



Cambridge O Level

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COMBINED SCIENCE

5129/21

Paper 2

May/June 2021

2 hours 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 100.
- 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.

1 Fig. 1.1 shows an animal cell.

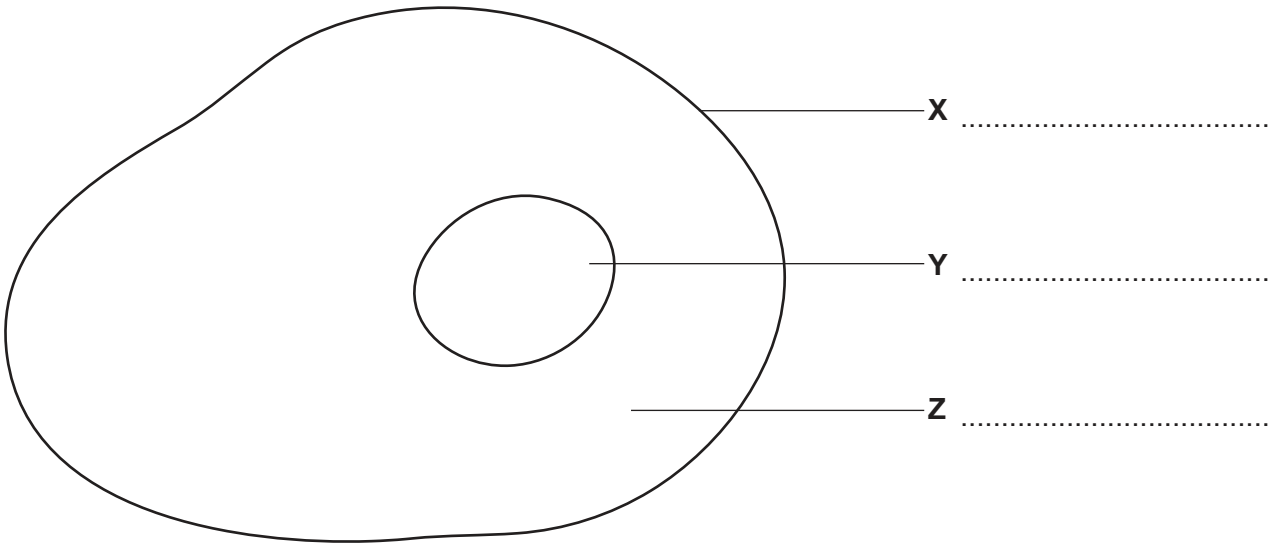


Fig. 1.1

(a) (i) On Fig. 1.1, name the structures X, Y and Z. [3]

(ii) State **one** function for structure X.

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

(b) Name **two** structures that are only present in plant cells.

1
2 [2]

[Total: 6]

2 The following is a list of gases.

argon

carbon dioxide

carbon monoxide

ethane

helium

hydrogen

methane

nitrogen

oxygen

Complete the following sentences using gases from the list.

Each gas may be used once, more than once or not at all.

(a) The two gases that react together to produce ammonia are

..... and [2]

(b) The gas that is used in the manufacture of margarine is

..... [1]

(c) The gas that is the main constituent of natural gas is

..... [1]

(d) The gas that is produced in the fermentation of glucose is

..... [1]

(e) The noble gas that is the most abundant in clean air is

..... [1]

[Total: 6]

- 3 A car travels at a constant speed of 8.0 m/s between time $t = 0$ s and time $t = 10$ s.

Then:

From $t = 10$ s to $t = 13$ s its speed decreases at 2 m/s^2 .

From $t = 13$ s to $t = 17$ s it travels at constant speed.

From $t = 17$ s to $t = 25$ s it accelerates in a non-constant way to a speed of 12 m/s.

On Fig. 3.1 plot the speed–time graph of the journey.

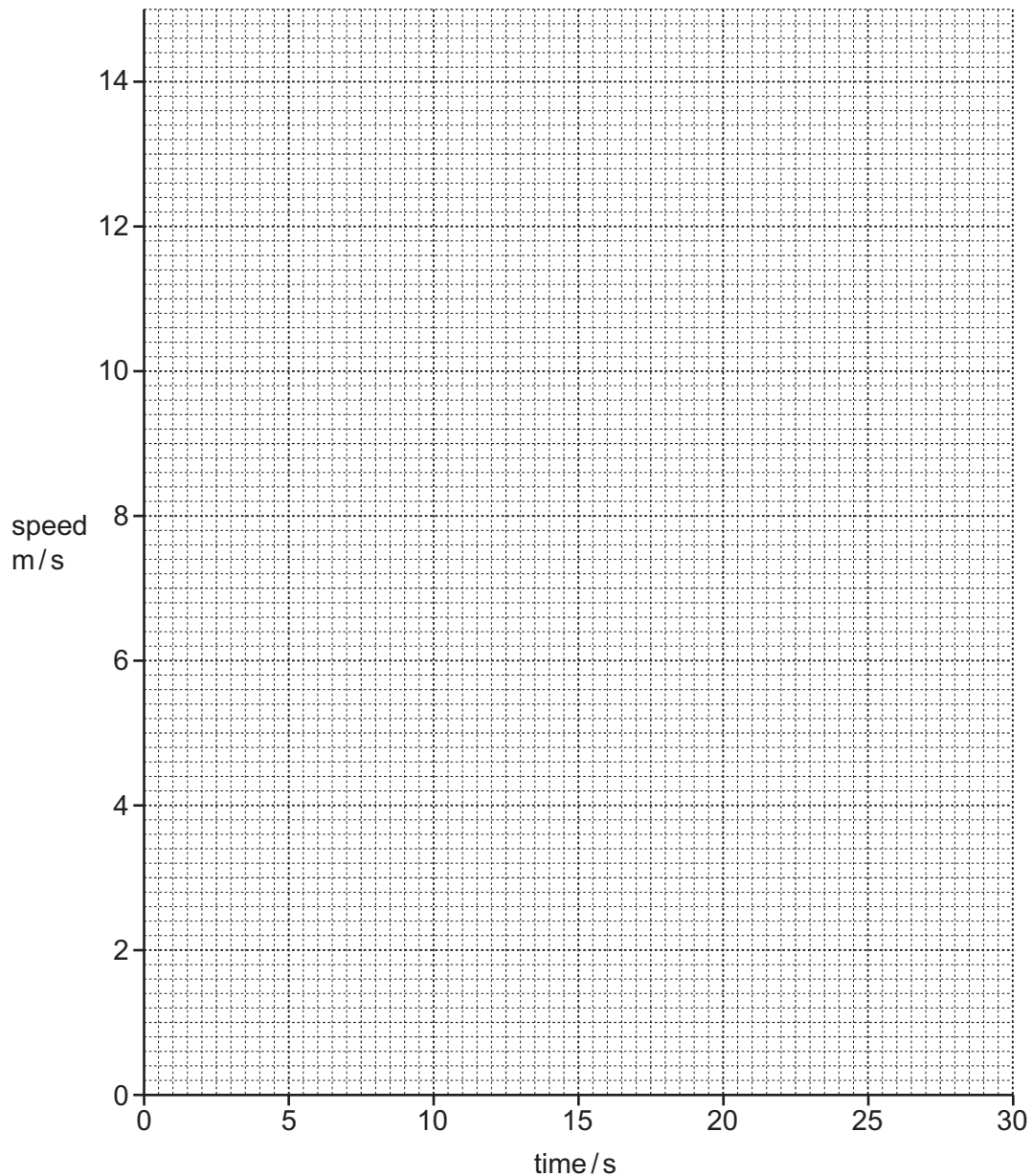


Fig. 3.1

[4]

- 4 Copper(II) oxide is reduced to copper by carbon.

The equation for the reaction is shown.



[A_r : Cu, 64; O, 16; C, 12]

- (a) (i) Calculate the relative molecular mass M_r of carbon dioxide.

..... [1]

- (ii) Complete the following sentences.

80 g of copper(II) oxide reacts with g of carbon and produces g of carbon dioxide.

4 g of copper(II) oxide produces g of carbon dioxide. [3]

- (b) Describe a test which shows copper is a metal.

.....
 [2]

- (c) State, in terms of reactivity, why copper(II) oxide is reduced by heating with carbon.

.....
 [1]

[Total: 7]

- 5 The alimentary canal starts at the mouth and ends at the anus.

Fig. 5.1 names the regions of the alimentary canal, represented by boxes.

- (a) Complete Fig. 5.1 by drawing lines with arrows between the boxes to show the route that food takes between the mouth and the anus.

Two arrows have been drawn for you.

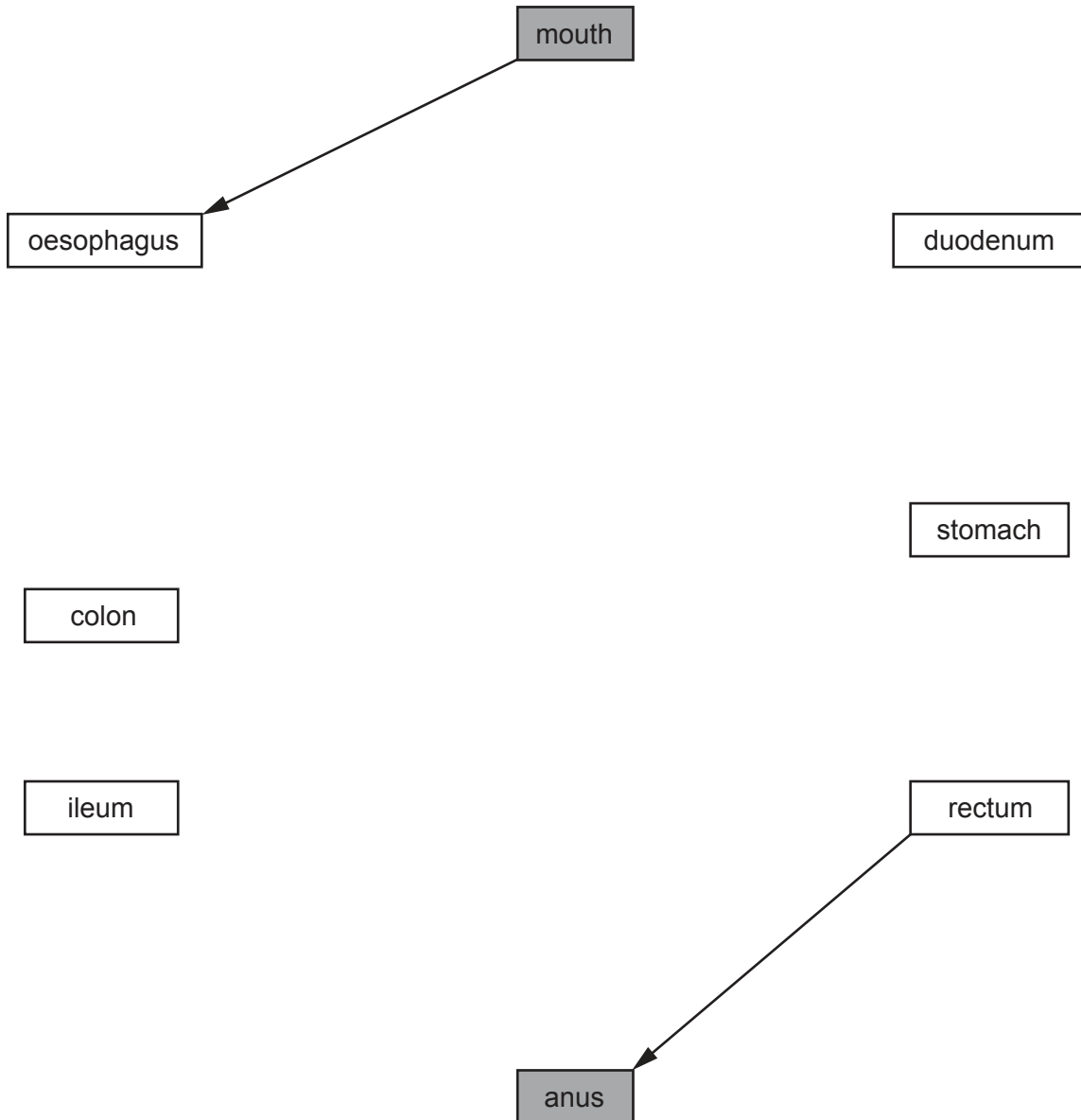


Fig. 5.1

[3]

(b) The liver is an organ associated with the alimentary canal.

State **three** functions of the liver.

1

.....

2

.....

3

.....

[3]

[Total: 6]

- 6 Fig. 6.1 shows a spring attached to a wooden block at rest on a surface.

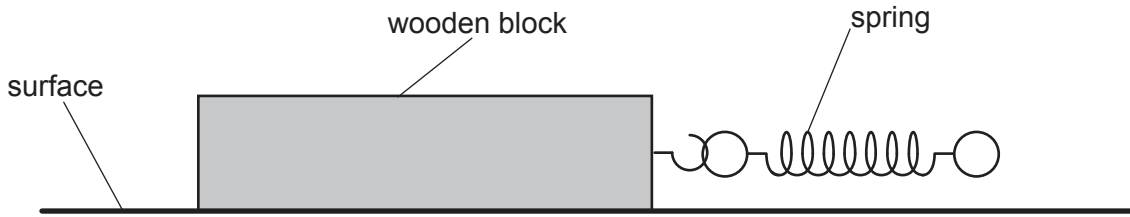


Fig. 6.1

The spring is pulled until the block begins to move.

- (a) Describe how the apparatus in Fig. 6.1 can be used to show that the amount of friction depends on the roughness of the surface.

.....

.....

.....

..... [3]

- (b) The dimensions of the block are shown in Fig. 6.2.

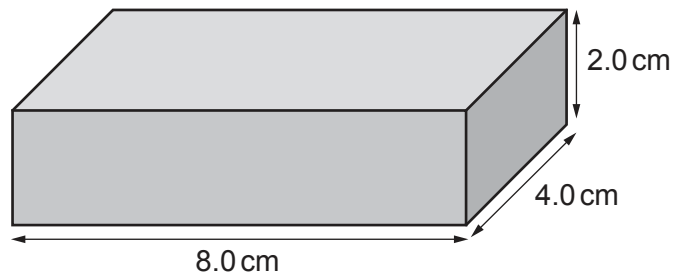


Fig. 6.2

The density of the wood is 0.50 g/cm^3 .

Calculate:

- (i) the volume of the block,

volume = cm^3 [1]

- (ii) the mass of the block.

mass = g [2]

[Total: 6]

7 (a) Complete the sentences about photosynthesis.

During photosynthesis carbon dioxide and are taken into a plant.

These chemicals are combined to produce and oxygen.

Energy is needed for this process.

Leaves contain which traps light energy and converts it into energy.

[4]

(b) Fig. 7.1 shows how the rate of photosynthesis in a plant changes with temperature.

The rate of photosynthesis depends on enzyme activity.

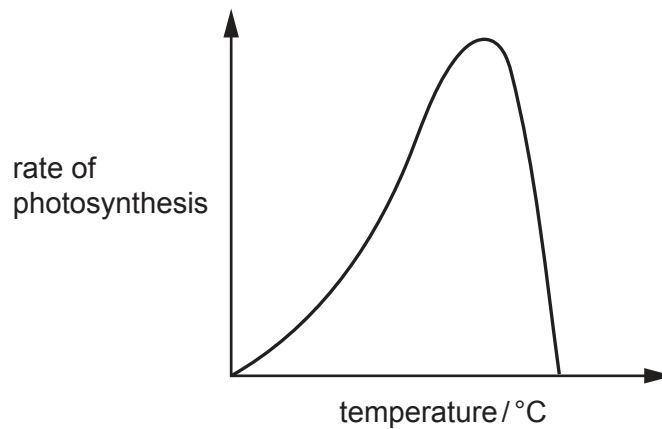


Fig. 7.1

Explain why the rate of photosynthesis changes as the temperature increases.

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 7]

8 Some reactions of ethanol are shown in Fig. 8.1.

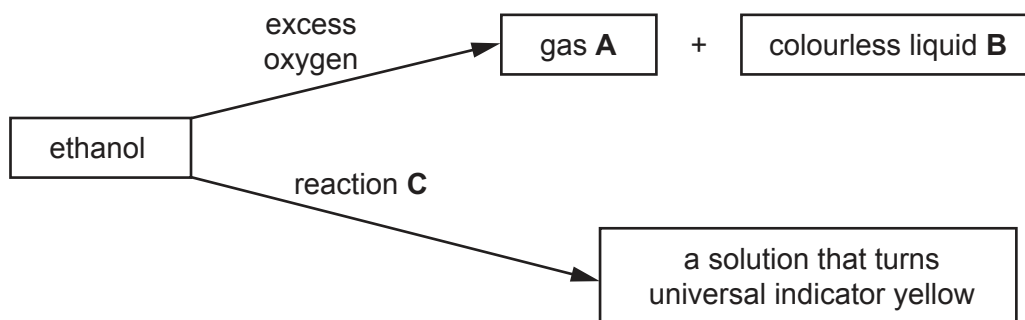


Fig. 8.1

(a) (i) Identify:

gas A

colourless liquid B

[2]

(ii) Name the type of reaction C.

..... [1]

(iii) Suggest the pH of the solution that turns the universal indicator yellow.

pH =

[1]

(b) Draw the structure of ethanol.

[1]

(c) In the manufacture of perfumes, solid substances are dissolved in ethanol.

State the name given to a liquid that dissolves substances.

..... [1]

[Total: 6]

9 (a) Some sources of energy are:

chemical geothermal hydroelectric nuclear solar

Use words from the list to identify the source of energy in which:

- (i) atoms regroup [1]
- (ii) the nuclei of atoms are rearranged [1]
- (iii) the energy passes through a vacuum. [1]

(b) Describe how energy is converted from one form to another in a wind turbine.

.....

.....

..... [2]

[Total: 5]

10 Table 10.1 contains six statements.

Tick (✓) the three correct statements about the heart.

Table 10.1

| statement | ✓ |
|---|---|
| 1 Blood is pumped from the heart to the lungs along veins. | |
| 2 The heart contains valves. | |
| 3 The heart does not carry our respiration. | |
| 4 The heart is composed of muscle. | |
| 5 The right hand side of the heart pumps blood around the body. | |
| 6 There are four chambers in the heart. | |

[3]

11 The electronic structure of a magnesium atom is shown in Fig. 11.1.

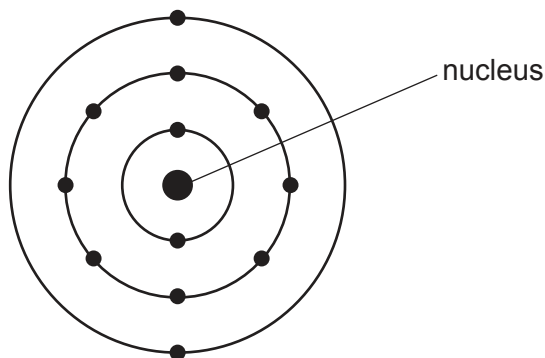


Fig. 11.1

(a) (i) State the number of protons in the nucleus of a magnesium atom.

.....

[1]

(ii) Describe and explain why magnesium forms a stable Mg^{2+} ion.

.....

[2]

(b) Some reactions of magnesium and magnesium oxide are shown in Fig. 11.2.

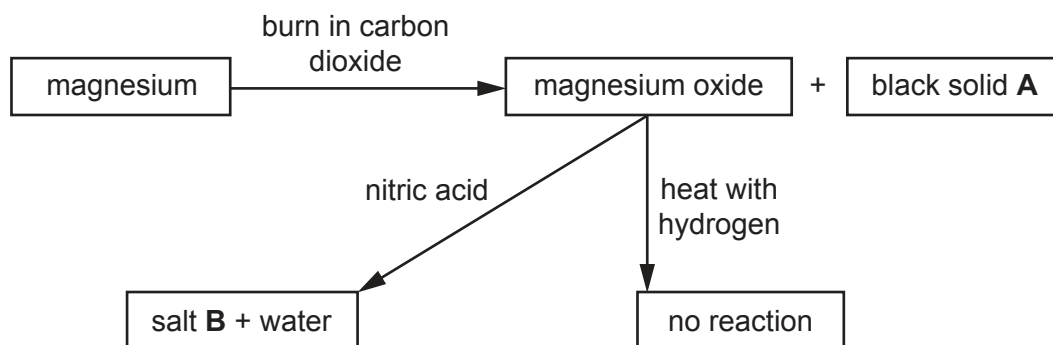


Fig. 11.2

(i) Identify the:

black solid **A**

salt **B**.

[2]

(ii) State the type of reaction that occurs when magnesium oxide reacts with nitric acid.

..... [1]

(c) Explain why magnesium oxide does **not** react with hydrogen.

..... [1]

[Total: 7]

12 (a) Gamma-rays and radio waves are examples of electromagnetic waves.

Describe three properties of gamma-rays that are the same as the properties of radio waves.

- 1
-
- 2
-
- 3
-

[3]

(b) Infrared radiation has a wavelength of 6×10^{-4} m.

The speed of infrared radiation is 3×10^8 m/s.

Calculate the frequency of this radiation and state the unit.

frequency = unit
[3]

[Total: 6]

13 Fig. 13.1 shows the male reproductive system.

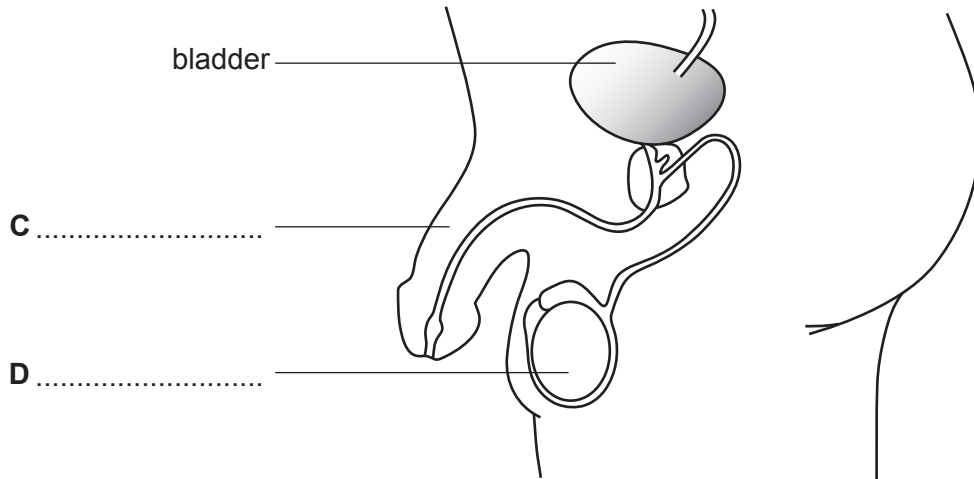


Fig. 13.1

(a) On Fig. 13.1, name the structures **C** and **D**.

Write your answers on Fig. 13.1.

[2]

(b) State a function for each of the following structures in the male reproductive system.

testis

.....

sperm duct

.....

prostate gland

.....

urethra

.....

[4]

[Total: 6]

- 14 The apparatus used to analyse a green substance using chromatography is shown in Fig. 14.1. The solvent used in the experiment is water.

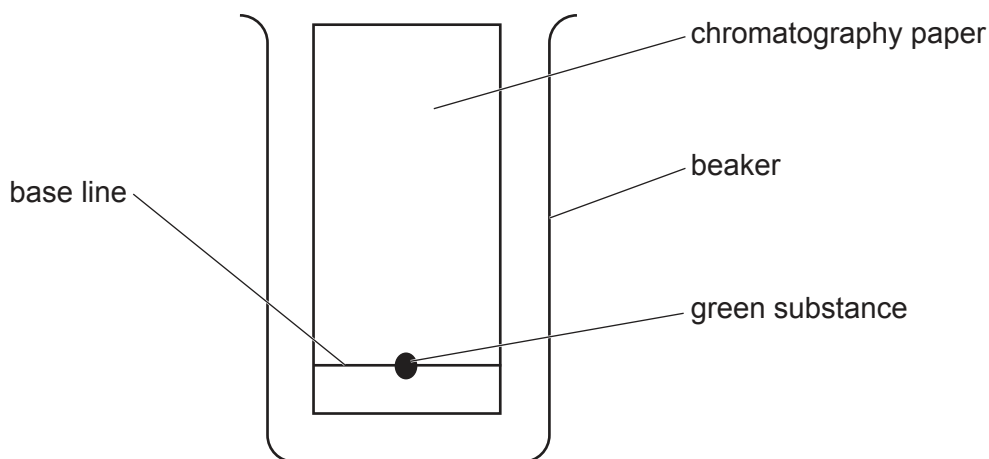


Fig. 14.1

- (a) On Fig. 14.1, draw a line to show the level of the water at the start of the chromatography experiment. [1]

- (b) Explain why the base line is drawn in pencil rather than ink.

.....
 [1]

- (c) The chromatogram obtained in the experiment is shown in Fig. 14.2.

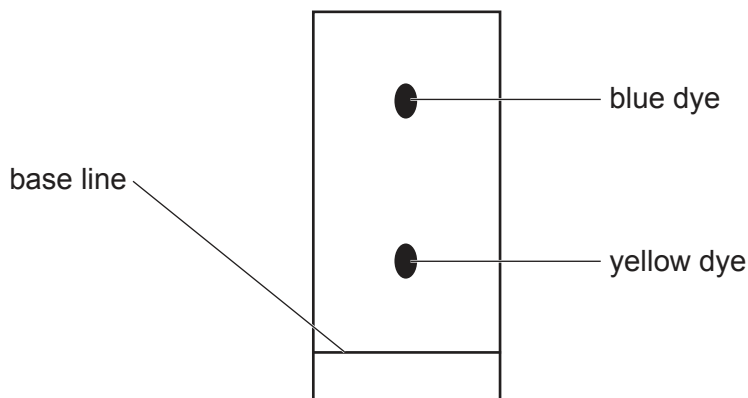


Fig. 14.2

State which dye in Fig. 14.2 is the most soluble in water.
 Give a reason for your choice.

dye

reason

.....

[1]

[Total: 3]

- 15 Fig. 15.1 shows a positively charged plastic sphere suspended from a horizontal support by an insulating thread.

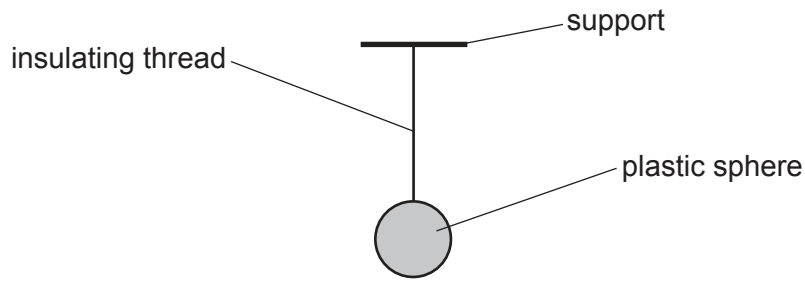


Fig. 15.1

- (a) Explain why the charge remains on the sphere.

..... [1]

- (b) A charged plastic rod is moved towards the sphere, as shown in Fig. 15.2.

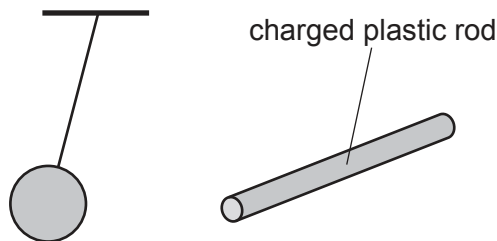


Fig. 15.2

Explain why the sphere moves away from the rod.

.....
 [2]

[Total: 3]

16 Fig. 16.1 shows part of a food web.

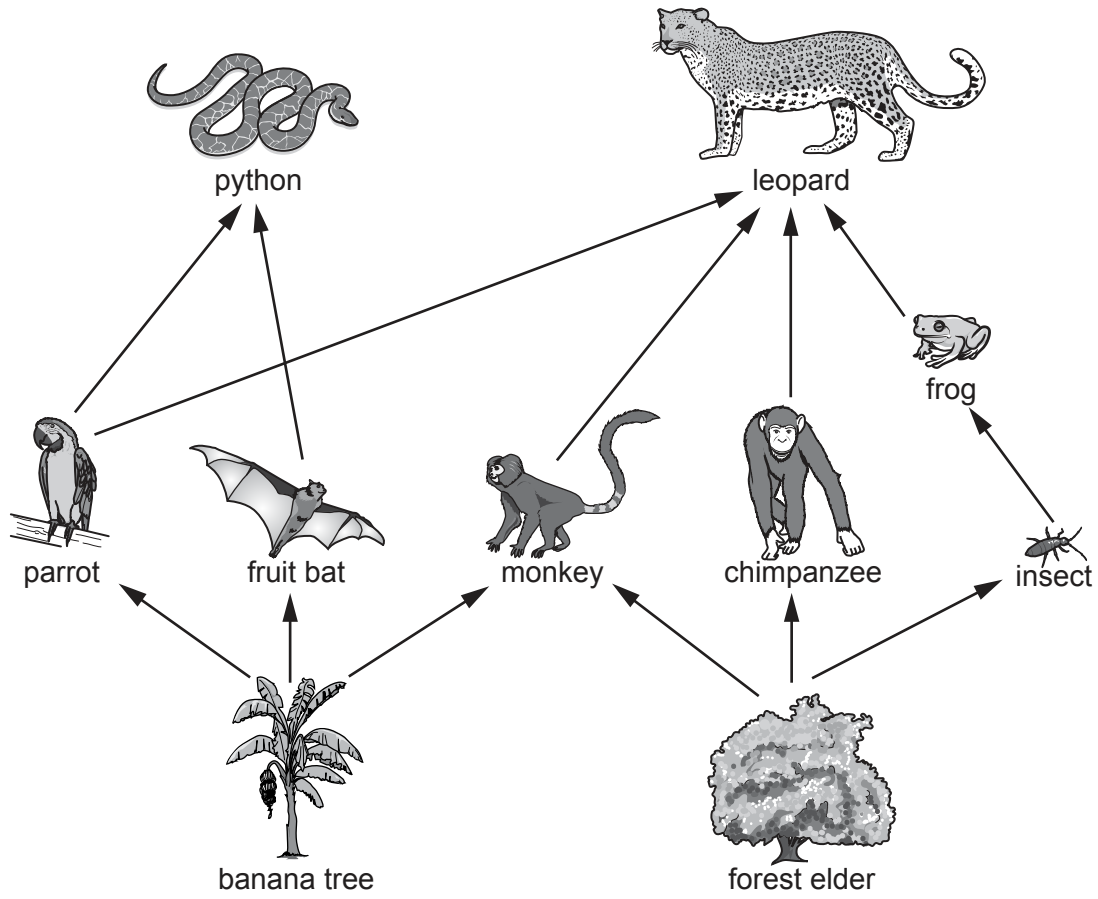


Fig. 16.1

(a) State the number of herbivores in this food web.

..... [1]

(b) Complete Fig. 16.2 to show the food chain from Fig. 16.1 that contains four organisms.



Fig. 16.2

[2]

(c) Explain how energy is lost between one trophic level and the next trophic level in a food chain.

.....

 [2]

17 Fig. 17.1 shows a circuit containing a resistor.

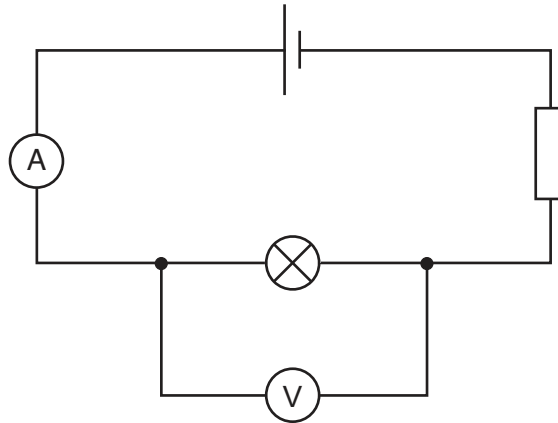


Fig. 17.1

The circuit is used to investigate two different cells **Y** and **Z**.

The results are shown in Table 17.1.

Table 17.1

| cell | potential difference across lamp/V | current through lamp/A |
|----------|------------------------------------|------------------------|
| Y | 1.88 | 0.21 |
| Z | 2.63 | 0.29 |

(a) Show that the lamp has a resistance of approximately 9Ω .

[2]

(b) The e.m.f. of cell **Z** is 3.5 Volts.

(i) Determine the potential difference across the resistor shown in the circuit.

potential difference = V [1]

(ii) Use your answer to (b)(i) to calculate the resistance of the resistor shown in the circuit.

resistance = Ω [1]

(iii) Calculate the e.m.f. of cell Y.

e.m.f. = V [2]

[Total: 6]

18 Petroleum is a source of fuels.

Fuels produce energy during combustion.

(a) State the name given to reactions that release energy.

..... [1]

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

Some uses of the fractions are shown in Table 18.1.

Complete Table 18.1 by naming the fraction that matches its use.

Table 18.1

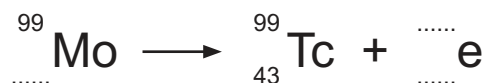
| use | name of fraction |
|---------------------------|------------------|
| fuel for oil stoves | |
| road making | |
| making waxes and polishes | |

[3]

[Total: 4]

19 Technetium-99 is produced when molybdenum-99 emits beta radiation.

(a) Complete the nuclear equation for the decay of molybdenum-99.



[2]

(b) Molybdenum-99 has a half-life of 66 hours.

Show that approximately 3% of a sample of molybdenum-99 will remain after 14 days.

[2]

[Total: 4]

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The Periodic Table of Elements

| | | Group | | | | | | | | | | |
|-----------------------------------|------------------------------------|--|---------------------------------------|--|--------------------------------------|--------------------------------------|--------------------------------------|--|--|--|--|--|
| I | II | III | IV | V | VI | VII | VIII | | | | | |
| | | 1 H hydrogen 1 | | | | | | | | | | |
| 3 Li lithium 7 | 4 Be beryllium 9 | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;"> Key atomic number atomic symbol name relative atomic mass </div> | | | | | | | | | | |
| 11 Na sodium 23 | 12 Mg magnesium 24 | 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 | | | | | |
| 19 K potassium 39 | 20 Ca calcium 40 | 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 | | | | | |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 31 Ga gallium 70 | 32 Ge germanium 73 | 33 As arsenic 75 | 34 Se selenium 79 | 35 Br bromine 80 | 36 Kr krypton 84 | | | | | |
| 55 Cs caesium 133 | 56 Ba barium 137 | 49 In indium 115 | 50 Sn tin 119 | 51 Sb antimony 122 | 52 Te tellurium 128 | 53 I iodine 127 | 54 Xe xenon 131 | | | | | |
| 87 Fr francium — | 88 Ra radium — | 81 Tl thallium 204 | 82 Pb lead 207 | 83 Bi bismuth 209 | 84 Po polonium — | 85 At astatine — | 86 Rn radon — | | | | | |
| | | 29 Cu copper 64 | 28 Ni nickel 59 | 27 Co cobalt 59 | 26 Fe iron 56 | 25 Mn manganese 55 | 24 Cr chromium 52 | | | | | |
| | | 47 Ag silver 108 | 46 Pd palladium 106 | 45 Rh rhodium 103 | 44 Ru ruthenium 101 | 43 Tc technetium — | 42 Mo molybdenum 96 | | | | | |
| | | 79 Au gold 197 | 78 Pt platinum 195 | 77 Ir iridium 192 | 76 Os osmium 190 | 75 Re rhenium 186 | 74 W tungsten 184 | | | | | |
| | | 111 Rg roentgenium — | 110 Ds darmstadtium — | 109 Mt meitnerium — | 108 Hs hassium — | 107 Bh bohrium — | 106 Sg seaborgium — | | | | | |
| | | 30 Zn zinc 65 | 30 Zn zinc 65 | 30 Zn zinc 65 | 30 Zn zinc 65 | 30 Zn zinc 65 | 30 Zn zinc 65 | | | | | |
| | | 112 Cn copernicium — | 112 Cn copernicium — | 112 Cn copernicium — | 112 Cn copernicium — | 112 Cn copernicium — | 112 Cn copernicium — | | | | | |
| | | 67 Ho holmium 165 | 68 Er erbium 167 | 69 Tm thulium 169 | 70 Yb ytterbium 173 | 71 Lu lutetium 175 | | | | | | |
| | | 99 Es einsteinium — | 100 Fm fermium — | 101 Md mendelevium — | 102 No nobelium — | 103 Lr lawrencium — | | | | | | |
| | | 66 Dy dysprosium 163 | 66 Dy dysprosium 163 | 66 Dy dysprosium 163 | 66 Dy dysprosium 163 | 66 Dy dysprosium 163 | 66 Dy dysprosium 163 | | | | | |
| | | 98 Cf californium — | 98 Cf californium — | 98 Cf californium — | 98 Cf californium — | 98 Cf californium — | 98 Cf californium — | | | | | |
| | | 65 Tb terbium 159 | 64 Gd gadolinium 157 | 63 Eu europium 152 | 62 Sm samarium 150 | 61 Pm promethium — | 60 Nd neodymium 144 | | | | | |
| | | 97 Bk berkelium — | 96 Cm curium — | 95 Am americium — | 94 Pu plutonium — | 93 Np neptunium — | 92 U uranium 238 | | | | | |
| | | 65 Tb terbium 159 | 65 Tb terbium 159 | 65 Tb terbium 159 | 65 Tb terbium 159 | 65 Tb terbium 159 | 65 Tb terbium 159 | | | | | |
| | | 95 Am americium — | 95 Am americium — | 95 Am americium — | 95 Am americium — | 95 Am americium — | 95 Am americium — | | | | | |
| | | 57 La lanthanum 139 | 58 Ce cerium 140 | 59 Pr praseodymium 141 | 60 Nd neodymium 144 | 61 Pm promethium — | 62 Sm samarium 150 | | | | | |
| | | 89 Ac actinium — | 90 Th thorium 232 | 91 Pa protactinium 231 | 92 U uranium 238 | 93 Np neptunium — | 94 Pu plutonium — | | | | | |
| | | 57 La lanthanum 139 | 57 La lanthanum 139 | 57 La lanthanum 139 | 57 La lanthanum 139 | 57 La lanthanum 139 | 57 La lanthanum 139 | | | | | |
| | | 89 Ac actinium — | 89 Ac actinium — | 89 Ac actinium — | 89 Ac actinium — | 89 Ac actinium — | 89 Ac actinium — | | | | | |

lanthanoids

actinoids

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