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2829534939

COMBINED SCIENCE **0653/42**

Paper 4 Theory (Extended) **February/March 2022**

1 hour 15 minutes

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 80.
- 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 **24** pages. Any blank pages are indicated.

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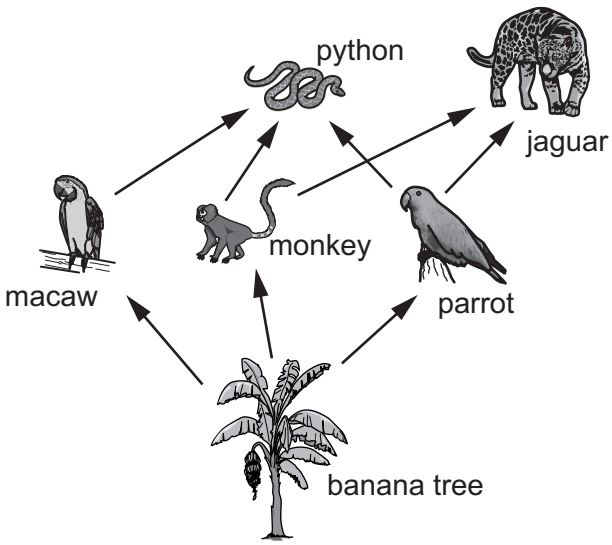
1 **(a)** Fig. 1.1 shows part of a food web.



not to scale

Fig. 1.1

(i) Construct a food chain using Fig. 1.1 that includes the macaw.

..... [2]

(ii) Describe how energy is transferred from the banana tree to the jaguar.

.....

.....

..... [2]

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(b) The leaves of a banana tree contain parts with different functions. The different parts have features that help them with their function.

Table 1.1 shows some of the parts of the leaf, their feature and their function.

Complete Table 1.1.

Table 1.1

part of leaf	feature	function
palisade mesophyll layer	.....	photosynthesis
spongy mesophyll layer	air spaces	.....
xylem tissue	hollow	.....

[3]

(c) Fig. 1.2 is a graph showing the effect of light intensity on the rate of photosynthesis.

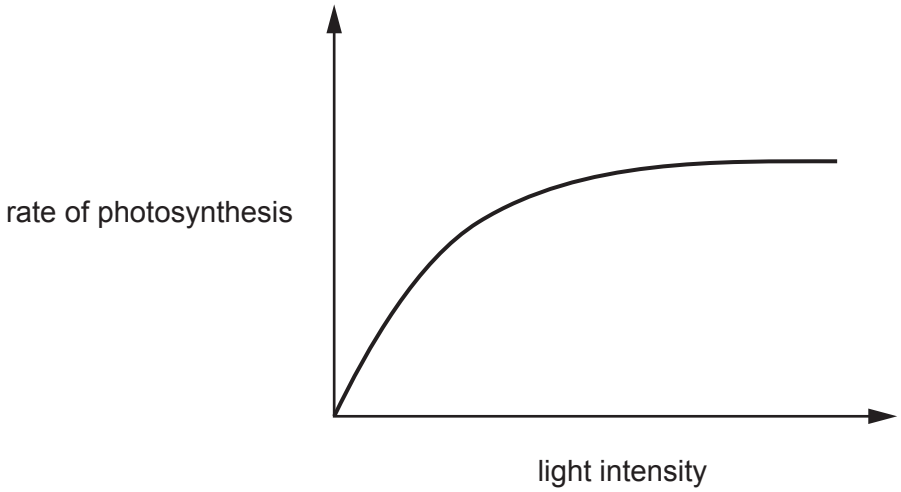

Fig. 1.2

Describe the effect of light intensity on the rate of photosynthesis in Fig. 1.2.

.....

.....

..... [2]

[Total: 9]

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2 Fig. 2.1 shows only the outer shell electrons in atoms of elements **X**, **Y** and **Z**.

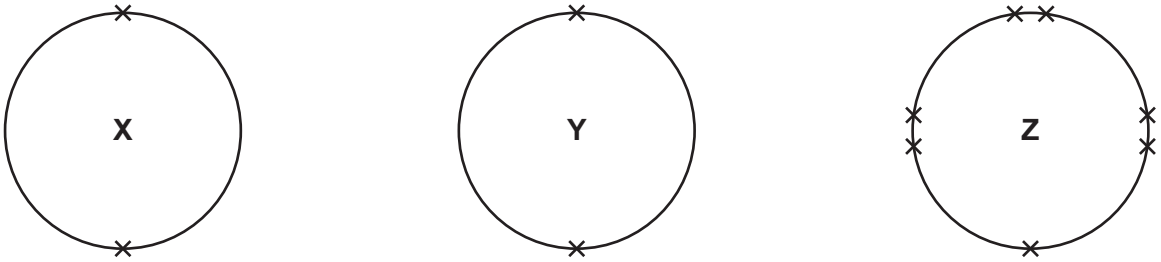

Fig. 2.1

(a) State which element, **X**, **Y** or **Z**, is a halogen.

Explain your answer.

element .....

explanation .....

.....

[1]

(b) Table 2.1 shows the formula and some information about substances which contain the elements **X**, **Y** and **Z**.

Table 2.1

formula	state at room temperature	other information
$\mathbf{XZ_2}$	solid	ionic compound
X	solid	metal
Y	gas	exists as single atoms
$\mathbf{Z_2}$	gas	exists as molecules

(i) Use the information in Fig. 2.1 and Table 2.1 to identify the group of the Periodic Table to which element **X** belongs.

Explain your answer.

group .....

explanation .....

.....

.....

[2]

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(ii) Element **Y** is **not** in the same group of the Periodic Table as element **X**.

Explain how information in Table 2.1 shows that elements **X** and **Y** are in different groups.

.....

..... [1]

(iii) Identify element **Y**.

..... [1]

(iv) Put ticks (✓) in the boxes to show which statements about $\mathbf{Z_2}$ are true and which are false.

statement	true	false
The bond between two atoms in $\mathbf{Z_2}$ is a double bond.		
The bonding in $\mathbf{Z_2}$ is covalent.		
$\mathbf{Z_2}$ molecules are diatomic.		
$\mathbf{Z_2}$ is non-metallic.		

[2]

(v) The ionic solid $\mathbf{XZ_2}$ contains ions of element **X** and ions of element **Z**.
State the charge on each of these ions.

Explain your answers.

charge on an ion of element **X** …….

charge on an ion of element **Z** …….....….....

explanation .....

.....

.....

[3]

[Total: 10]

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3 A child in a toy car moves forward at a constant speed of 0.7 m / s.

The car and child have a total mass of 20 kg.

Fig. 3.1 shows the forces acting on the car.

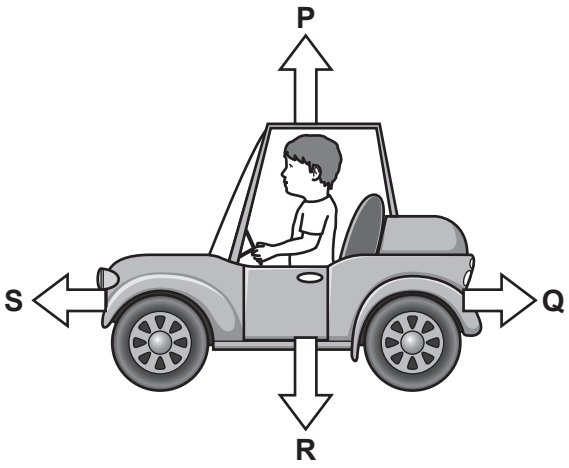

Fig. 3.1

(a) (i) State the name of force **Q**.

..... [1]

(ii) Force **S** is 25 N.

State the magnitude of force **Q**.

force **Q** = ... N [1]

(b) Calculate the kinetic energy of the car and child.

kinetic energy = ... J [2]

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(c) Fig. 3.2 shows a speed–time graph for the motion of the toy car.

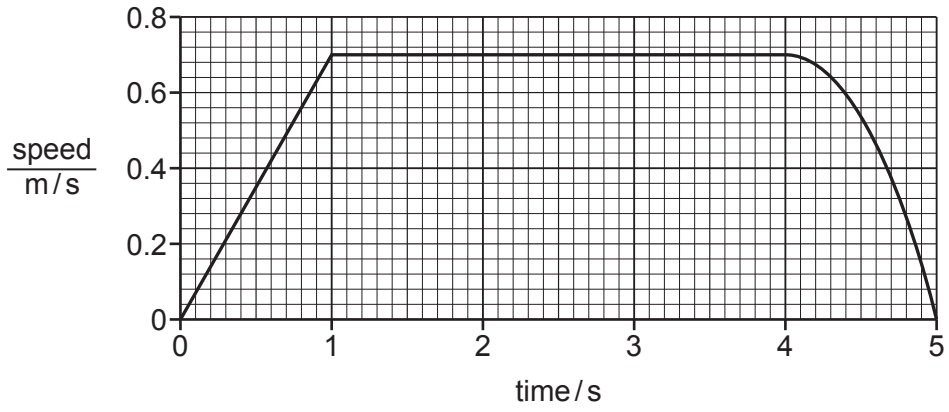

Fig. 3.2

(i) Calculate the distance travelled by the car in the first 4 seconds of its motion.

distance = ... m [3]

(ii) Calculate the acceleration of the car between time = 0 s and time = 1 s.

Give the units of your answer.

acceleration = ... units ..... [3]

[Total: 10]

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4 **(a)** Fig. 4.1 shows the first part of the alimentary canal and associated organs.

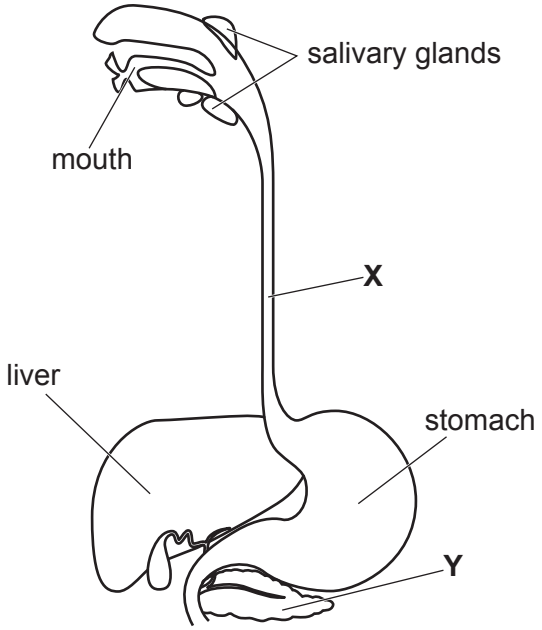

Fig. 4.1

(i) Identify structures **X** and **Y** in Fig. 4.1.

X .....

Y .....
[2]

(ii) Explain the importance of salivary glands to chemical digestion in the mouth.

.....

.....

.....

.....

..... [3]

(b) Describe the dietary importance of fibre (roughage).

.....

..... [1]

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(c) Water moves in and out of cells in the body.

Fig. 4.2 shows a red blood cell in a beaker of concentrated sugar solution.

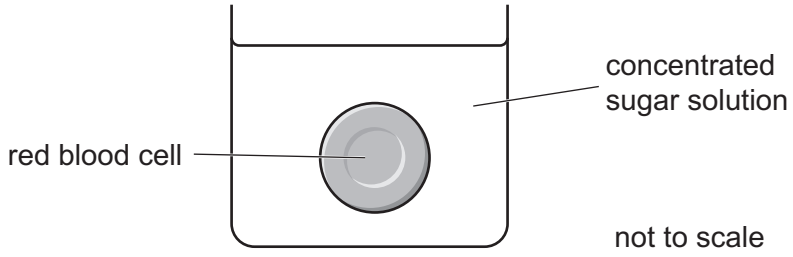

Fig. 4.2

The cell in Fig. 4.2 loses water and shrinks.

Explain why.

Use ideas about water potential in your answer.

.....

.....

.....

.....

..... [3]

(d) Red blood cells are found inside capillaries.

Explain how the structure of capillaries is adapted to their function.

.....

.....

..... [2]

[Total: 11]

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5 Hydrogen and oxygen are made when dilute sulfuric acid is electrolysed using inert electrodes, as shown in Fig. 5.1.

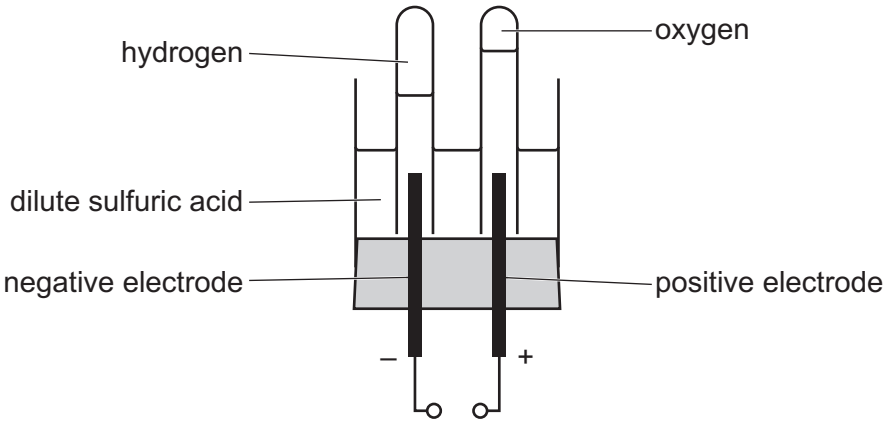

Fig. 5.1

(a) Describe the tests and positive results for hydrogen and for oxygen.

test for hydrogen .....

result .....

test for oxygen .....

result .....

[2]

(b) The ionic equations for the reaction at each electrode are shown.

at the negative electrode $2H^+(.....) + 2e^- \longrightarrow H_2(.....)$

at the positive electrode $4OH^-(.....) \longrightarrow O_2(.....) + 2H_2O(.....) + 4e^-$

(i) Complete the ionic equations by adding in the missing state symbols. [2]

(ii) Explain the changes that happen at each electrode.

Use ideas about electrons in your answer.

.....

.....

.....

..... [2]

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(c) The sulfuric acid is **not** all used up during the electrolysis.

State a test and its result to show that the solution is acidic at the end of the electrolysis.

test .....

result .....
[1]

[Total: 7]

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6 **(a)** Fig. 6.1 shows a thin converging lens.

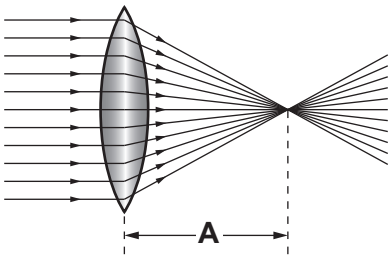

Fig. 6.1

State the name of the distance labelled **A**.

..... [1]

(b) Fig. 6.2 shows a glass measuring cylinder containing 50.0 cm^3 of liquid at 20 °C.

A student is using the thin converging lens as a magnifying glass to read the level of liquid on the scale.

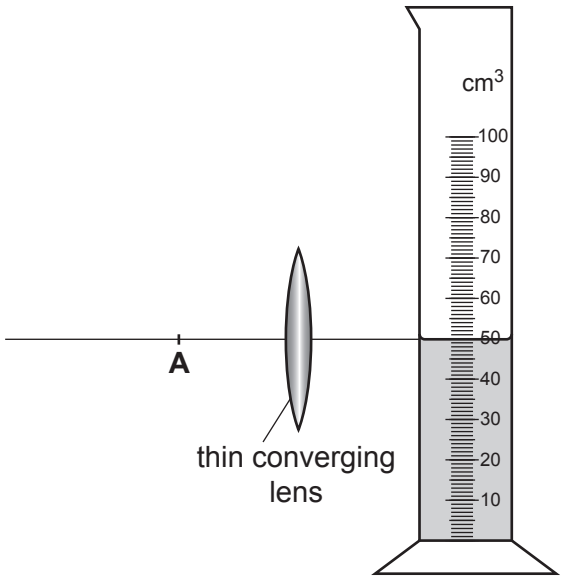

Fig. 6.2

(i) On Fig. 6.2, mark with an **X** a point where the student positions her eye to see a magnified image of the level of the liquid on the scale. [1]

(ii) The density of the liquid in the measuring cylinder is 0.85 g / cm^3 at 20 °C.

Calculate the mass of the liquid in the measuring cylinder.

mass = ... g [2]

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(c) The student increases the temperature of the liquid from 20 °C to 60 °C.

(i) Explain why the volume of the liquid increases as the temperature increases.

Use ideas about the distances between molecules and the motion of molecules in your answer.

.....

.....

.....

..... [2]

(ii) State whether the density of the liquid increases or decreases.

Explain your answer.

density .....

explanation .....

.....

[1]

[Total: 7]

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7 **(a)** A study investigates the number of people with lung cancer in different age ranges.

Fig. 7.1 shows the results.

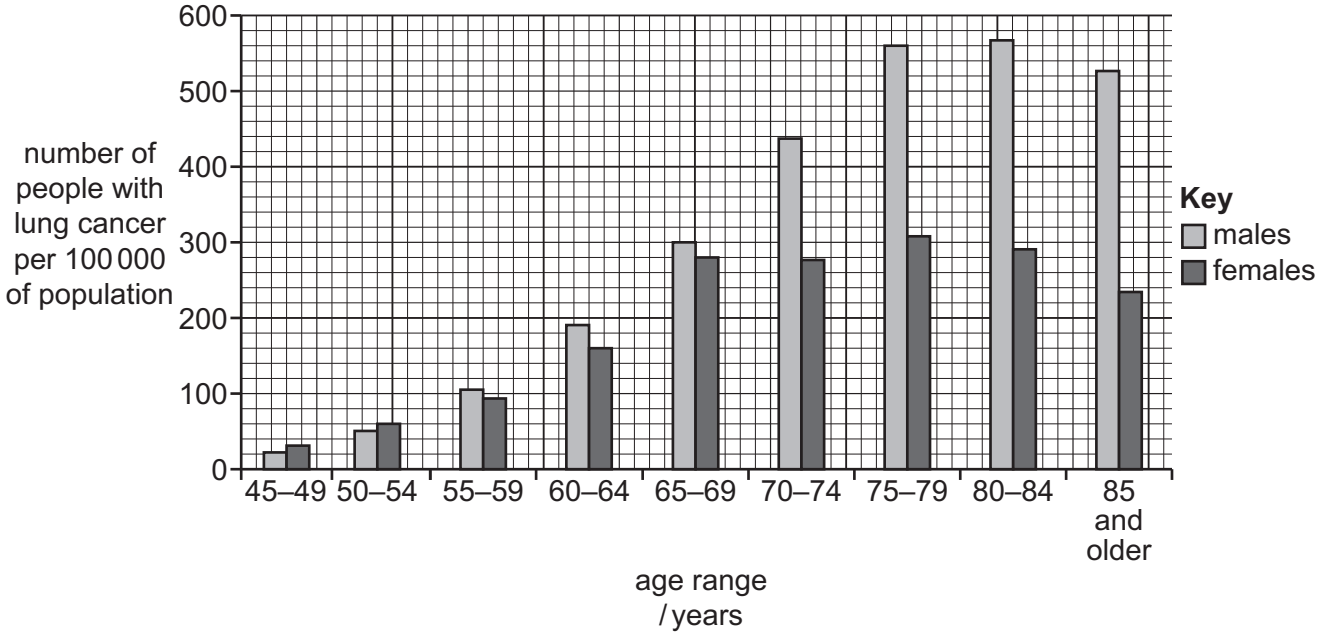

Fig. 7.1

(i) Calculate the difference in the number of males and females with lung cancer in the 65–69-year-old age range.

..... per 100 000 of population [2]

(ii) Lung cancer has been linked to tobacco smoke.

Complete these sentences about the three main toxic components of tobacco smoke.

The component most likely to cause lung cancer is ..... .

Carbon monoxide reduces the ability of red blood cells to transport ..... .

The addictive component of tobacco smoke is ..... .

[3]

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(b) The gas exchange surface in humans is alveoli.
Fig. 7.2 shows healthy alveoli and alveoli damaged by tobacco smoke.

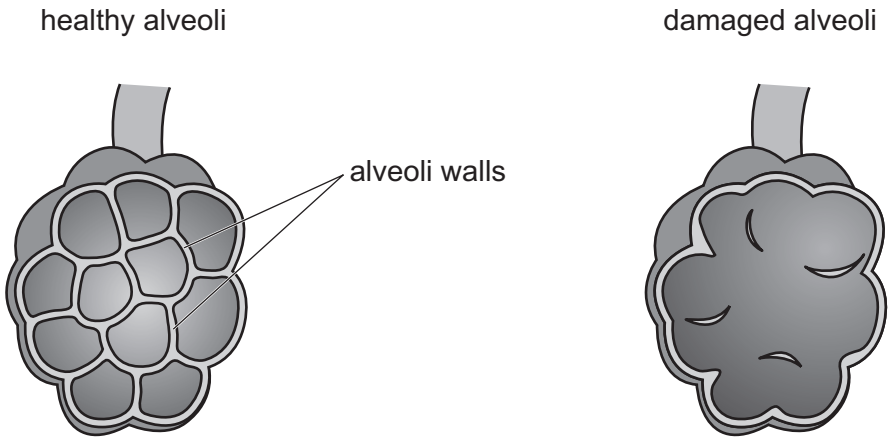

Fig. 7.2

A component in tobacco smoke breaks down the alveoli walls.

Use Fig. 7.2 to explain how tobacco smoke reduces gas exchange in the lungs.

.....

.....

..... [2]

[Total: 7]

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8 Heptane, C_7H_{16}, is a hydrocarbon. It is used to produce smaller molecules, as shown in Fig. 8.1.

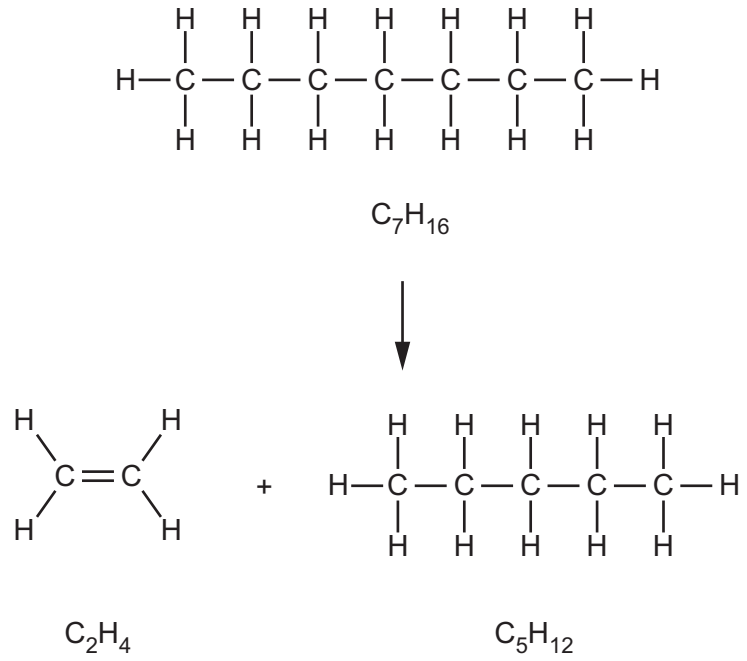

Fig. 8.1

(a) (i) State the name of this process.

..... [1]

(ii) State **two** conditions needed for this process.

1 .....

2 .....

[2]

(b) Put ticks (✓) in the boxes to show which statements describe each compound.

Use Fig. 8.1 to help you.

You may tick one or more box in each row.

	compound		
	C_7H_{16}	C_2H_4	C_5H_{12}
It has molecules which contain 23 atoms.			
It is unsaturated.			
It is an alkane.			
It produces carbon dioxide and water when it burns.			

[3]

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(c) Describe the colour change when aqueous bromine reacts with C_2H_4.

from ..... to ..... [1]

(d) The compound C_2H_4 is a member of a homologous series.

Describe **two** similarities that are shared by all members of a homologous series.

1 .....

2 .....
[2]

[Total: 9]

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9 Fig. 9.1 shows two lamps, **A and B**, used for lighting in a theatre.

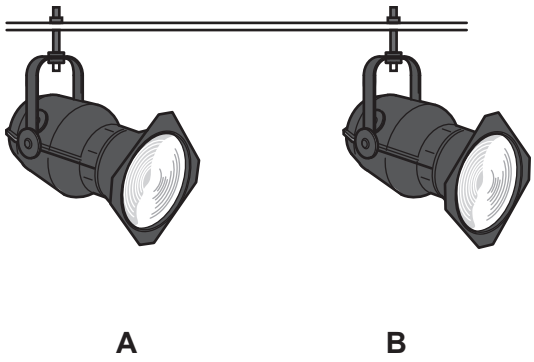


Fig. 9.1

Fig. 9.2 shows the circuit used for the two lamps.

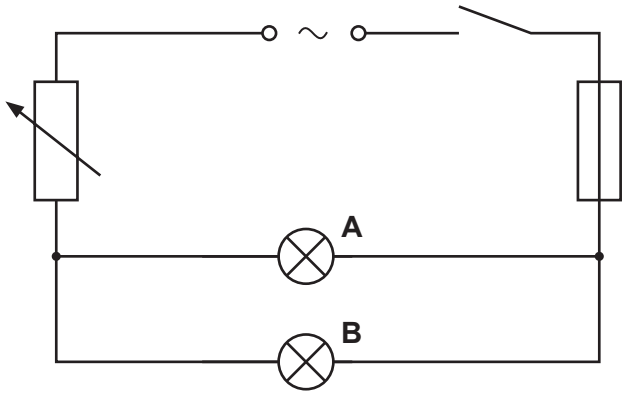
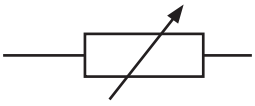


Fig. 9.2

(a) State the name and purpose of the component with the symbol shown.



name .....

purpose .....

.....

[2]

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(b) The potential difference across the lamps is 220 V.

The current in each lamp is 5.0 A.

Calculate the combined resistance of lamps **A** and **B**.

resistance = ... Ω [3]

(c) **(i)** During a performance in the theatre, the fuse blows and both lamps go out. There is no damage to the wiring and no short circuit.

The fuse in Fig. 9.2 has a rating of 10 A.

Suggest what causes the fuse to blow.

Explain your answer.

.....

.....

..... [2]

(ii) Explain why 13 A is a suitable rating for the replacement fuse.

.....

.....

..... [2]

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(d) Lamp **A** emits infrared radiation and red visible light.

Lamp **B** emits blue visible light and ultraviolet radiation.

Fig. 9.3 shows an incomplete electromagnetic spectrum.

On Fig. 9.3, write infrared, ultraviolet and visible light in their correct places.

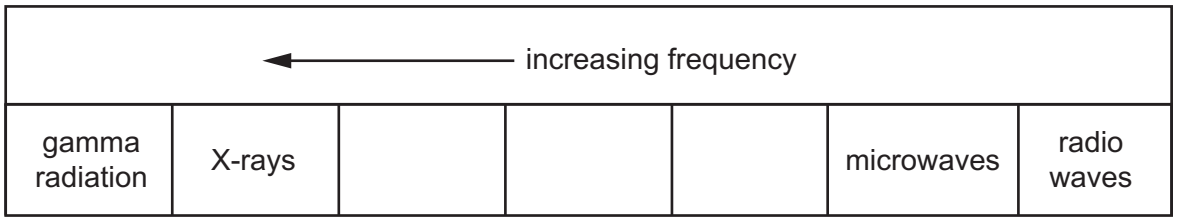

Fig. 9.3

[1]

[Total: 10]

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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.).

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