Cambridge Assessment International Education

Cambridge IGCSE™ (9–1)

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

0123456789

CO-ORDINATED SCIENCES **0973/04**

Paper 4 Theory (Extended) **For examination from 2025**

SPECIMEN PAPER **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.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m / s^2).

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 **30** pages. Any blank pages are indicated.

1 A student investigates the effect of temperature on the rate of photosynthesis in an aquatic plant.

Fig. 1.1 shows the apparatus used.

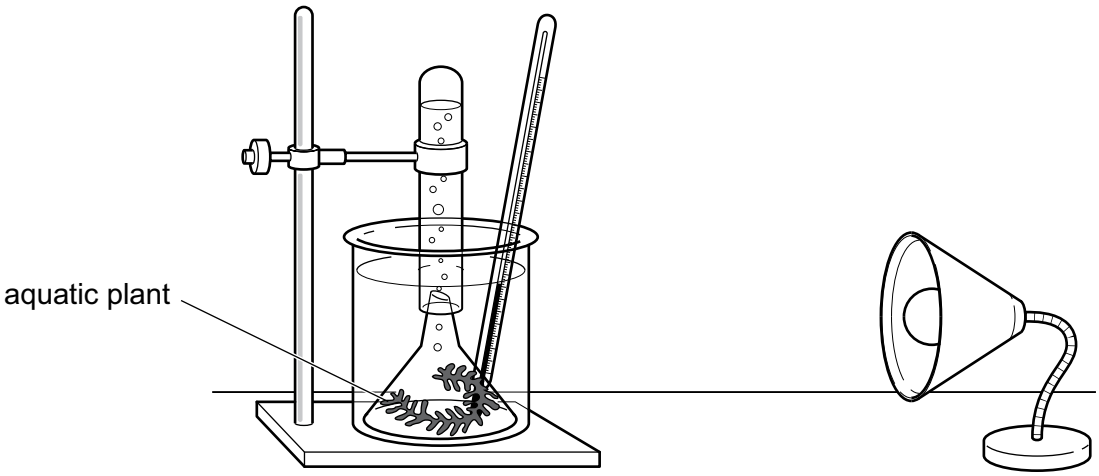

Fig. 1.1

The student counts the number of bubbles of gas released in one minute.

They repeat the investigation with water at different temperatures.

Table 1.1 shows the results.

Table 1.1

temperature / °C	number of bubbles released per minute
25	5
30	25
35	38
40	55
45	71
50	40
55	25
60	0

(a) (i) Name the gas released by the aquatic plant.

..... [1]

(ii) Describe the results shown in Table 1.1.

Include data from Table 1.1 in your answer.

.....

.....

.....

..... [2]

(b) Photosynthesis is an enzyme-controlled reaction.

Explain the results between 50 and 60 °C.

.....

.....

.....

.....

.....

..... [3]

(c) The leaves of a plant are described as sources or as sinks depending on the time of the year.

Describe the difference between sources and sinks.

.....

.....

.....

.....

..... [2]

(d) State the name of the carbohydrate in plants that is used:

as an energy store .....

in respiration .....

to build cell walls. .....
[3]

[Total: 11]

2 Measles is a transmissible disease.

Fig. 2.1 shows the number of measles antibodies in the blood after vaccination and after infection.

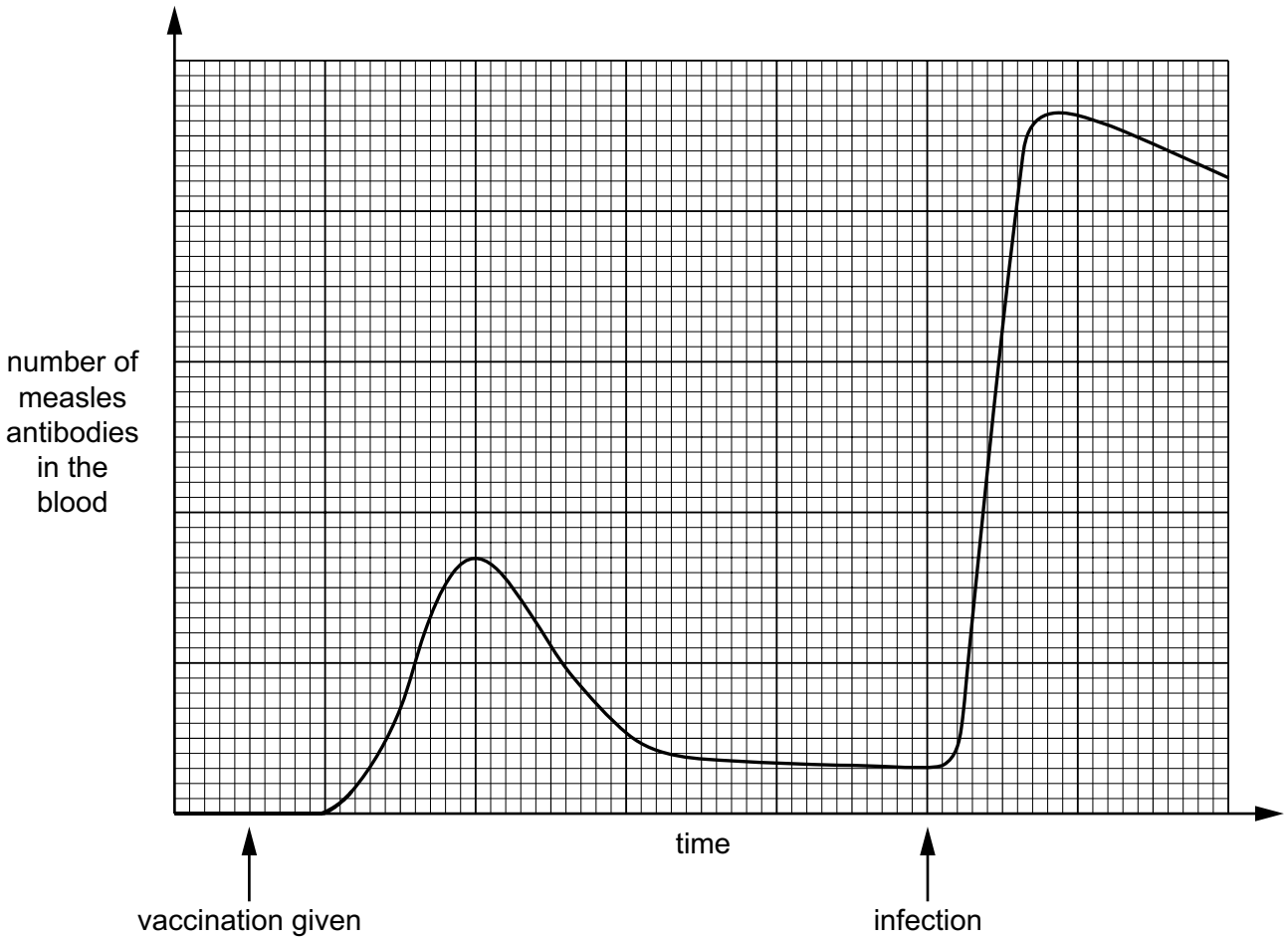

Fig. 2.1

(a) Complete the sentences to explain the immune response seen in Fig. 2.1.

Vaccinations contain a weakened form of the ..... or their antigens.

The antigens stimulate an immune response by a type of white blood cell called

..... .

These white blood cells produce antibodies, increasing the number of antibodies in the blood.

Long-term immunity is provided by the production of ..... cells.

If the body becomes infected after vaccination, antibody production in the body

..... .

The antibodies bind to antigens with a ..... shape destroying them or

marking them for destruction by ..... .

[6]

(b) State the name of the type of immunity gained in Fig. 2.1.

..... [1]

(c) State **two** indirect ways that transmissible diseases can be transmitted.

.....

..... [2]

[Total: 9]

3 **(a)** A country introduced a law called the Endangered Species Act. It was hoped that the Act would help to conserve species that were at risk from extinction.

Table 3.1 shows the numbers of birds from different species before and after the Act was introduced.

Table 3.1

species	number of birds	
	before the Act	after the Act
bald eagle	416	9789
Kirtland's warbler	210	1415
nene goose	400	1275
peregrine falcon	324	1700
whooping crane	54	513

(i) State which species was the most at risk from extinction before the Act.

..... [1]

(ii) Calculate the percentage increase in the number of Kirtland's warblers.

Give your answer to the nearest whole number.

percentage increase = ...% [3]

(b) List **three** reasons why species become endangered or extinct.

1 .....

2 .....

3 .....

[3]

(c) The nene goose is a herbivore and the bald eagle is a carnivore.

(i) State the name of the trophic level in the food chain for the nene goose.

..... [1]

(ii) Explain why the way the nene goose feeds is more energy efficient than that of the bald eagle.

.....

.....

.....

.....

..... [3]

[Total: 11]

4 **(a)** A student investigates the effect of exercise on oxygen consumption.

The oxygen used by the student before, during and after exercise is monitored.

Fig. 4.1 is a graph of the results.

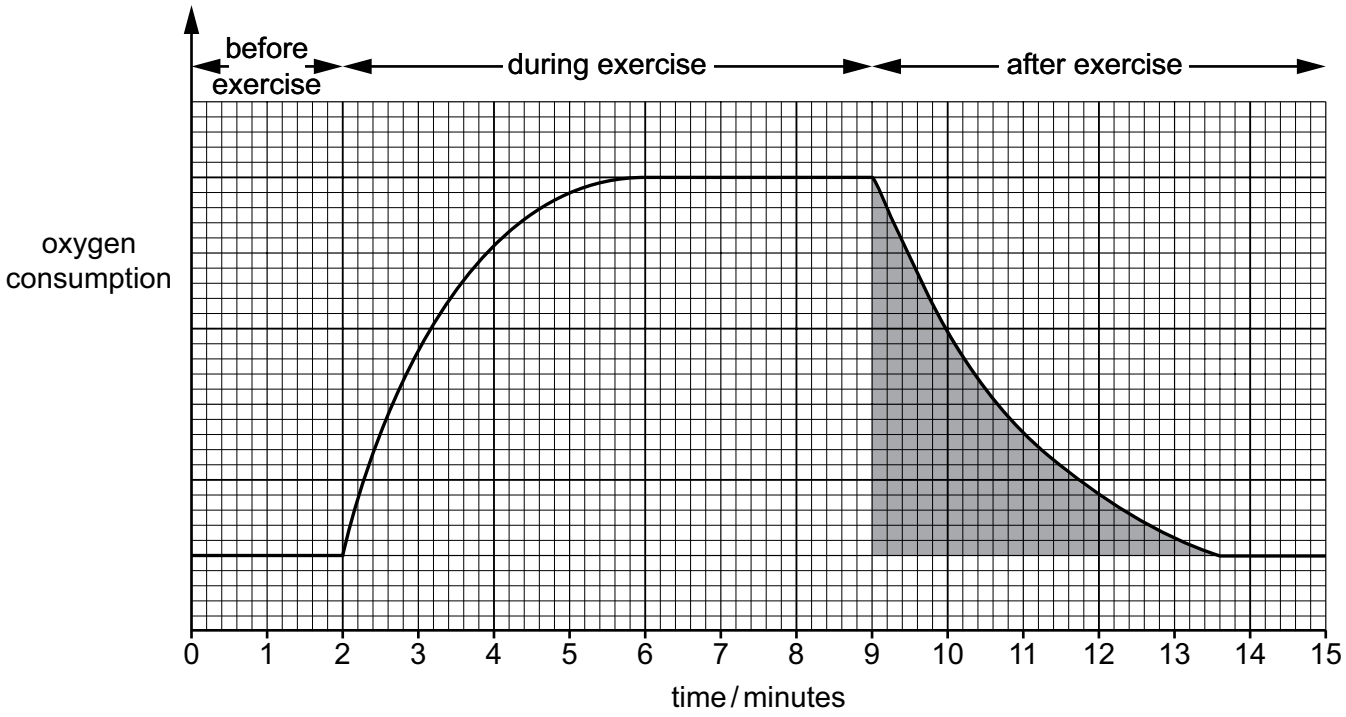

Fig. 4.1

(i) State the balanced symbol equation for the type of respiration occurring before exercise in Fig. 4.1.

..... [2]

(ii) Use Fig. 4.1 to calculate the time taken by the student to exercise.

..... minutes [1]

(b) The shaded part of the graph represents an oxygen debt caused by a build-up of lactic acid.

(i) State where lactic acid builds up in the body during vigorous exercise.

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

(ii) Describe how the lactic acid is removed by the body.

.....

.....

.....

.....

.....

.....

..... [3]

(c) Regular exercise reduces the risk of developing coronary heart disease (CHD).

Describe **one** change to a person's diet that can reduce the risk of developing CHD.

..... [1]

[Total: 9]

5 **(a)** Fig. 5.1 shows the arrangement of the particles in the three states of matter.

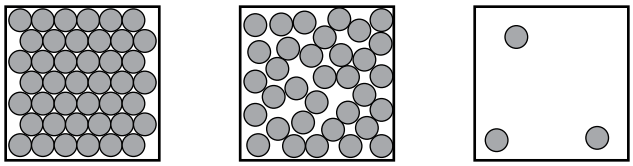

Fig. 5.1

Table 5.1 shows information about the particles in the three states of matter.

Complete Table 5.1.

Table 5.1

state of matter	particle separation	particle arrangement	particle motion
solid	.....	regular	vibrate about fixed positions
liquid	close together	.....	move around each other
gas	far apart	random	.....

[3]

(b) Fig. 5.2 shows a cooling curve for water.

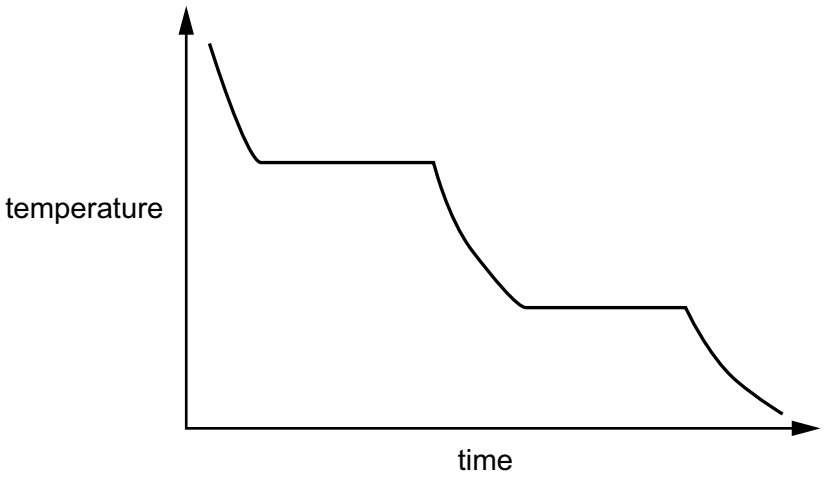

Fig. 5.2

(i) Write a letter **G** on Fig. 5.2 to show when the water is a gas and is cooling down. [1]

(ii) Write a letter **F** on Fig. 5.2 to show when the water is freezing. [1]

(iii) Explain how Fig. 5.2 shows that the water is pure rather than a mixture.

.....

..... [1]

(iv) While cooling, water vapour condenses to form liquid water.

Explain what happens to the particles when forming liquid water. Use ideas about the kinetic particle theory in your answer.

.....

..... [2]

(c) Water is a simple molecular compound with a low melting point and a low boiling point.

Explain why the melting point and boiling point are low.

.....

.....

..... [2]

[Total: 10]

6 **(a)** Aluminium is in Group III of the Periodic Table.

Give **one** reason why aluminium is often used in containers for food and drinks.

..... [1]

(b) Many metals react with dilute acids.

Complete the general equation for this reaction.

Choose words from the list below.

alloy
base
hydrogen
oxygen
salt
water

metal + acid → ..... + ... [2]

(c) When aluminium metal reacts with dilute hydrochloric acid, aluminium atoms form aluminium ions.

The ionic half-equation for this reaction is shown.

$$Al \rightarrow Al^{3+} + 3e^{-}$$

State whether this reaction is oxidation or reduction.

Explain your answer.

.....

..... [1]

(d) (i) Copper reacts with oxygen to form copper(II) oxide.

State whether copper(II) oxide is an acidic oxide or a basic oxide.

Give a reason for your answer.

.....

..... [1]

(ii) Copper(II) oxide, CuO, reacts with sulfuric acid to form copper(II) sulfate and water.

Write the balanced symbol equation for this reaction.

..... [1]

(e) Fig. 6.1 shows the reaction pathway diagram for the reaction between copper(II) oxide and sulfuric acid.

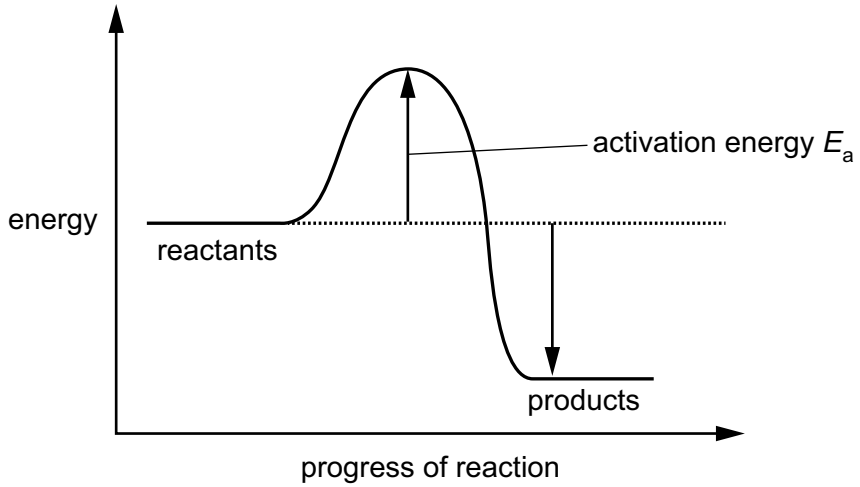

Fig. 6.1

(i) State whether the reaction is exothermic or endothermic.

Explain your answer.

.....

..... [1]

(ii) Define activation energy E_a.

.....

.....

..... [2]

[Total: 9]

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7 **(a)** Hydrogen–oxygen fuel cells use a chemical reaction to produce electricity.

Name the only chemical product made by a hydrogen–oxygen fuel cell.

..... [1]

(b) A vehicle with a petrol (gasoline) engine produces carbon dioxide gas.

Carbon dioxide is a greenhouse gas.

Describe how carbon dioxide causes global warming.

.....

.....

.....

..... [3]

(c) Hydrogen–oxygen fuel cells do **not** produce carbon dioxide.

Describe **one** other advantage and **one** disadvantage of using hydrogen–oxygen fuel cells instead of petrol (gasoline) engines to power vehicles.

advantage .....

.....

disadvantage .....

.....

[2]

(d) (i) A major component of petrol is the compound C_7H_{16}. C_7H_{16} belongs to a homologous series.

Name the homologous series.

..... [1]

(ii) C_7H_{16} burns in oxygen to make carbon dioxide and water.

$$C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$$

Calculate the volume of carbon dioxide made when 2.5 g of C_7H_{16} burns completely in oxygen.

The molar gas volume at r.t.p. is 24 dm^3.

Show your working.

volume of carbon dioxide = ... dm^3 [4]

[Total: 11]

8 **(a)** Magnesium chloride contains the ions Mg^{2+} and Cl^{-}.

(i) State the formula for magnesium chloride.

formula = ... [1]

(ii) Magnesium chloride is a good conductor of electricity when aqueous. It does **not** conduct electricity when solid.

Explain why the conductivity of magnesium chloride is different in these two states.

good conductor when aqueous .....

.....

.....

does **not** conduct electricity when solid .....

.....

.....
[2]

(b) Molten magnesium chloride can be electrolysed.

Construct the balanced ionic half-equation for the reaction at the cathode.

..... [2]

(c) Magnesium chloride is made when magnesium reacts with dilute hydrochloric acid.

A student reacts a piece of magnesium with 40 cm^3 of dilute hydrochloric acid at 20 °C. The student measures the time taken for the reaction to finish.

The student repeats the experiment at 30 °C and 40 °C.

Explain how increasing the temperature affects the rate of reaction.

.....

.....

.....

.....

.....

..... [4]

(d) The rate of reaction between magnesium and dilute hydrochloric acid can be increased by adding a catalyst.

State how a catalyst increases the rate of a reaction.

.....

..... [1]

[Total: 10]

9 **(a)** A car accelerates from rest with a **constant** acceleration of $10\,m/s^2$ for 3.0 seconds.

(i) Define acceleration.

..... [1]

(ii) On Fig. 9.1, draw a speed–time graph for the car's motion.

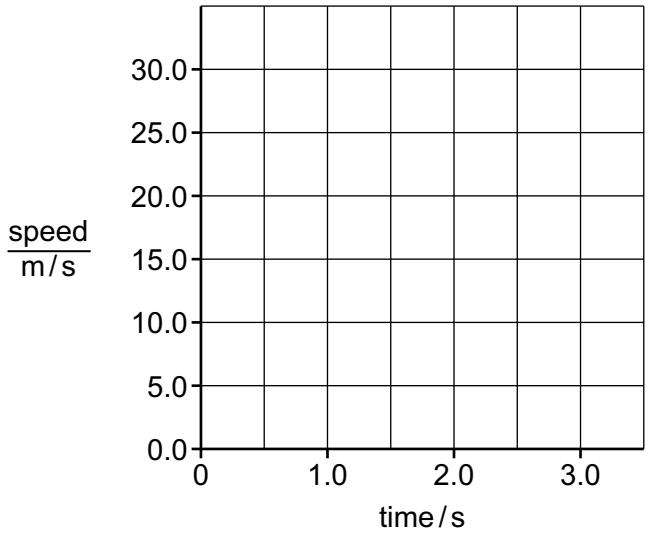

Fig. 9.1

[2]

(iii) The mass of the car is 1750 kg.

Calculate the force required to produce an acceleration of $10\,m/s^2$.

force = ... N [2]

(b) Acceleration is a vector quantity.

(i) State what is meant by the term vector quantity.

.....

..... [1]

(ii) Place ticks (✓) in Table 9.1 to identify the quantities that are vectors.

One example has been done for you.

Table 9.1

quantity	vector
acceleration	✓
distance	
energy	
gravitational field strength	
mass	
velocity	

[2]

(c) Two lamps are connected in parallel with a 12 V battery. The lamps are identical.

Fig. 9.2 shows the circuit diagram for the lamps.

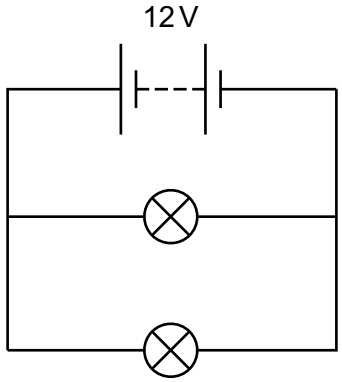

Fig. 9.2

The current in the battery is 0.60 A.

Calculate the resistance of **one** of the lamps.
State the unit for your answer.

resistance = ... unit = ... [3]

(d) Each headlamp of the car contains a thin converging lens.

A converging lens can be used to form a virtual image.

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

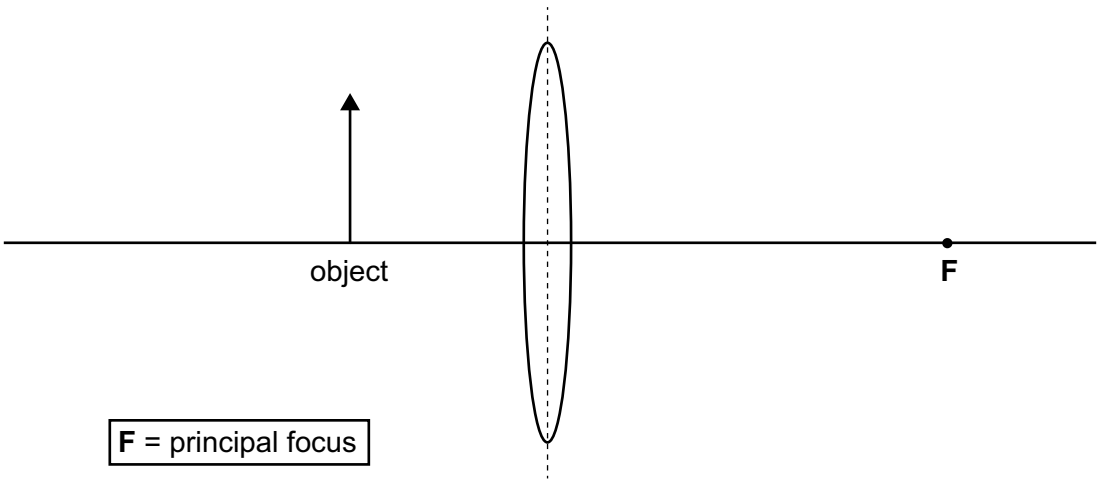

Fig. 9.3

[3]

[Total: 14]

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10 Fig. 10.1 shows a simple diagram of the Solar System.

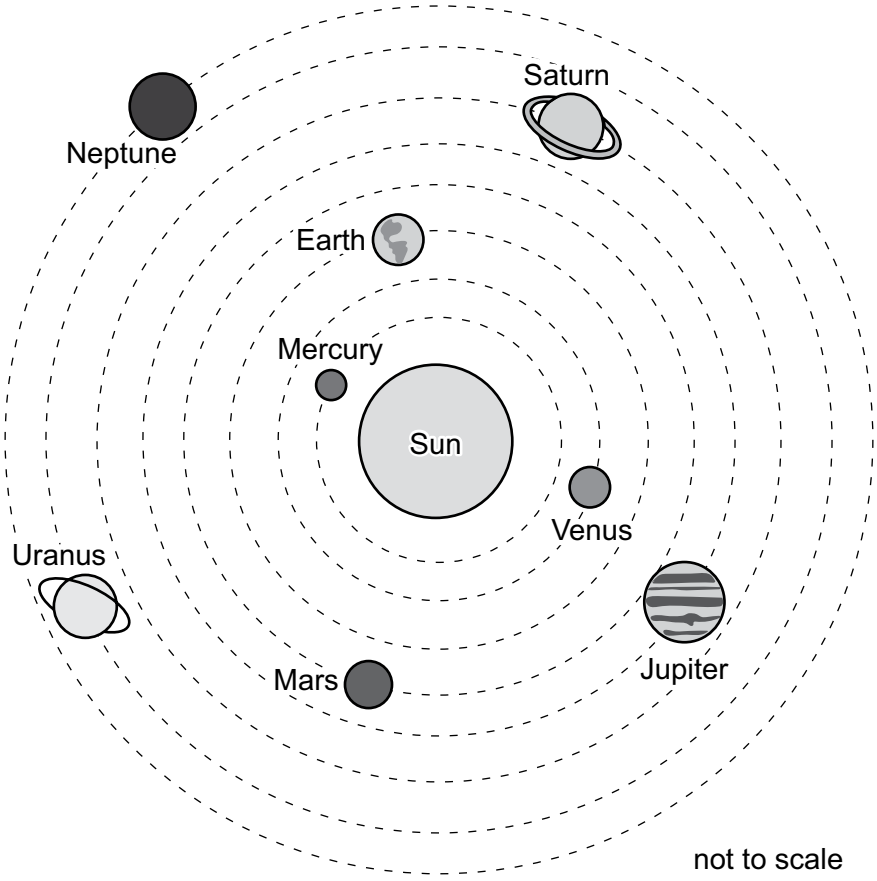

Fig. 10.1

(a) Saturn is in orbit around the Sun.

(i) Draw an arrow (→) on Fig. 10.1 to show the direction of the force that keeps Saturn in orbit around the Sun. [1]

(ii) State the name of the force that keeps Saturn in orbit around the Sun.

..... [1]

(iii) The mean distance between Saturn and the Sun is 1.43×10^{12} m.
It takes 11 000 Earth days for Saturn to complete one orbit of the Sun.

Calculate the orbital speed of Saturn.

orbital speed = ... m / s [3]

(b) The Sun is a stable star formed 5 billion years ago.

Describe the formation of a stable star.

.....

.....

..... [2]

(c) Describe what the Big Bang Theory states in terms of the formation of the Universe.

.....

.....

.....

..... [2]

[Total: 9]

11 Fig. 11.1 shows a set of traffic lights containing light-emitting diodes (LEDs).

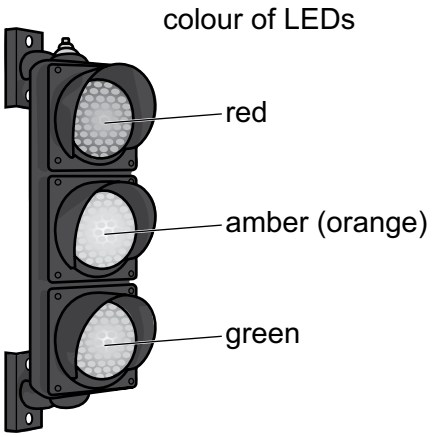

Fig. 11.1

(a) The different coloured LEDs emit light with different frequencies and wavelengths.

(i) Table 11.1 contains the frequencies and wavelengths of red, amber (orange) and green light.

Place ticks (✓) in Table 11.1 to identify the frequency and wavelength of the red LED.

The amber (orange) LED has been done for you.

Table 11.1

		red LED	**amber (orange) LED**
frequency / Hz	4.62×10^{14}		
	4.92×10^{14}		✓
	5.66×10^{14}		
wavelength / m	5.30×10^{-7}		
	6.10×10^{-7}		✓
	6.50×10^{-7}		

[1]

(ii) Use the data in Table 11.1 for the amber (orange) LED to show that the speed of light is 3.0×10^{8} m / s.

[1]

(b) Each LED has a potential difference of 3.6 V across it and a current of 0.025 A in it.

(i) Calculate the total power input for each LED.

total power input = ... W [2]

(ii) The LEDs have an efficiency of 40%.

Calculate the useful power output for each LED.

useful power output = ... W [2]

(c) Draw the circuit symbol for an LED.

[1]

[Total: 7]

12 Fig. 12.1 shows a diagram of a nuclear power station.

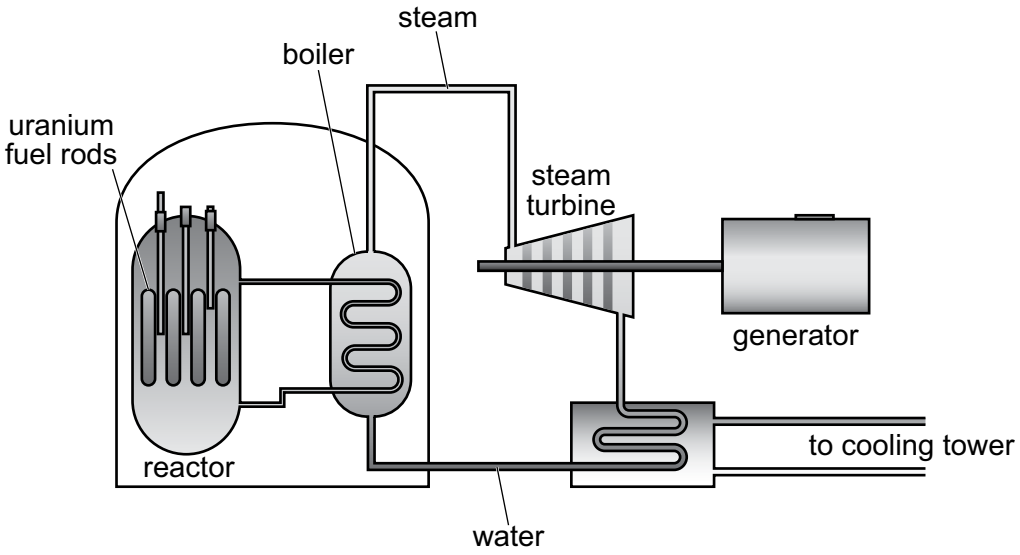

Fig. 12.1

(a) The nuclear power station uses nuclear fission of uranium to generate electricity.

(i) State what is meant by nuclear fission.

.....

..... [1]

(ii) Thermal energy from the nuclear fission of uranium changes water into steam in the boiler.

Describe how the steam exerts a pressure inside the boiler.

.....

.....

.....

..... [2]

(iii) The pressure in the steam causes the turbine to move faster.

State the type of energy store that increases when the turbine moves faster.

..... [1]

(b) Fig. 12.2 shows a simple a.c. generator similar to the generator found in the power station.

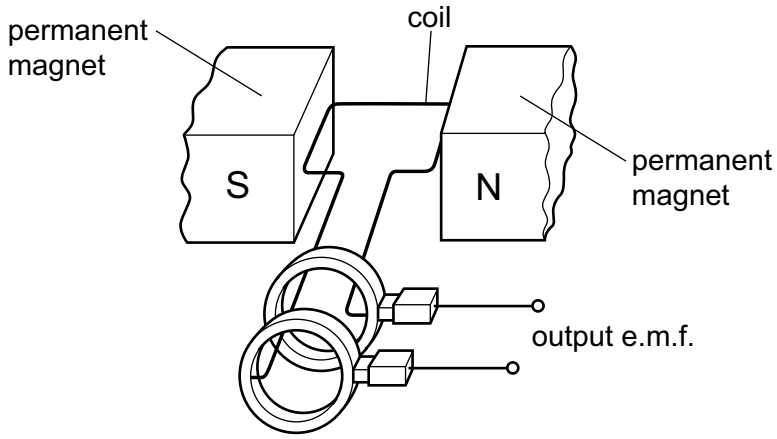

Fig. 12.2

(i) A magnetic field exists between the permanent magnets.

State what is meant by a magnetic field.

.....

..... [1]

(ii) One way of increasing the output e.m.f. of the generator is to rotate the coil faster.

State **two** other ways of increasing the output e.m.f. of the generator.

1 .....

.....

2 .....

.....
[2]

(iii) Fig. 12.3 shows the output e.m.f. from the generator.

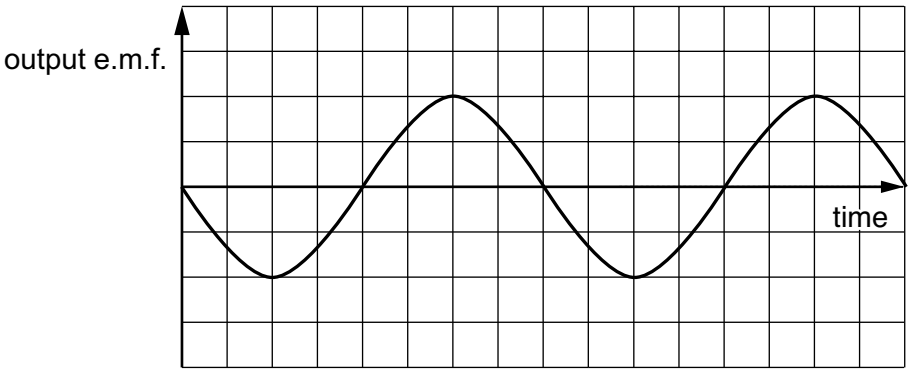

Fig. 12.3

On Fig. 12.3, sketch the output e.m.f. from the generator when the coil rotates faster. [3]

[Total: 10]

The Periodic Table of Elements

Key

atomic number
atomic symbol
name
relative atomic mass

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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

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.).