Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

2684094165

CO-ORDINATED SCIENCES **0654/42**

Paper 4 Theory (Extended) **October/November 2021**

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 **28** pages. Any blank pages are indicated.

1 Enzymes have an important role in the process of digestion.

(a) Define the term *enzyme*.

.....

..... [2]

(b) Fig. 1.1 shows the effect of pH on two different enzymes.

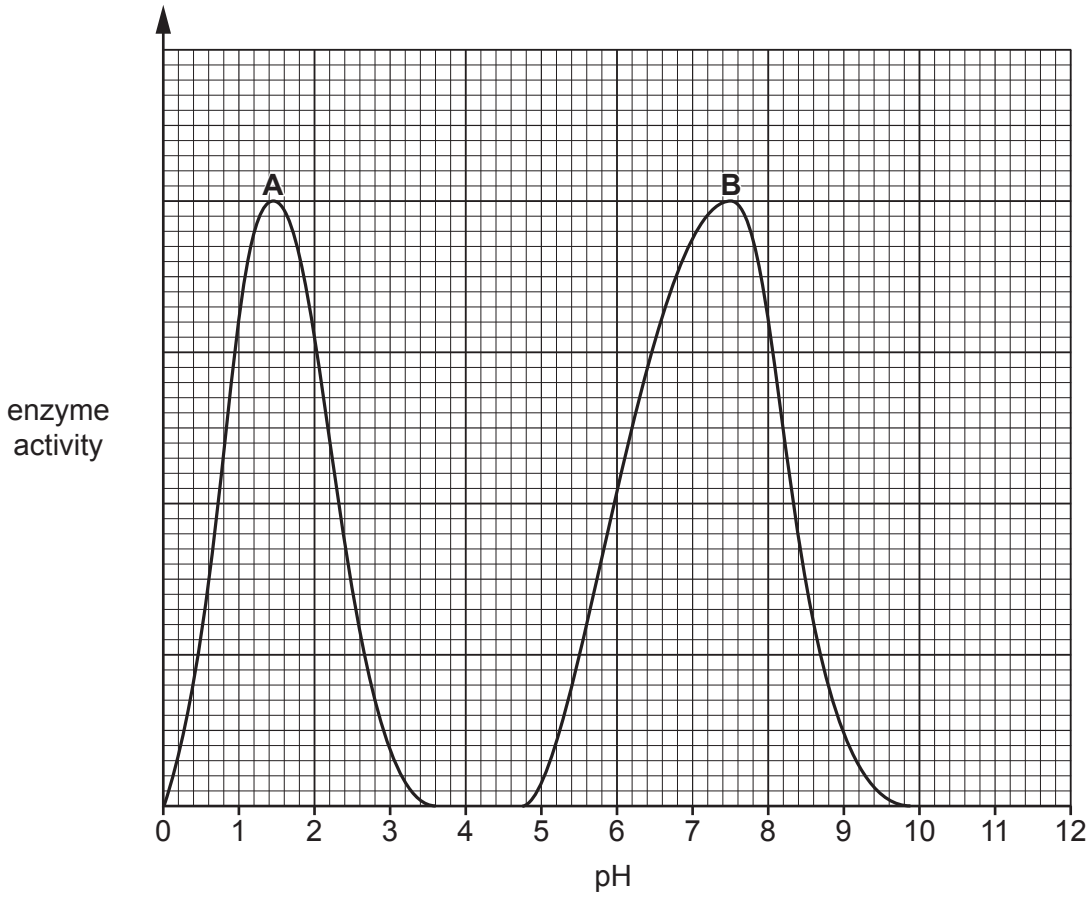


Fig. 1.1

(i) State the pH at which enzyme **B** is most active in Fig. 1.1.

..... [1]

(ii) Explain the results for enzyme **B** at pH 10 in Fig. 1.1.

.....

.....

.....

.....

..... [3]

(iii) State where in the alimentary canal enzyme **A** is most likely to be found.

..... [1]

(iv) Suggest the name of enzyme **A**.

..... [1]

(c) Once food is digested, nutrients are absorbed across the villi walls.

(i) State where villi are found in the alimentary canal.

..... [1]

(ii) State the function of the lacteal in the villi.

..... [1]

[Total: 10]

2 Carbon monoxide is a common pollutant in the air.

Many countries have rules to limit the maximum percentage of carbon monoxide in exhaust gases produced by car engines.

Table 2.1 shows how the maximum allowed percentage (%) of carbon monoxide in car exhaust gases has changed in the United Kingdom.

Table 2.1

year	maximum allowed percentage (%) of carbon monoxide
1985	4.5
1990	3.5
1995	0.5
2000	0.3

(a) Suggest **one** reason why the maximum allowed percentage (%) of carbon monoxide in car exhaust gases has decreased since 1985.

.....

..... [1]

(b) Describe and explain how carbon monoxide is produced when petrol is burned in a car engine.

.....

.....

..... [2]

(c) Catalytic converters are fitted to car exhausts to reduce the volume of pollutants released into the air.

Complete the symbol equation to show how a catalytic converter removes carbon monoxide gas.

.... CO + ... → .....

[2]

(d) Catalytic converters remove oxides of nitrogen as well as carbon monoxide from exhaust gases.

State **two** other effects of air pollution which are reduced by using catalytic converters.

.....

.....

.....[2]

(e) The catalyst in a catalytic converter is made from metal.

State where in the Periodic Table this metal is most likely to be found.

Choose from the list.

group I elements

group VII elements

group 0 elements

transition elements

..... [1]

[Total: 8]

3 **(a)** Fig. 3.1 shows four electrical component names and their symbols.

Draw lines to match each component name with its symbol.

One line has been drawn as an example.

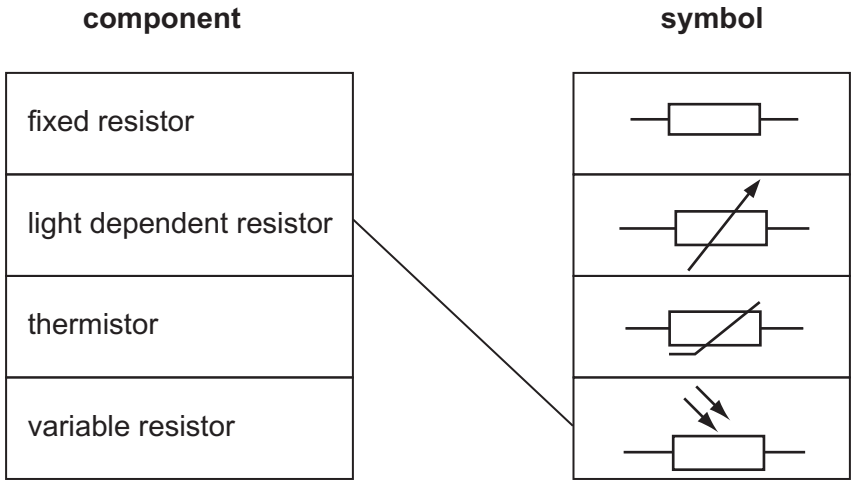


Fig. 3.1

[2]

(b) A student investigates how the resistance of a thermistor changes with temperature.

Fig. 3.2 shows the results of this investigation.

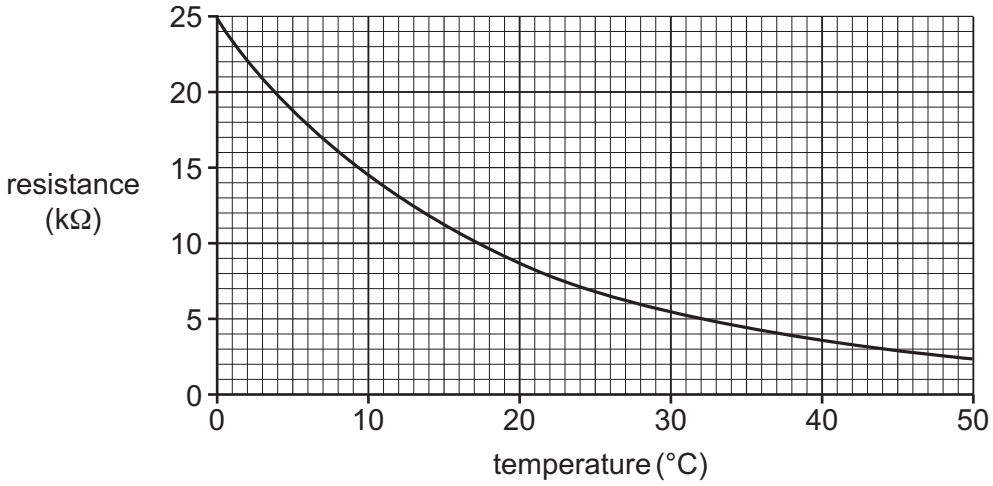


Fig. 3.2

(i) Using Fig. 3.2, state the temperature when the resistance of the thermistor is 5 kΩ.

temperature = ... °C [1]

(ii) Calculate the total resistance of two identical thermistors placed in series when the resistance of each thermistor is 5 kΩ.

total resistance = ... kΩ [1]

(iii) Calculate the total resistance of two identical thermistors placed in parallel when the resistance of each thermistor is 5 kΩ.

total resistance = ... kΩ [2]

(c) A fixed resistor has a current of 3.4 A passing through it.

Calculate the charge passing through the fixed resistor during 25 seconds. State the unit of your answer.

charge = ... unit ..... [3]

[Total: 9]

4 **(a)** A student investigates the effect of light intensity on the rate of photosynthesis at two different temperatures.

Fig. 4.1 shows the results.

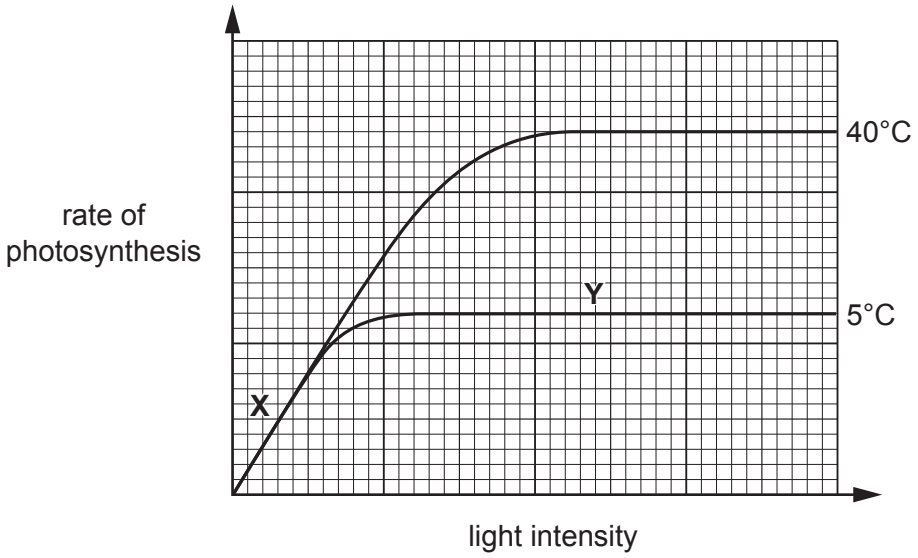


Fig. 4.1

(i) Compare the effect of light intensity on the rate of photosynthesis at the two different temperatures seen in Fig. 4.1.

.....

.....

.....

.....

.....

..... [3]

(ii) State the factor limiting the rate of photosynthesis at point **X** in Fig. 4.1.

..... [1]

(iii) Complete the sentences to explain why light is necessary for photosynthesis.

The light energy is absorbed by a chemical in the leaf called ..... .

This chemical then transfers the light energy to ..... energy in molecules.

The energy is used to synthesise ..... .

[3]

(b) State the word equation for photosynthesis.

..... [2]

(c) Name the cells in a leaf where most photosynthesis occurs.

..... [1]

[Total: 10]

5 Large hydrocarbon molecules can be cracked to make smaller molecules.

The equation represents the cracking of hydrocarbon, $C_{20}H_{42}$.

$$C_{20}H_{42} \rightarrow C_6H_{14} + 2C_5H_{10} + 2C_2H_4$$

(a) State the formula of the product of the reaction which is an **alkane**.

..... [1]

(b) Table 5.1 shows the boiling point, flammability and viscosity of $C_{20}H_{42}$ compared with the properties of C_6H_{14}, C_5H_{10} and C_2H_4.

Table 5.1

	boiling point	**flammability**	**viscosity**
A	lowest	lowest	lowest
B	lowest	highest	highest
C	highest	lowest	lowest
D	highest	lowest	highest

State which letter, **A**, **B**, **C** or **D**, shows how the properties of $C_{20}H_{42}$ compare with the properties of C_6H_{14}, C_5H_{10} and C_2H_4.

..... [1]

(c) The hydrocarbon C_2H_4 is burnt in air.

Complete combustion occurs.

Write the balanced symbol equation for this reaction.

..... [2]

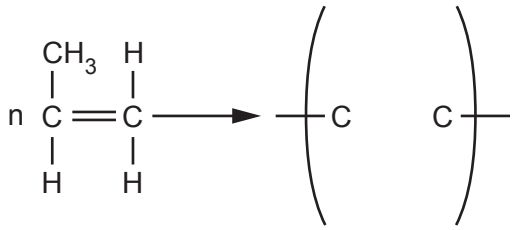
(d) Nylon is a polymer produced when monomers join together and release a small molecule.

State the name of the small molecule released.

..... [1]

(e) Poly(propene) is a polymer made from the monomer propene.

Complete the equation to show the structure of poly(propene).



[2]

(f) Propene, C_3H_6, reacts with aqueous bromine.

The balanced symbol equation for the reaction is shown.

$$C_3H_6 + Br_2 \rightarrow C_3H_6Br_2$$

(i) Describe what is seen when propene reacts with aqueous bromine.

..... [1]

(ii) Fig. 5.1 shows the energy level diagram for the reaction of propene with aqueous bromine.

Complete the energy level diagram in Fig. 5.1.

Include labelled arrows to show:

- the energy given out
- the activation energy.

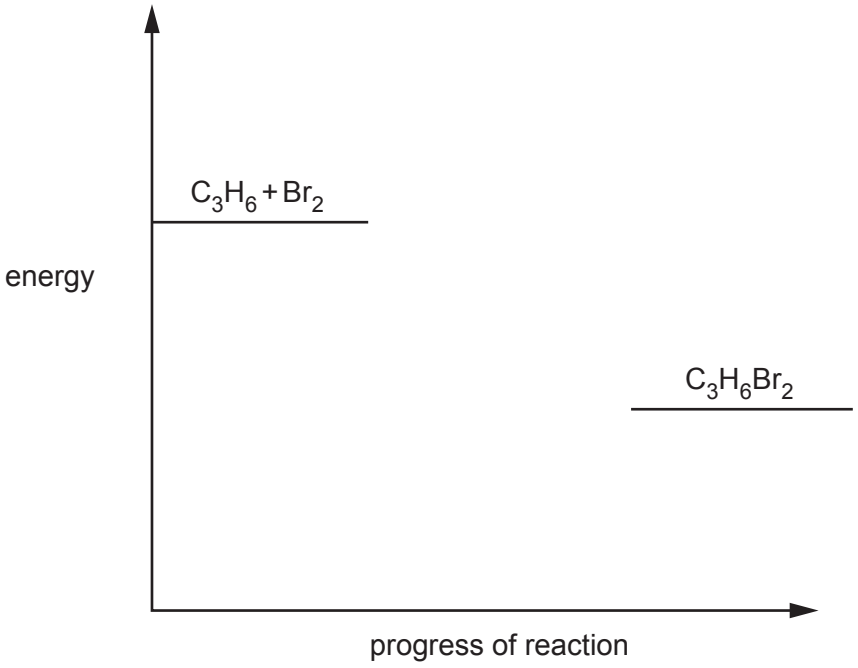


Fig. 5.1

[3]

[Total: 11]

6 Fig. 6.1 shows a rollercoaster ride at a theme park. The rollercoaster travels on a frictionless track.

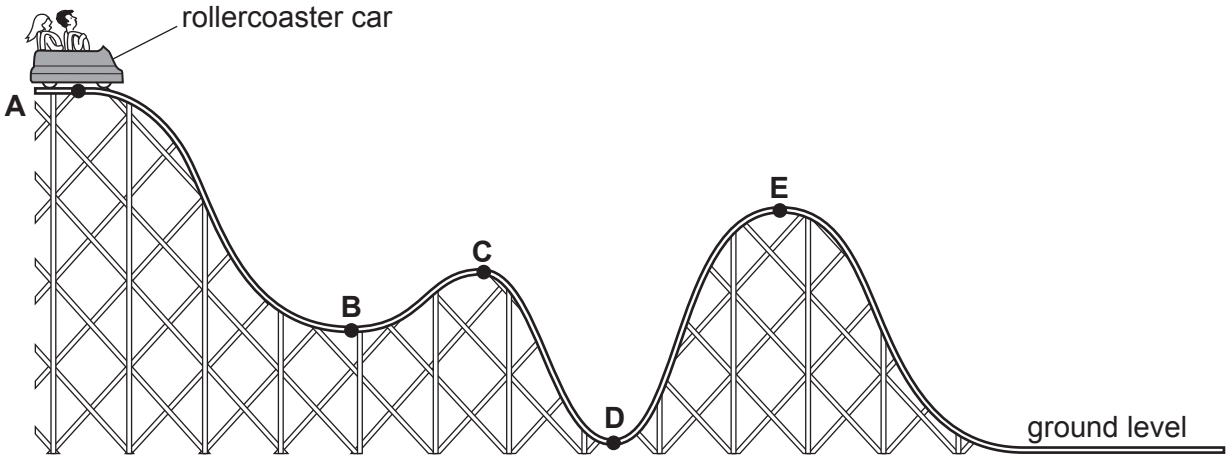


Fig. 6.1

(a) Use a letter from **A** to **E** to state the position at which the rollercoaster car has:

- the least gravitational potential energy .....
- less kinetic energy than it does at position **E** .....
- the most kinetic energy. ..... [2]

(b) The rollercoaster car has a mass of 750 kg. At position **C** the rollercoaster car is 36 m above the ground level and is moving at 20 m/s.

(i) Calculate the gravitational potential energy lost by the rollercoaster car as it travels from **C** to the ground level.
gravitational field strength g = 10 N / kg

gravitational potential energy = ... J [2]

(ii) Calculate the kinetic energy of the rollercoaster car at **C**.

kinetic energy = ... J [2]

(iii) State the change in the total energy of the rollercoaster car as it travels on the frictionless track from **C** to ground level.

change in total energy = ... J [1]

(c) Fig. 6.2 shows a speed-time graph for the rollercoaster car's journey between positions **D** and **E**.

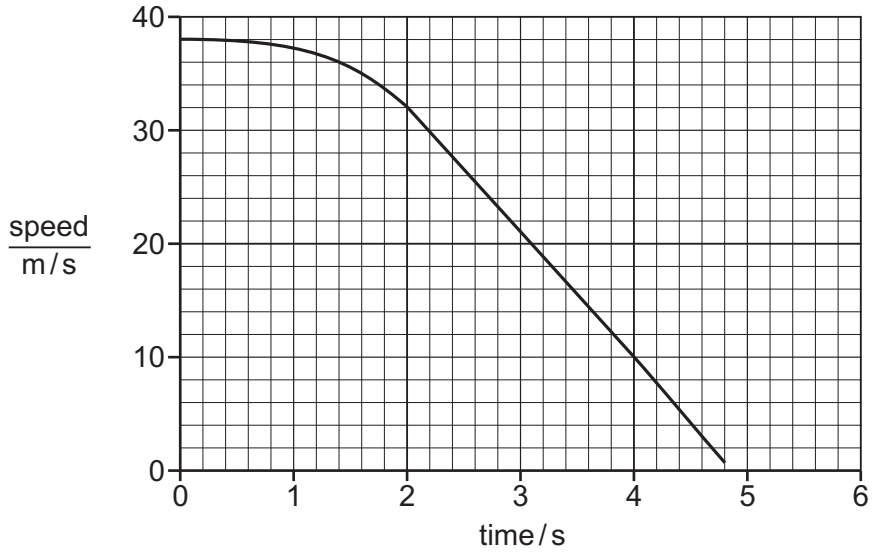


Fig. 6.2

(i) Use Fig. 6.2 to determine the change in speed of the rollercoaster car between t = 2 s and t = 4 s.

change in speed = ... m / s [1]

(ii) Calculate the acceleration of the rollercoaster car between t = 2 s and t = 4 s.

acceleration = ... m / s^2 [2]

(iii) Use Fig. 6.2 to describe the motion of the rollercoaster car between t = 0 s and t = 5 s.

.....

.....

.....

.....

..... [3]

[Total: 13]

7 **(a)** Fig. 7.1 is a diagram of a human eye.

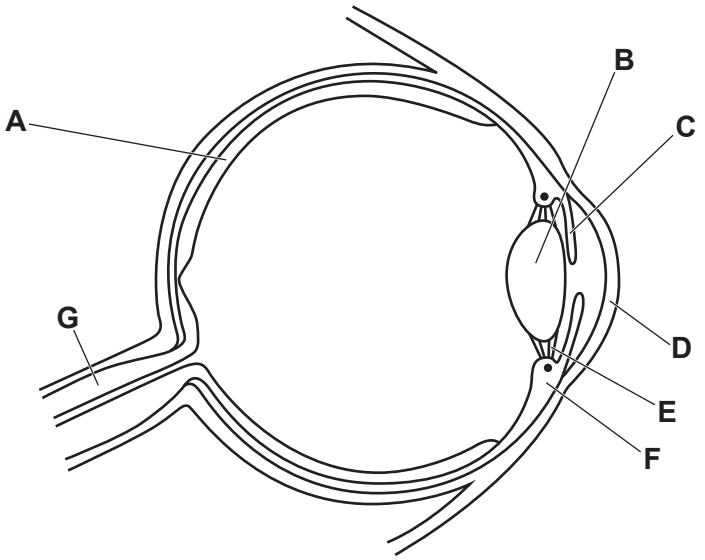


Fig. 7.1

(i) Table 7.1 shows some of the letters, the names and functions of the parts in Fig. 7.1.

Complete Table 7.1.

Table 7.1

name of part	letter in Fig. 7.1	function
		adjusts the amount of light entering the eye
	G	
retina		
	D	refracts light entering the eye

[4]

(ii) State the letters in Fig. 7.1 of the **two** parts of the eye responsible for changing the shape of the lens during accommodation.

..... [1]

(iii) Name the **two** muscles in the iris responsible for the pupil reflex.

1 .....

2 .....

[2]

(b) The pupil reflex is an involuntary action.

Place ticks (✓) in the boxes to show **two voluntary** actions.

blinking when dust gets in your eye	
eating a burger	
reading a book	
removing your hand from a very hot object	
sweating when you get hot	

[2]

[Total: 9]

8 A scientist investigates the electrolysis of lead(II) bromide.

Fig. 8.1 shows the apparatus the scientist uses.

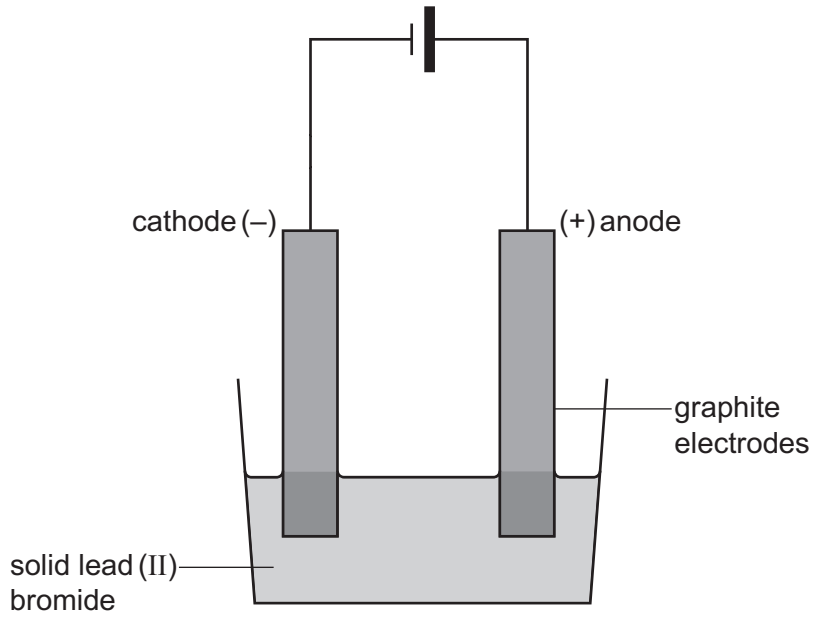


Fig. 8.1

(a) Explain why electrolysis will **not** take place using the apparatus shown in Fig. 8.1.

.....

.....

..... [2]

(b) The electrodes are made of graphite.

Explain why graphite conducts electricity.

Use ideas about the structure and bonding in graphite.

.....

.....

..... [2]

(c) Another scientist investigates the electrolysis of concentrated aqueous sodium chloride.

Fig. 8.2 shows the apparatus the scientist uses.

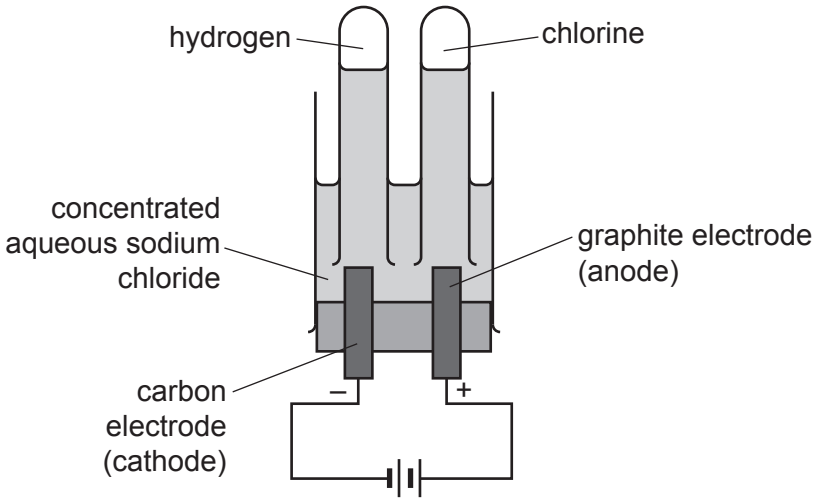


Fig. 8.2

(i) Describe the test for chlorine gas and its positive result.

test .....

result ..... [2]

(ii) The scientist collects 3.3 cm^3 of chlorine gas, Cl_2, in the electrolysis experiment.

Calculate the mass of chlorine gas collected.

The molar gas volume at 25 °C is 24 dm^3.

Show your working.
[A_r: C*l*, 35.5]

mass of chlorine gas = ... [4]

[Total: 10]

9 Fig. 9.1 shows a helium filled balloon attached to a spring. The spring is attached to a table top to stop the balloon moving upwards.

The balloon is in equilibrium.

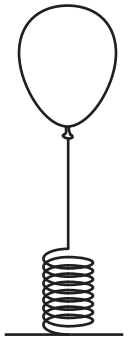


Fig. 9.1

(a) The helium filled balloon has a mass of 6.5 g.

(i) Calculate the weight of the helium filled balloon.
gravitational field strength g = 10 N / kg

weight = ... N [2]

(ii) The balloon causes the spring to extend by 0.50 cm.
The spring constant of the spring is 0.45 N / cm.
Calculate the force on the spring.

force = ... N [2]

(iii) State the total downwards force acting on the balloon.

force = ... N [1]

(b) A student places the balloon under an infrared lamp to warm the helium gas.

(i) Suggest the colour of balloon which will give the greatest rate of increase in gas temperature.
Explain your answer.

colour .....

explanation

.....

..... [2]

(ii) Explain why the size of the balloon increases as it is heated.

.....

.....

.....

.....

..... [3]

[Total: 10]

10 **(a)** Table 10.1 shows the daily energy requirements of different females.

Table 10.1

type of person	daily energy requirement / kJ
30-year-old female	7 800
30-year-old breast-feeding female	9 100
30-year-old pregnant female	10 200

(i) Calculate the difference in daily energy requirement between a 30-year-old female and a 30-year-old breast-feeding female in Table 10.1.

..... kJ [1]

(ii) Explain why there is a difference in daily energy requirement of a 30-year-old female and a 30-year-old pregnant female in Table 10.1.

.....

.....

.....

..... [2]

(b) State **one** food group which is a good source of **vitamin C**.

..... [1]

(c) Vitamins and minerals are important components of a balanced diet.

Name **three other** components of a balanced diet.

1 .....

2 .....

3 .....

[3]

(d) Dissolved nutrients cross the placenta from mother to fetus.

The boxes on the left show some parts of a pregnant female's body.

The boxes on the right show the functions of these parts.

Draw lines to link each part with its function.

amniotic fluid	acts as a barrier against toxins
placenta	protects the fetus from mechanical damage
umbilical cord	transfers materials between fetus and the placenta
uterus	where the fetus develops

[3]

(e) State the name of the excretory gas that would pass from fetus to the mother.

..... [1]

[Total: 11]

11 **(a)** An oxygen atom has the electronic structure 2,6.

Use the electronic structure to explain which group of the Periodic Table oxygen is in.

.....

..... [2]

(b) Sodium forms an **ionic** compound with oxygen.

State the formulae of a sodium ion and an oxide ion.

Use the formulae of the ions to determine the formula of the ionic compound sodium oxide.

formula of a sodium ion .....

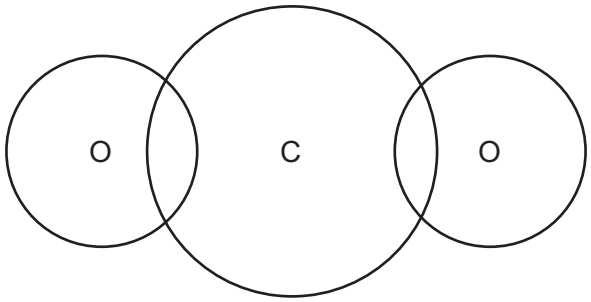
formula of an oxide ion .....

formula of sodium oxide .....
[3]

(c) Oxygen can also form **covalent** bonds.

Complete the dot-and-cross diagram to show the covalent bonding in a molecule of carbon dioxide.

You only need to include the outer shell electrons.



[3]

(d) Covalent compounds, such as carbon dioxide, have low melting points.

State which letter, **A**, **B**, **C** or **D**, in Table 11.1 gives the correct explanation for why most covalent compounds have low melting points.

Table 11.1

	explanation
A	covalent bonds are strong
B	covalent bonds are weak
C	electrons are free to move
D	weak intermolecular forces of attraction

..... [1]

(e) Calculate the relative molecular mass, M_r, of aluminium sulfate, Al_2SO_4.

Show your working.

[A_r: A*l*, 27; O, 16; S, 32]

relative molecular mass = ... [2]

[Total: 11]

12 (a) (i) State the speed of visible light in a vacuum.

..... m/s [1]

(ii) Red light has a wavelength of 7.1×10^{-7} m.

Use your answer to **(a)(i)** to calculate the frequency of red light.

frequency = ... Hz [2]

(b) A laser is a device which emits a ray of light.
Fig. 12.1 shows a beam of red light from a laser passing through a rectangular glass block.

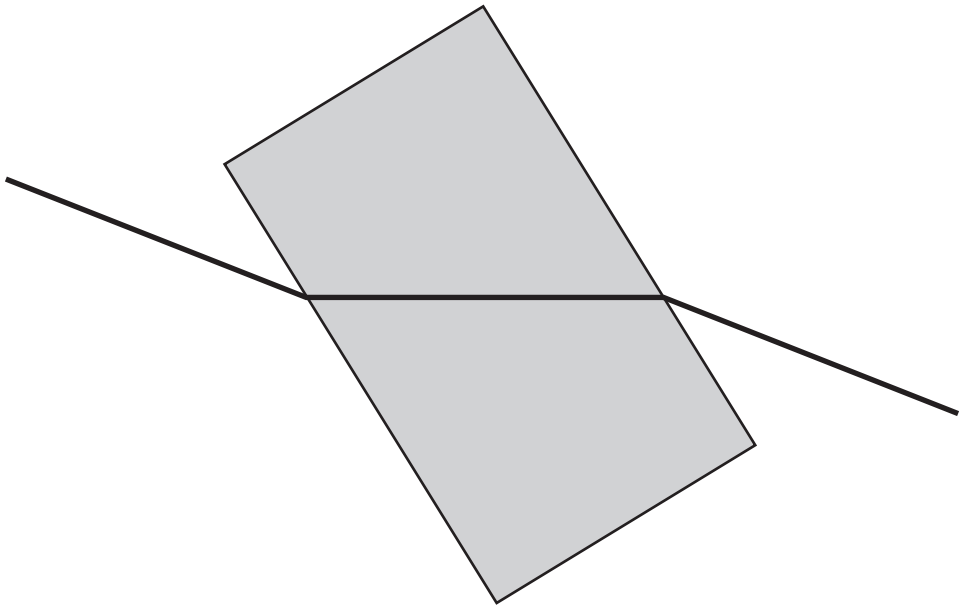


Fig. 12.1

(i) Name the process shown in Fig. 12.1.

..... [1]

(ii) Describe what causes the process shown in Fig. 12.1.

.....

..... [2]

(c) The laser used in Fig. 12.1 has a useful power output of 1200 W and is 80% efficient.

Calculate the power input of the laser.

power input = ... W [2]

[Total: 8]

BLANK PAGE

BLANK PAGE

The Periodic Table of Elements

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 –		114 Fl flerovium –		116 Lv livermorium –		

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.).