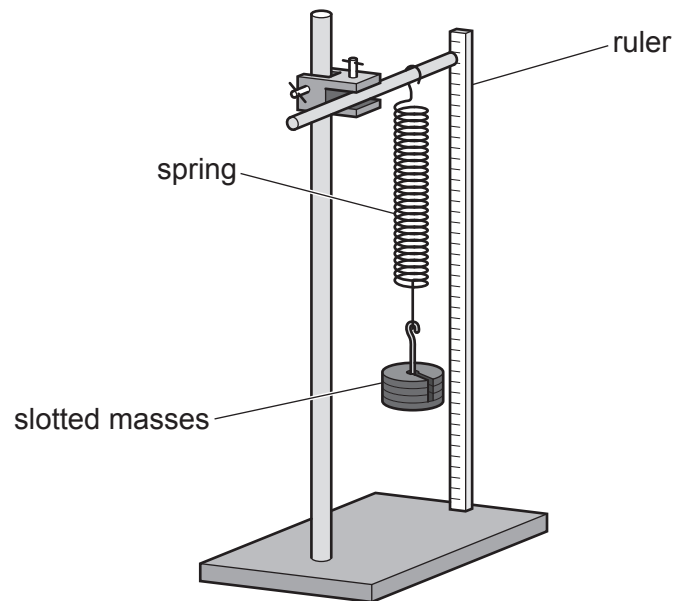


Fig. 3.1

(a) The student records the length of the spring as it extends.

Fig. 3.2 shows the results obtained by the student.

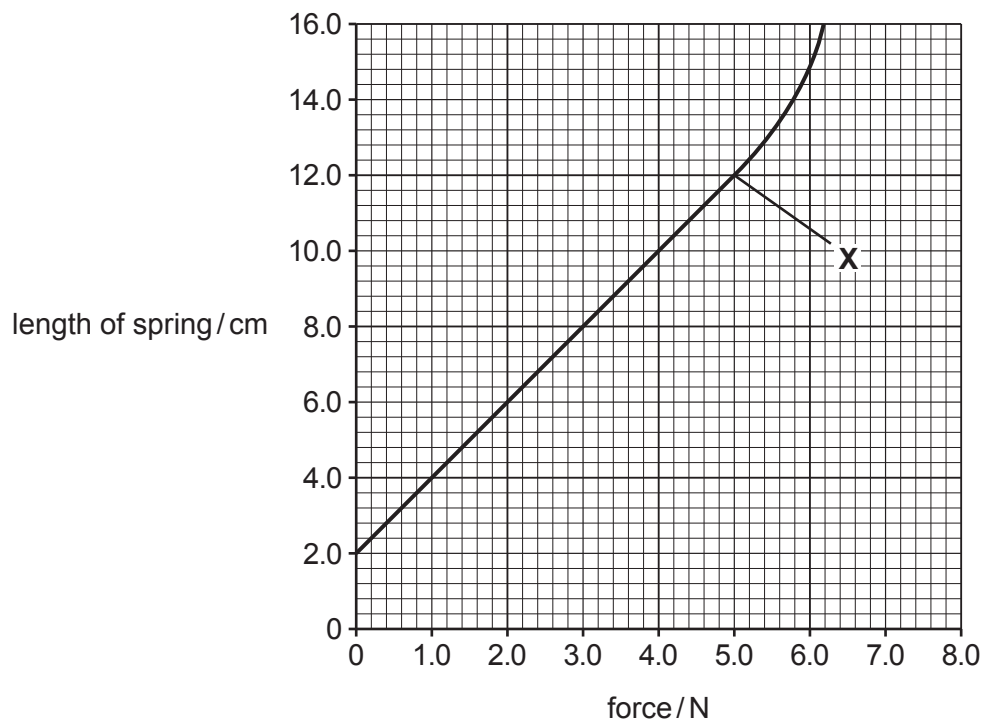


Fig. 3.2

(i) Use Fig. 3.2 to determine the original length of the spring.

..... cm [1]

(ii) Use Fig. 3.2 to calculate the spring constant of the spring.

spring constant = N/cm [2]

(iii) State the term used to describe point **X** on the graph.

..... [1]

(b) The slotted masses used by the student are made from steel.

Fig. 3.3 shows one of the slotted masses.

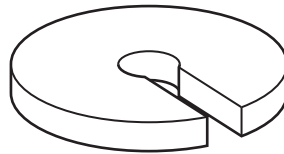


Fig. 3.3

Describe how the student determines the density of the steel used to make the slotted masses.

measurement 1

.....

.....

measurement 2

.....

.....

calculation

.....

.....

[3]

(c) Fig. 3.4 shows how a long spring can be used to demonstrate wave motion.

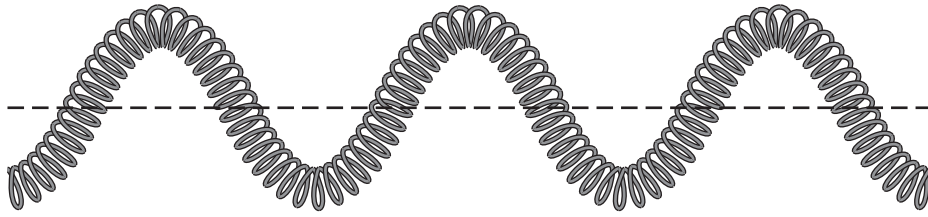


Fig. 3.4

- (i) On Fig. 3.4 use a double headed arrow ($\updownarrow$ or $\leftrightarrow$) to label the amplitude of the wave. [1]
- (ii) The wave shown in Fig. 3.4 is a transverse wave.

Complete the sentence to describe the properties of a transverse wave.

Transverse waves are made by oscillations which act
to the direction of energy transfer. [1]

[Total: 9]

BLANK PAGE

- 4 (a) Phenylketonuria (PKU) is an inherited disorder controlled by a single gene.

People with PKU have to limit how much protein they eat.

The allele for PKU is recessive (d).

Fig. 4.1 is a pedigree diagram showing the inheritance of PKU in one family.

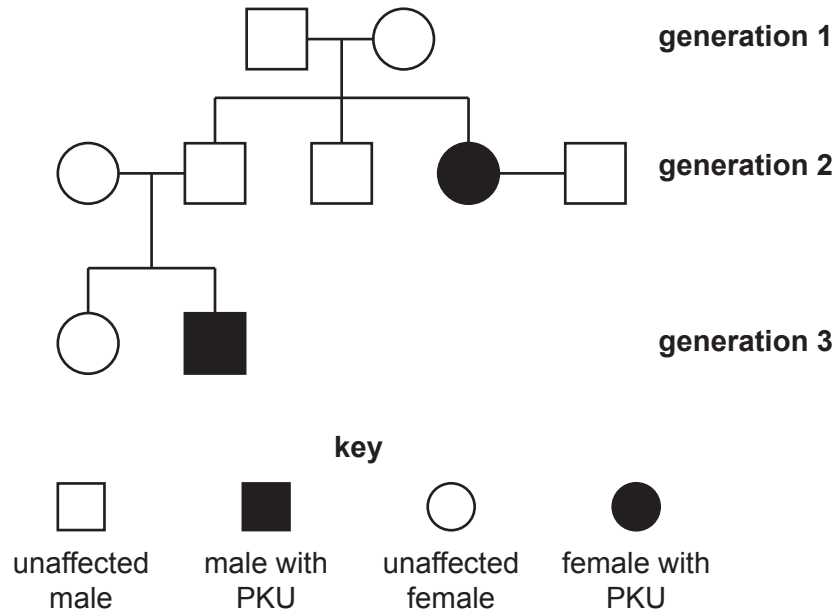


Fig. 4.1

- (i) Use Fig. 4.1 to state the number of people:

that are homozygous recessive for PKU

with XX chromosomes.

[2]

- (ii) The two people in generation 1 in Fig. 4.1 have the same genotype.

State this genotype.

..... [1]

- (iii) State the percentage likelihood of an offspring having PKU if both parents have heterozygous genotypes.

..... [1]

(b) State the names of two diseases that are associated with protein-energy malnutrition.

1

2 [2]

(c) Table 4.1 shows some large nutrient molecules.

Complete Table 4.1 to name the smaller molecules from which they are made.

Table 4.1

large nutrient molecule	smaller molecules they are made from
glycogen	
protein	
starch	

[3]

(d) State the name of the enzyme that breaks down protein.

..... [1]

[Total: 10]

- 5 Electrolysis can be used to break down a substance into useful products.

Fig. 5.1 shows the electrolysis of dilute sulfuric acid.

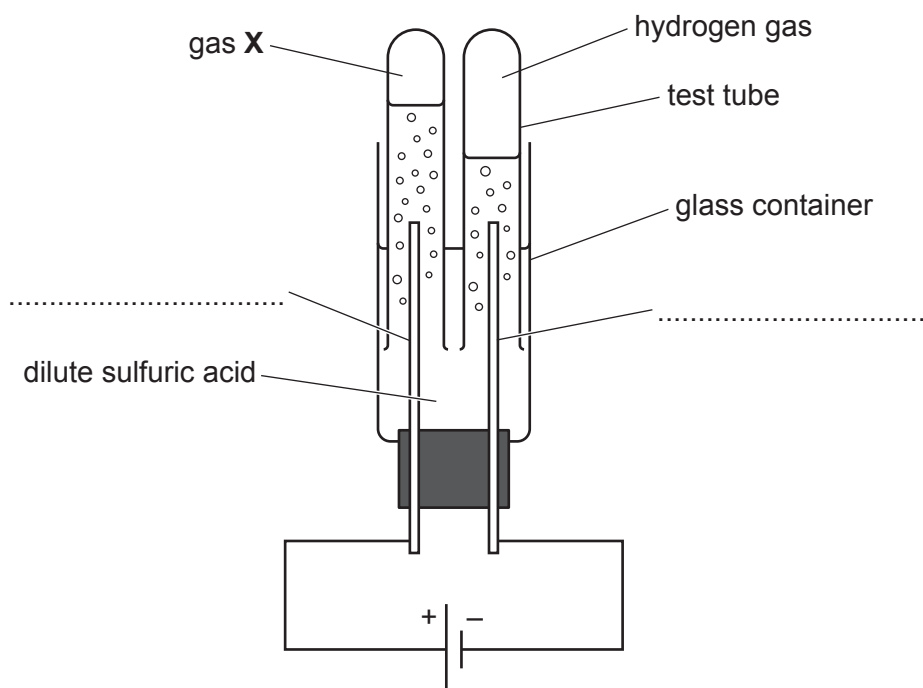


Fig. 5.1

- (a) (i) Complete the labels on Fig. 5.1.

Choose words from the list.

anode

anion

cathode

cation

electrolyte

[2]

- (ii) State the name of gas **X** in Fig. 5.1.

..... [1]

- (iii) Hydrogen gas, H_2 , is made at the negative electrode.

Complete and balance the ionic half-equation for this reaction.



[2]

- (iv) State if the reaction in part (iii) is oxidation or reduction.

Explain your answer using ideas about electrons.

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

- (v) Describe the test for hydrogen and the observation for a positive result.

test

result [2]

- (b) In an experiment a student passes electricity through dilute sulfuric acid and collects 6 dm^3 of hydrogen gas.

Calculate the mass of 6 dm^3 of hydrogen gas.

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

mass of hydrogen gas = g [3]

[Total: 11]

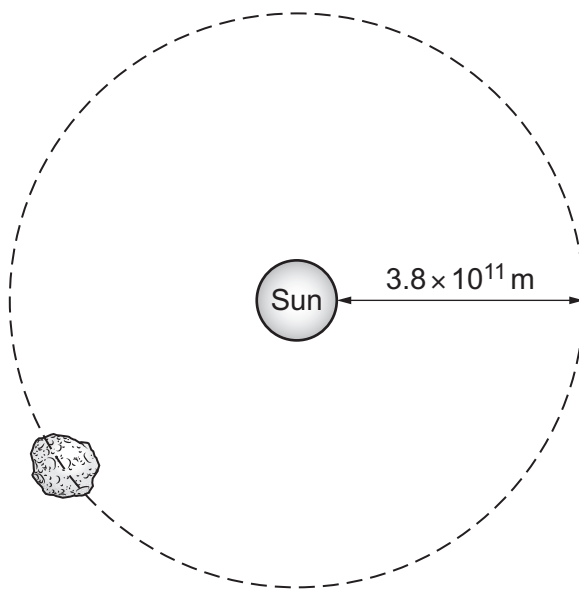
- 6 Asteroids are large rocks which orbit the Sun.

Fig. 6.1 shows a diagram of an asteroid.



Fig. 6.1

- (a) Fig. 6.2 shows the asteroid orbiting the Sun.



Not to scale

Fig. 6.2

It takes 1245 days for the asteroid to complete one full orbit of the Sun.

The asteroid orbits in a circle 3.8×10^{11} m from the Sun.

Show that the average speed of the asteroid is 22 000 m/s.

[3]

(b) Scientists have found evidence that asteroids contain the isotope strontium-87.

(i) Strontium-87 is produced by the decay of rubidium-87.

Use correct nuclide notation to complete the decay equation for rubidium-87.



[1]

(ii) Fig. 6.3 shows how a sample of rubidium-87 decays.

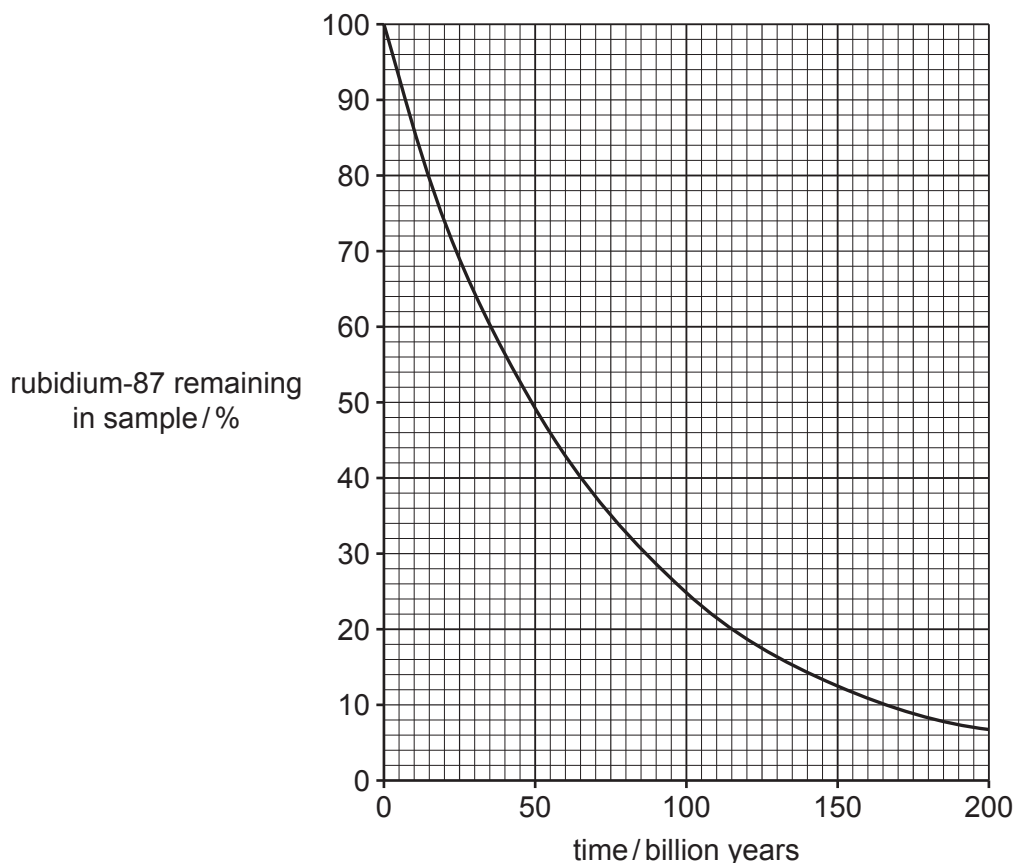


Fig. 6.3

Use Fig. 6.3 to determine the half-life of rubidium-87.

Give a suitable unit for your answer.

half-life = unit [2]

(iii) Asteroids are thought to be 5 billion years old.

Use Fig. 6.3 to determine the percentage of rubidium-87 that has decayed to strontium-87 in the asteroid.

percentage = % [1]

[Total: 7]

[Turn over]

- 7 (a) A student investigates the effect of light intensity on the rate of photosynthesis.

The student places a lamp 10 cm from an aquatic plant.

The student records the number of bubbles of oxygen released in two minutes.

The student repeats this investigation increasing the distance of the lamp each time.

Table 7.1 shows the results.

Table 7.1

distance of lamp from aquatic plant /cm	number of oxygen bubbles released in two minutes
10	102
20	85
30	62
40	29
50	9

The number of bubbles of oxygen the aquatic plant releases is used to indicate the rate of photosynthesis.

- (i) Calculate the rate of oxygen bubbles released when the lamp is placed 30 cm from the aquatic plant.

..... bubbles/min [1]

- (ii) Complete the sentences to describe and explain the results in Table 7.1.

Decreasing the distance of the lamp from the aquatic plant

..... the light intensity.

Light energy is converted into energy in molecules.

This transfer of energy is done by in the chloroplasts.

During this process oxygen is produced and are synthesised. [4]

- (iii) The investigation is repeated with much less carbon dioxide dissolved in the water.

Explain the effect this will have on the number of oxygen bubbles released.

.....

 [2]

(b) Photosynthesis is an enzyme-controlled reaction.

State **two** conditions that cause enzymes to denature.

1

2 [2]

(c) A plant will grow towards a source of light.

(i) State the name of this tropic response.

..... [1]

(ii) State the name of the chemical that causes this tropic response.

..... [1]

[Total: 11]

- 8 (a) Ammonia is manufactured in the Haber process.

Fig. 8.1 describes the Haber process.

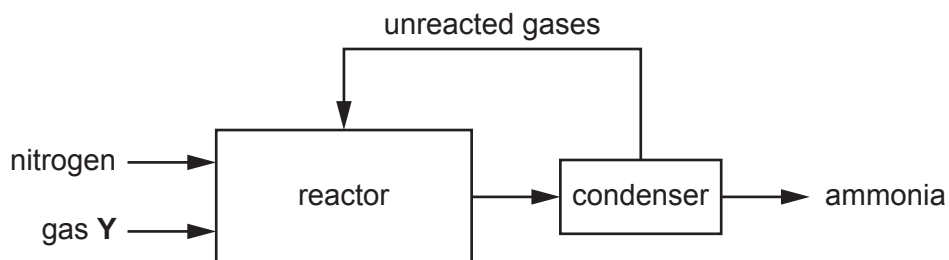


Fig. 8.1

- (i) Gas Y is obtained from the reaction of methane with steam.

State the name of gas Y.

..... [1]

- (ii) State the temperature and pressure used in the reactor.

temperature °C

pressure atmospheres
[2]

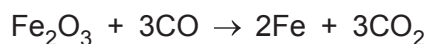
- (iii) Iron is also used in the Haber process.

State and explain why iron is used.

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

- (b) Iron is extracted from hematite in a blast furnace.

One stage of this process involves the reaction of iron oxide, Fe_2O_3 , with carbon monoxide.

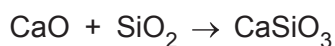


Calculate the mass of iron made when 400 kg of iron oxide reacts with excess carbon monoxide.

[A_r : Fe, 56; O, 16]

mass of iron = kg [2]

- (c) (i) Calcium carbonate, CaCO_3 , in limestone is used to help remove impurities from the iron.



Complete the sentences to describe how calcium carbonate removes impurities.

The calcium carbonate in the limestone
to form

This then reacts with the impurities in the hematite to
produce

This is separated from the iron and used to make road surfaces.

[4]

- (ii) CaO is a **basic** oxide. SiO_2 is an **acidic** oxide.

Explain why.

CaO is a basic oxide because

SiO_2 is an acidic oxide because

[1]

[Total: 12]

- 9 Fig. 9.1 shows two identical infrared heating lamps that are heating two metal cubes. The lamps are at the same distance from the cubes. The lamps are heating each cube for the same time.

One lamp is heating the dull white metal cube and the other the dull black metal cube.

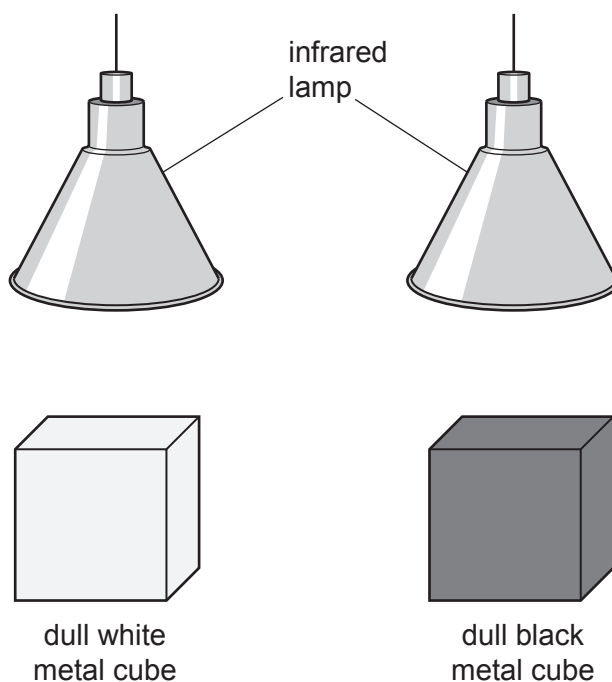


Fig. 9.1

- (a) (i) Explain why the temperature of the dull black cube rises more than the temperature of the dull white cube.

..... [1]

- (ii) The dull black metal cube is replaced by a shiny black metal cube.

Explain why the temperature of the shiny black cube rises less than the temperature of the dull black cube.

..... [1]

- (iii) Infrared radiation emitted by the lamps includes radiation with a wavelength of 0.75 mm.

Calculate the frequency of this infrared radiation.

frequency = Hz [3]

- (iv) Thermal energy is conducted through the metal cubes.

Describe the process of conduction in a metal.

.....

.....

.....

.....

.....

..... [3]

- (b) One of the cubes is now filled with hot water. A student uses a digital thermometer containing a thermocouple to measure the temperature of the water inside the cube.

- (i) Describe the structure of a thermocouple used to measure temperature.

.....

.....

..... [1]

- (ii) The thermocouple produces an electromotive force (e.m.f.).

Place ticks (✓) in Table 9.1 to compare e.m.f. to potential difference.

Table 9.1

	electromotive force only	potential difference only	electromotive force and potential difference
measured in volts			
measured using a voltmeter			
equal to the energy supplied by a source in driving a charge around a circuit			

[3]

[Total: 12]

- 10 (a) Scientists estimate the percentage of energy used from anaerobic respiration and aerobic respiration as the intensity of exercise increases.

Fig. 10.1 is a graph of the results.

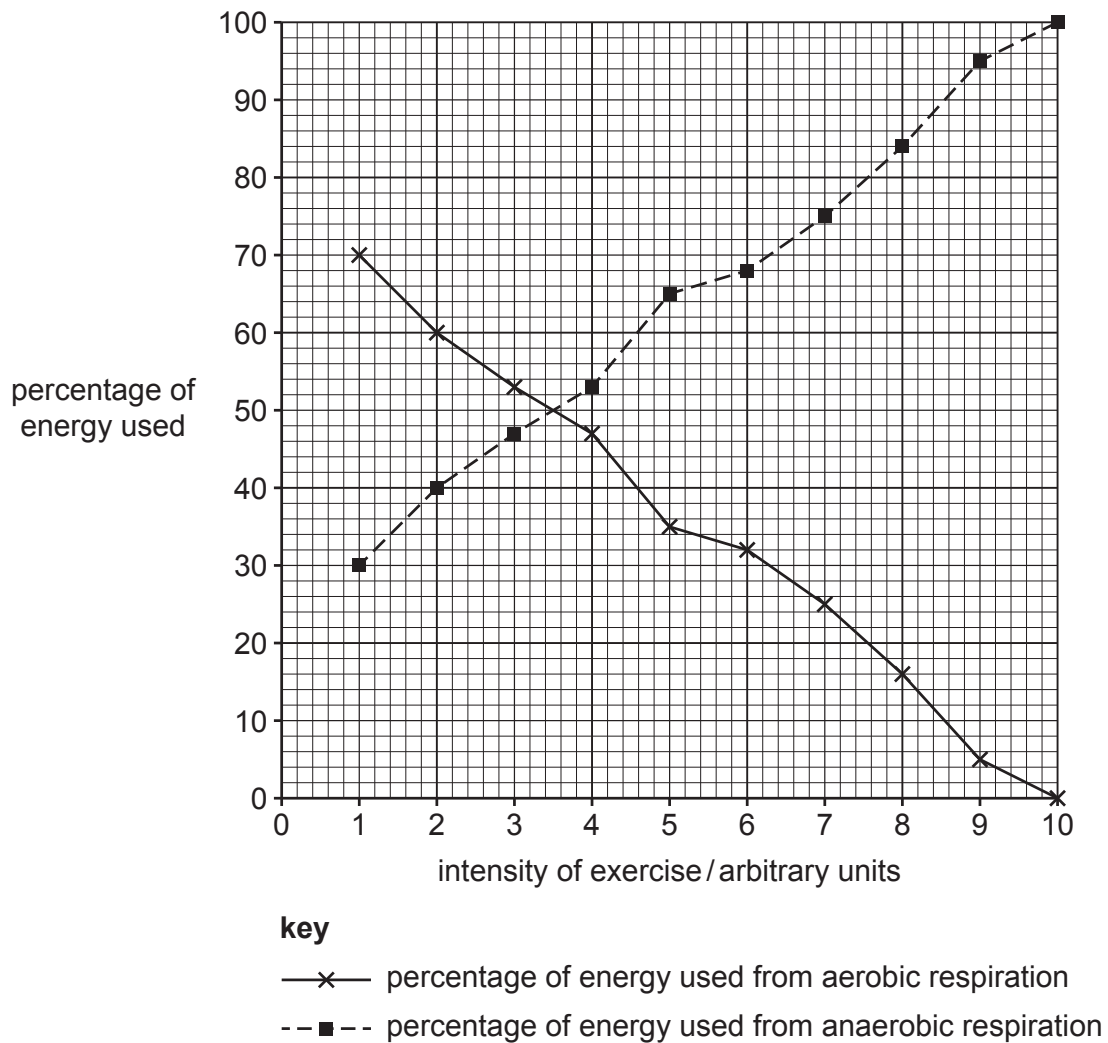


Fig. 10.1

- (i) Describe the results, shown in Fig. 10.1, as the intensity of exercise increases.

.....

 [1]

- (ii) Identify the intensity of exercise when the percentage of energy used from aerobic respiration and the percentage of energy used from anaerobic respiration are equal.

..... arbitrary units [1]

- (b) Explain why aerobic respiration in muscles is better for the body than anaerobic respiration.

.....

.....

.....

.....

..... [3]

- (c) Mammals have a double circulatory system.

- (i) Tick (✓) **all** the boxes that show the advantages of a double circulatory system.

allows the passage of nervous impulses to body tissues	
allows higher pressure of blood to the body tissues	
allows higher pressure of blood to the lungs	
prevents diffusion of substances from the blood	
separates oxygenated and deoxygenated blood	

[2]

- (ii) Describe how the heart pumps blood.

.....

.....

..... [1]

[Total: 8]

- 11 (a) Butane, C_4H_{10} , is an alkane.

Complete the sentence about alkanes.

Alkanes are hydrocarbons whose molecules contain
only covalent bonds. [2]

- (b) Table 11.1 shows the energy given out when 1 g of different alkanes burns.

Table 11.1

alkane	energy given out / kJ
butane	49.2
ethane	52.6
methane	55.6
propane	50.4

- (i) State the relationship between the number of carbon atoms in the alkane and the energy given out.

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

- (ii) State the name given to any reaction that gives out energy.

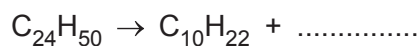
..... [1]

- (c) Butane is a small alkane molecule.

Large alkane molecules are cracked into smaller, more useful molecules.

The equation shows the cracking of $C_{24}H_{50}$ to make $C_{10}H_{22}$ and **one** other product.

Complete the equation.



[1]

- (d) Table 11.2 shows the percentage (%) supply and demand for some of the different fractions obtained from crude oil.

Table 11.2

fraction	% supply	% demand
refinery gases	2	4
gasoline (petrol)	5	23
naphtha	8	5
kerosene	12	7
diesel oil	17	23
fuel oil	56	38

Suggest and explain which fraction is cracked to obtain more gasoline (petrol).

.....

.....

.....

..... [2]

[Total: 7]

12 Fig. 12.1 shows a large electromagnet used to lift scrap metal.

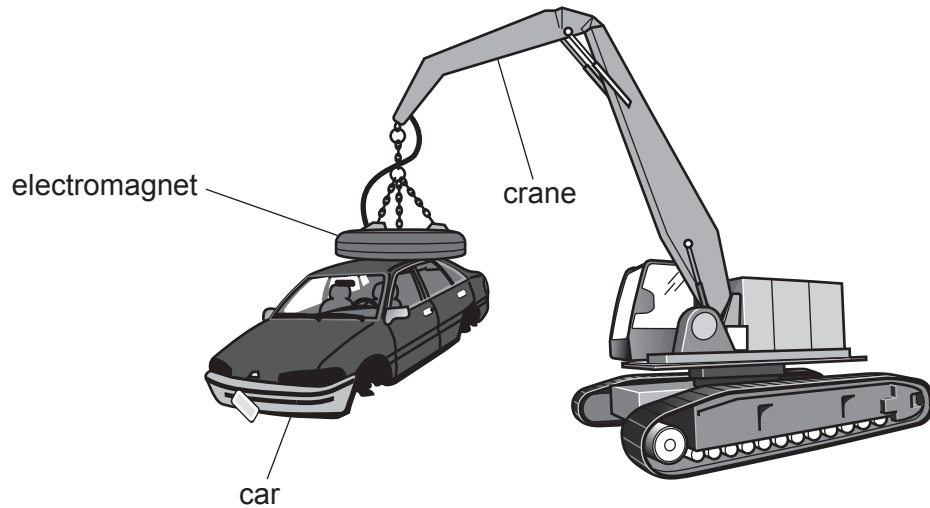


Fig. 12.1

- (a) The electromagnet lifts the car to a height of 15 m. The car has a mass of 1200 kg.

Calculate the work done on the car when it is lifted to a height of 15 m.

The gravitational field strength is $g = 10 \text{ N/kg}$.

work done = J [2]

- (b) The electromagnet is made from a solenoid.

Fig. 12.2 shows a solenoid.

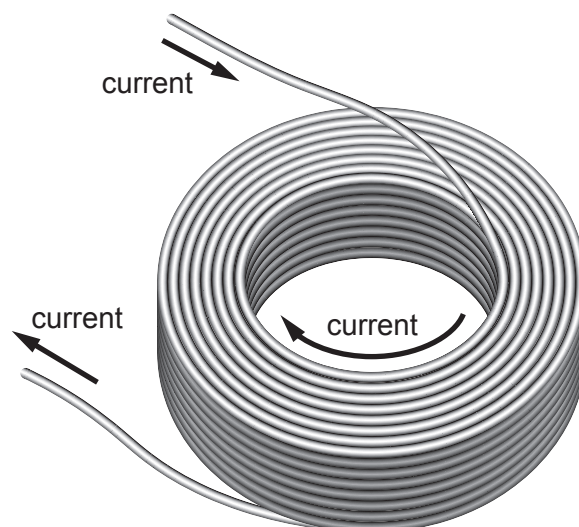


Fig. 12.2

- (i) On Fig. 12.2 draw the pattern of the magnetic field produced when a current passes through the solenoid.

Include an arrow showing the direction of the magnetic field.

[2]

- (ii) The solenoid uses a current of 50A.

Calculate the amount of charge which flows through the solenoid in 30 s.

State the unit for your answer.

charge = unit [3]

- (iii) The solenoid has a resistance of 5.0Ω when the current is 50A.

Calculate the power of the electromagnet.

power = W [4]

- (c) Electromagnets can be made much stronger than permanent magnets.

State **one other** advantage of using an electromagnet to lift scrap metal.

.....

..... [1]

[Total: 12]

BLANK PAGE

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
Key atomic number atomic symbol name relative atomic mass							1										
							H										
							hydrogen										
3	4											5	6	7	8	9	10
Li	Be											B	C	N	O	F	Ne
lithium	beryllium											boron	carbon	nitrogen	oxygen	fluorine	neon
7	9											11	12	14	16	19	20
11	12											13	14	15	16	17	18
Na	Mg											Al	Si	P	S	Cl	Ar
sodium	magnesium											aluminium	silicon	phosphorus	sulfur	chlorine	argon
23	24											27	28	31	32	35.5	40
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
potassium	calcium	scandium	titanium	vanadium	chromium	manganese	iron	cobalt	nickel	copper	zinc	gallium	germanium	arsenic	selenium	bromine	krypton
39	40	45	48	51	52	55	56	59	59	64	65	70	73	75	79	80	84
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
rubidium	strontium	yttrium	zirconium	niobium	molybdenum	technetium	ruthenium	rhodium	palladium	silver	cadmium	indium	tin	antimony	tellurium	iodine	xenon
85	88	89	91	93	96	–	101	103	106	108	112	115	119	122	128	127	131
55	56	57–71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs	Ba	lanthanoids	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
caesium	barium		hafnium	tantalum	tungsten	rhenium	osmium	iridium	platinum	gold	mercury	thallium	lead	bismuth	polonium	astatine	radon
133	137		178	181	184	186	190	192	195	197	201	204	207	209	–	–	–
87	88	89–103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
Fr	Ra	actinoids	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og
francium	radium		rutherfordium	dubnium	seaborgium	bohrium	hassium	meitnerium	darmstadtium	roentgenium	copernicium	nihonium	flerovium	moscovium	livermorium	tennessine	oganesson
–	–		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

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

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