Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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4215205791

CO-ORDINATED SCIENCES **0654/42**

Paper 4 Theory (Extended) **May/June 2023**

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 **32** pages. Any blank pages are indicated.

1 **(a)** Fig. 1.1 is a diagram of parts of the eye.

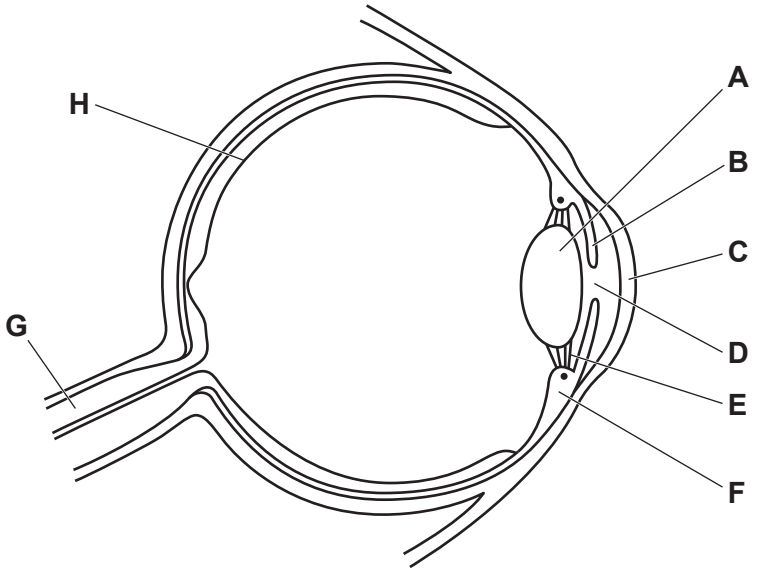


Fig. 1.1

(i) State the letter in Fig. 1.1 which identifies the part that contains:

circular and radial muscles .....

receptor cells .....

neurones. .....

[3]

(ii) Draw an **X** on Fig. 1.1 to identify the position of the blind spot. [1]

(iii) Describe the changes to the parts labelled **A**, **E** and **F** when someone changes their focus from a near object to a distant object.

A .....

E .....

F .....

[3]

(iv) State the name of the hormone that causes part **D** in Fig. 1.1 to widen in response to a 'fight or flight' situation.

..... [1]

(b) Accommodation of the eye is an example of sensitivity.

Complete the sentence to describe the term sensitivity.

Sensitivity is the ability to detect or sense ..... ,

which are changes in the internal or external .....

and to make appropriate responses.

[2]

[Total: 10]

2 Alkanes are **saturated hydrocarbons**.

(a) State what is meant by the term saturated hydrocarbon.

.....

.....

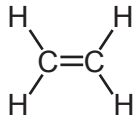
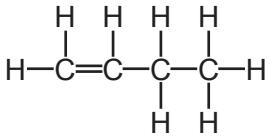
..... [2]

(b) **Alkenes** are also hydrocarbons.

Table 2.1 shows information about three alkenes.

Complete Table 2.1.

Table 2.1

name	molecular formula	structure
.....	C_2H_4	
propene	C_3H_6	.....
.....	C_4H_8	

[3]

(c) Propane and propene are both colourless gases.

Describe a test to show which gas is propane and which gas is propene.

test .....

result with propane .....

.....

result with propene .....

.....

[3]

(d) The monomer C_4H_8 in Fig. 2.1 can be used to make a polymer.

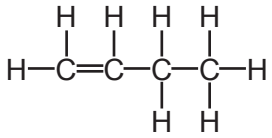


Fig. 2.1

Complete Fig. 2.2 to show the structure of the polymer made.

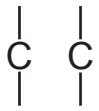


Fig. 2.2

[2]

[Total: 10]

3 Fig. 3.1 shows an insect called a pond skater.

Pond skaters spread their weight over their 6 legs so that they can move over the surface of water.

Fig. 3.1

(a) The pond skater has a mass of 0.25 g and is stationary on the surface of the water.

(i) Use the values in the list to complete the sentences about the pond skater.

The gravitational field strength, *g*, is 10 N / kg.

You can use each value once, more than once or not at all.

0 N **0.0025 kg** **0.0025 N** **0.25 g** **0.25 kg** **2.5 N**

The weight of the pond skater is ..... .

The force acting upwards on the pond skater by the water is ..... .

The resultant force acting on the pond skater is ..... .

[2]

(ii) The pond skater stands on all 6 legs, with the foot of each leg making contact with the surface of the water.

The area of each foot is $1.2 \times 10^{-7}\,m^2$.

Calculate the pressure exerted by each foot on the surface of the water.

pressure = ... Pa [2]

(b) The pond skater moves across the surface of a pond.

Fig. 3.2 shows a speed–time graph for part of the pond skater's journey.

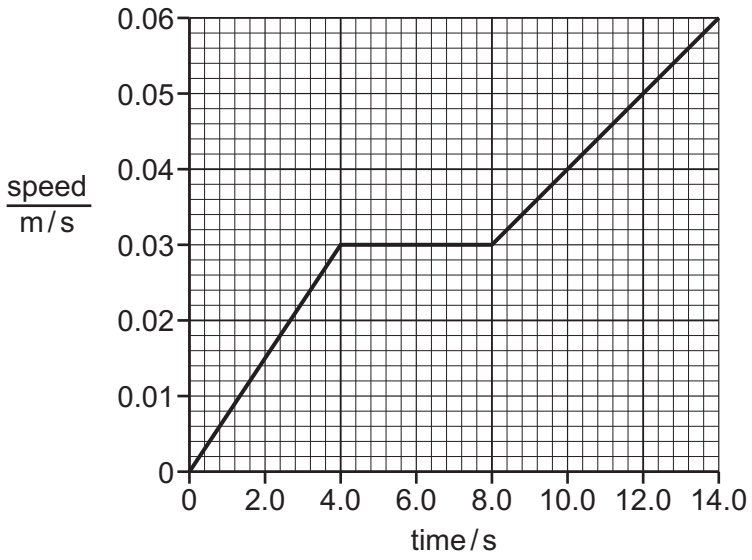


Fig. 3.2

(i) Place an **X** on Fig. 3.2 to show a time at which the pond skater is travelling at a constant speed. [1]

(ii) Use Fig. 3.2 to calculate the maximum acceleration of the pond skater.

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

(c) The movement of the pond skater on the surface of the water produces waves.

Fig. 3.3 shows a diagram of a wave produced by the pond skater.

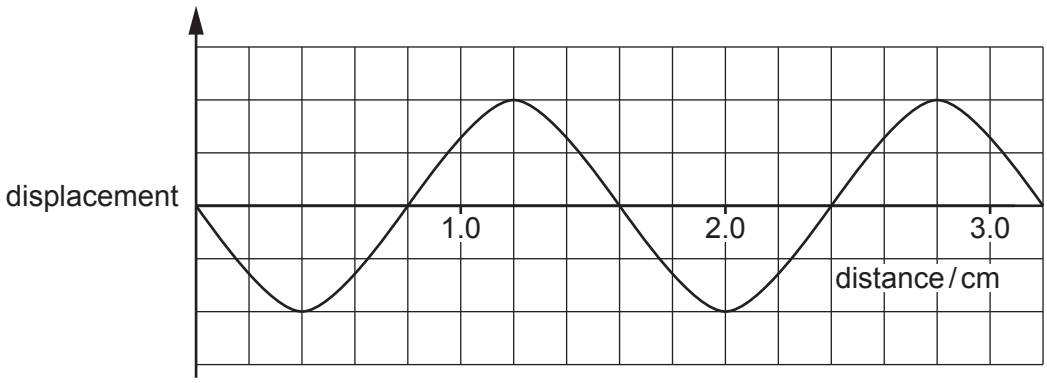


Fig. 3.3

(i) Use Fig. 3.3 to determine the wavelength of the water wave in m.

wavelength = ... m [2]

(ii) An observer sees 10 full waves pass a point in 5 seconds.

Use your answer to **(c)(i)** to calculate the speed of the wave.

speed = ... m / s [3]

[Total: 12]

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4 **(a)** Photosynthesis is an enzyme-controlled reaction.

Fig. 4.1 is a graph showing the effect of temperature on the rate of photosynthesis.

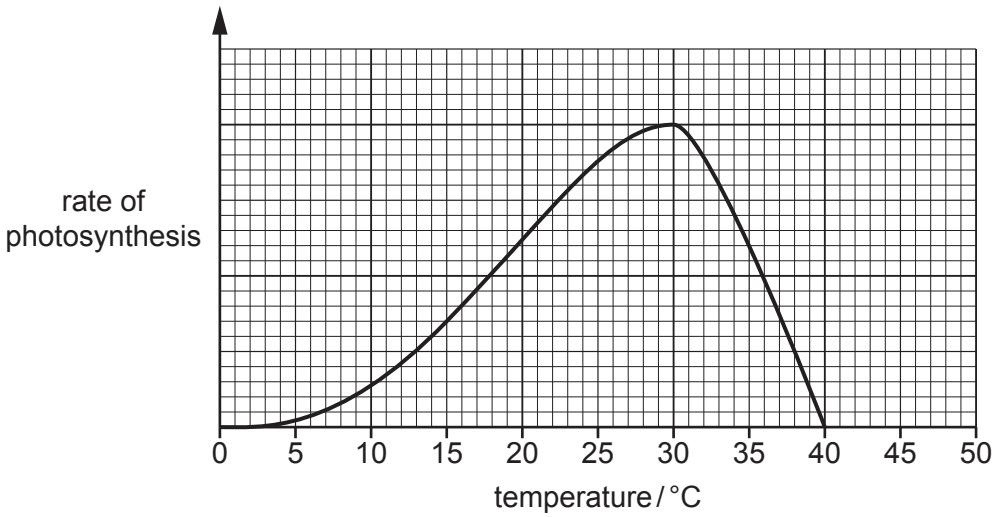

Fig. 4.1

(i) Explain the results between 0–30 °C in Fig. 4.1.

.....

.....

.....

.....

..... [2]

(ii) Explain the result at 40 °C in Fig. 4.1.

.....

.....

.....

.....

.....

.....

..... [3]

(b) State the name of the substance that converts light energy to chemical energy during photosynthesis.

..... [1]

(c) State the names of the two raw materials used in photosynthesis.

1 .....

2 .....
[2]

(d) Describe two ways the cells in the palisade mesophyll layer are adapted for photosynthesis.

1 .....

.....

2 .....

.....
[2]

[Total: 10]

5 Ammonia is made from the reaction of nitrogen and hydrogen in the Haber process.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(a) State the sources of the nitrogen and hydrogen used in the Haber process.

nitrogen .....

hydrogen .....

[2]

(b) Fig. 5.1 shows the energy level diagram for the reaction between nitrogen and hydrogen.

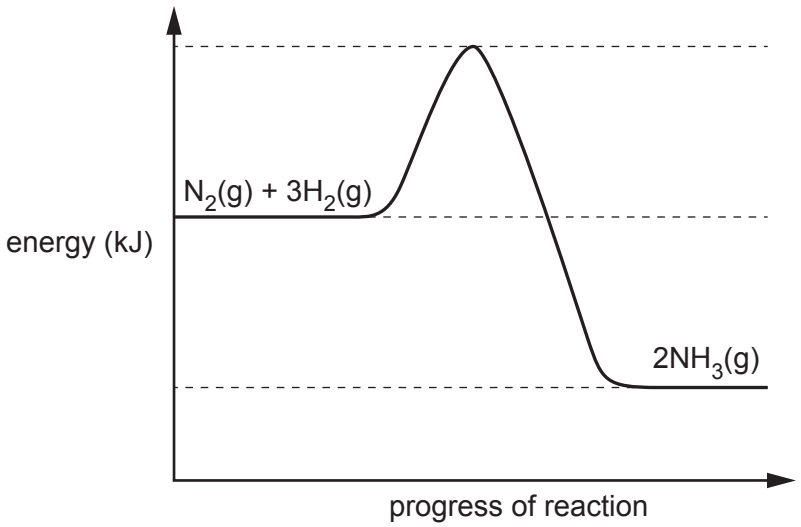

Fig. 5.1

(i) Draw an arrow on Fig. 5.1 to show the energy change in the reaction.

Label your arrow **A**. [1]

(ii) Draw an arrow on Fig. 5.1 to show the activation energy of the reaction.

Label your arrow **B**. [1]

(iii) Explain if Fig. 5.1 represents an exothermic or endothermic reaction.

Use ideas about bond breaking and bond making in your answer.

.....

.....

.....

.....

.....

..... [4]

(c) 58.8 kg of nitrogen gas reacts with hydrogen gas to make 142.8 kg of ammonia gas.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

Calculate the volume occupied by 142.8 kg of ammonia gas.

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

volume of ammonia gas = ... dm^3 [3]

[Total: 11]

6 **(a)** Fig. 6.1 shows the average power output over a summer's day from a solar panel made from solar cells.

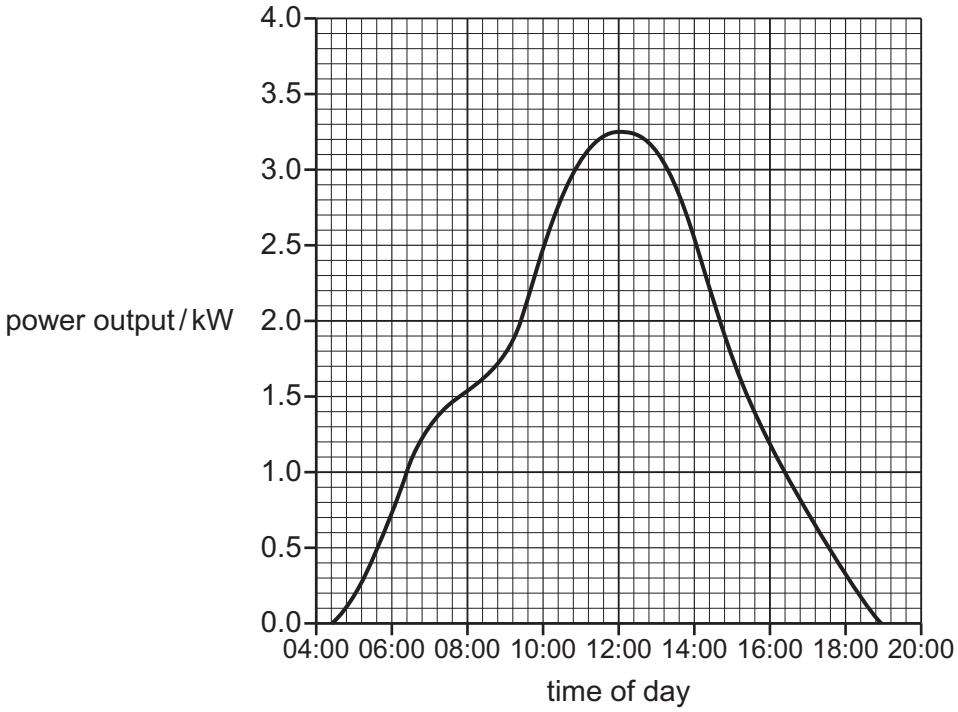

Fig. 6.1

(i) State the time at which the power output of the solar panel is at its maximum.

time of day ..... [1]

(ii) Suggest **one** reason why the power output of the solar panel is at a maximum at this time.

.....

..... [1]

(b) Table 6.1 gives some data about different types of power stations.

Table 6.1

power station	fuel	efficiency /%	output voltage /kV	output power /MW
P	coal	30	22	1500
Q	natural gas	40	31	1000
R	uranium	30	23	1300

Use Table 6.1 to complete each sentence.

Each letter, **P**, **Q** or **R**, can be used once, more than once or not at all.

The power station that produces the least carbon dioxide is power station ..... .

The power station that releases the most energy per second is power station ..... .

The power station with the generator that produces the largest current is power station ..... .
[2]

(c) Power stations use transformers to increase the output voltage.

Fig. 6.2 shows a simple transformer.

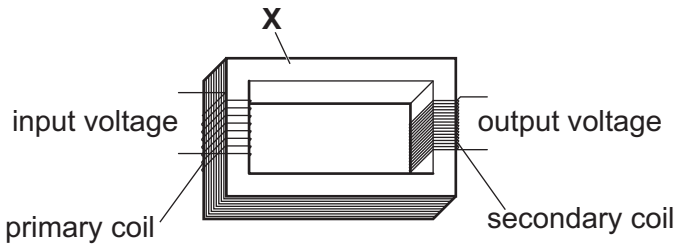

Fig. 6.2

(i) State the name of the part of the transformer labelled **X**.

..... [1]

(ii) Describe how the output voltage across the secondary coil is produced.

.....

.....

.....

.....

.....

..... [3]

(iii) Fig. 6.2 shows a step-up transformer containing 8 turns in the primary coil and 17 turns in the secondary coil.

The input voltage across the primary coil is 22 kV.

Calculate the output voltage across the secondary coil.

output voltage = ... kV [2]

[Total: 10]

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7 **(a)** Fig. 7.1 shows a food web.

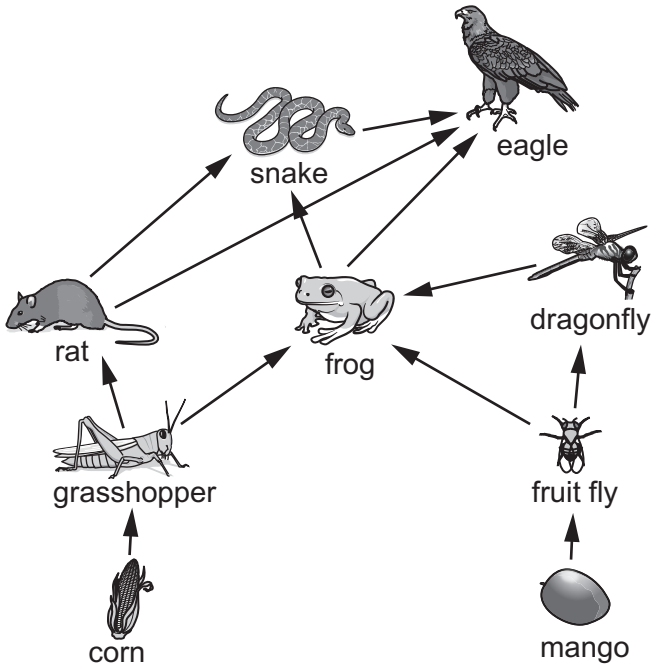

Fig. 7.1

(i) Use the information in Fig. 7.1 to state the name of one:

herbivore

.....

quaternary consumer

.....

organism that occupies the first trophic level.

.....

[3]

(ii) State three ways that energy is lost between trophic levels.

1 .....

2 .....

3 .....

[3]

(iii) State the principal source of energy for all biological systems.

..... [1]

(b) Fertilisers are sometimes used to improve the growth of crop plants.

Excessive use of fertilisers pollutes rivers.

(i) Explain why this pollution increases the growth of producers in rivers.

.....

.....

.....

.....

.....

..... [2]

(ii) Explain how death of producers in rivers reduces the oxygen concentration in the water.

.....

.....

.....

.....

.....

..... [2]

[Total: 11]

8 **(a)** Copper has two isotopes, copper-63 and copper-65.

Table 8.1 shows information about copper-63 and copper-65.

Complete Table 8.1.

Table 8.1

isotope	proton (atomic) number	nucleon (mass) number	protons	neutrons	electrons
copper-63	29	63	29	34	.....
copper-65	29	65	.....	.....	29

[3]

(b) Complete the sentence to describe what is meant by isotopes.

Choose words from the list.

compound
electron
element
group
nucleon
nucleus
proton

Isotopes are atoms of the same ..... which have the same ..... number but a different ..... number.

[3]

(c) An element is in Group II and Period 3 of the Periodic Table.

Predict the electronic structure of this element.

Tick (✓) **one** box.

2.3 ☐

2.2.3 ☐

2.8.2 ☐

2.8.3 ☐

[1]

(d) Complete Fig. 8.1 to show the covalent bonding in a molecule of nitrogen, N_2.

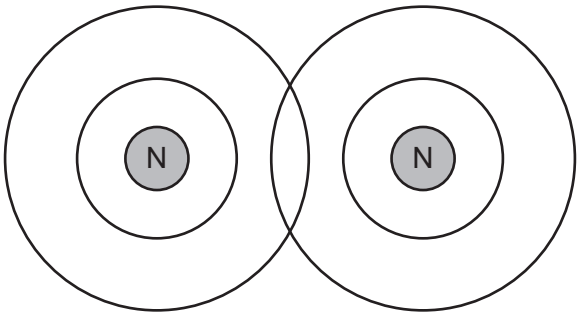

Fig. 8.1

[2]

(e) The element nitrogen is **covalently** bonded.

The melting point of nitrogen is –210 °C.

Calcium nitride, Ca_3N_2, is an **ionic** compound.

The melting point of calcium nitride is 1195 °C.

Explain the difference in melting points in terms of attractive forces.

.....

.....

..... [2]

[Total: 11]

9 A student investigates series and parallel circuits using filament lamps.

(a) Fig. 9.1 shows the first circuit the student makes using three identical filament lamps.

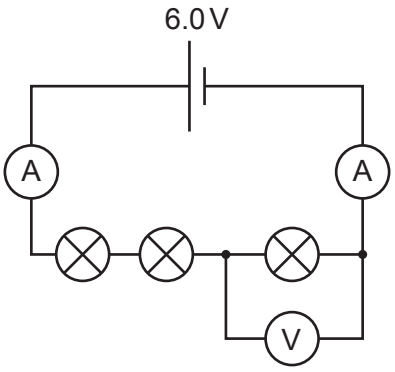

Fig. 9.1

(i) Determine the potential difference shown on the voltmeter.

potential difference = ... V [1]

(ii) Explain why the reading on both ammeters is the same.

.....

..... [1]

(b) Fig. 9.2 shows the second circuit made by the student using the same three identical filament lamps.

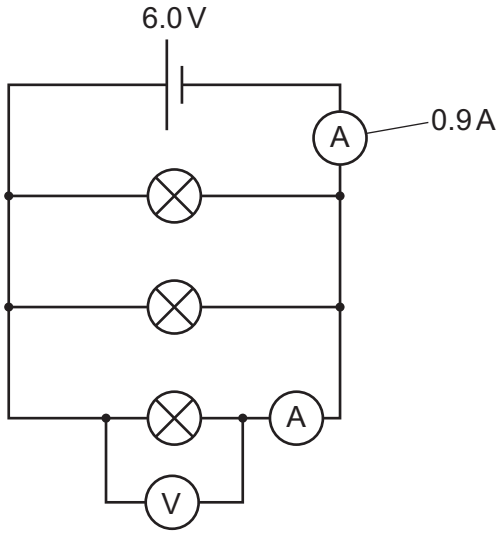

Fig. 9.2

One of the ammeters shows a current of 0.9A as shown in Fig. 9.2.

The voltmeter shows a potential difference of 6.0V.

Calculate the resistance of one of the filament lamps.

resistance = ... Ω [3]

(c) The filament lamps emit energy in the form of infrared radiation and visible light.

Complete the sentences to compare infrared radiation with visible light.

Infrared radiation and visible light are both parts of the ..... .

The wavelength of infrared radiation is ..... than the wavelength of visible light.

The frequency of infrared radiation is ..... than the frequency of visible light.

The speed of infrared radiation and visible light is ..... .
[2]

[Total: 7]

10 (a) Fig. 10.1 is a diagram of a sperm cell in humans.

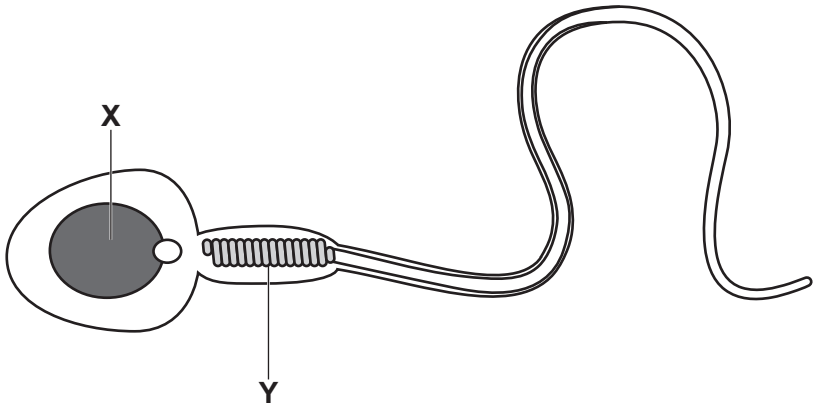

Fig. 10.1

(i) Cell structure **X** contains unpaired chromosomes.

State the **two** words used to describe cell structure **X** in Fig. 10.1.

..... [2]

(ii) State the number of chromosomes in cell structure **X** in Fig. 10.1.

..... [1]

(iii) Mitochondria are the site of aerobic respiration.

Suggest why part **Y** in Fig. 10.1 contains many mitochondria.

.....

.....

.....

.....

..... [2]

(b) Table 10.1 compares some of the features of asexual reproduction and sexual reproduction.

Place ticks (✓) in the boxes in Table 10.1 to show the correct features of asexual reproduction and sexual reproduction.

Table 10.1

	asexual reproduction	sexual reproduction
involves formation of a zygote		
no genetic variation		
involves production of offspring		

[2]

(c) Describe two **disadvantages** of sexual reproduction.

1 .....

.....

2 .....

.....

[2]

[Total: 9]

11 Electrolysis is the breakdown of an ionic compound, when molten or in aqueous solution, by the passage of electricity.

The products of electrolysis of some aqueous solutions, using inert electrodes, are shown in Table 11.1.

Table 11.1

aqueous solution	product at anode	product at cathode
copper chloride	.....	copper
magnesium sulfate	oxygen	.....
sodium bromide	bromine	hydrogen

(a) Part of the reactivity series, from most reactive to least reactive, is shown.

sodium
magnesium
(hydrogen)
copper

Use this information to complete Table 11.1. [2]

(b) State why hydrogen forms at the cathode, rather than sodium, during the electrolysis of aqueous sodium bromide.

.....

..... [1]

(c) Copper is formed at the cathode in the electrolysis of aqueous copper chloride.

Construct the ionic half-equation for the formation of copper at the cathode.

..... [2]

(d) Aqueous copper(II) sulfate is electrolysed using inert electrodes.

Oxygen gas is formed at the anode. Copper metal is formed at the cathode.

(i) The ionic half-equation for the formation of oxygen gas at the anode is shown.

$$4OH^- \rightarrow 2H_2O + O_2 + 4e^-$$

State if this reaction is oxidation or reduction.

Explain your answer using ideas about electrons.

.....

..... [1]

(ii) The experiment is repeated using **copper electrodes** instead of inert electrodes.

Describe what happens at the anode and the cathode using copper electrodes.

anode .....

cathode .....
[2]

[Total: 8]

12 (a) Table 12.1 shows information about three types of ionising radiation.

Table 12.1

type of ionising radiation	nature of radiation	relative ionising effect	relative penetrating ability
alpha	.....	high	.....
beta	fast-moving electron	medium	medium
gamma	electromagnetic radiation	low	.....

(i) Complete Table 12.1. [2]

(ii) Fig. 12.1 shows the path taken by a beta particle as it moves through an electric field.

Complete Fig. 12.1 to show the paths taken by alpha particles and gamma rays as they pass through an electric field.

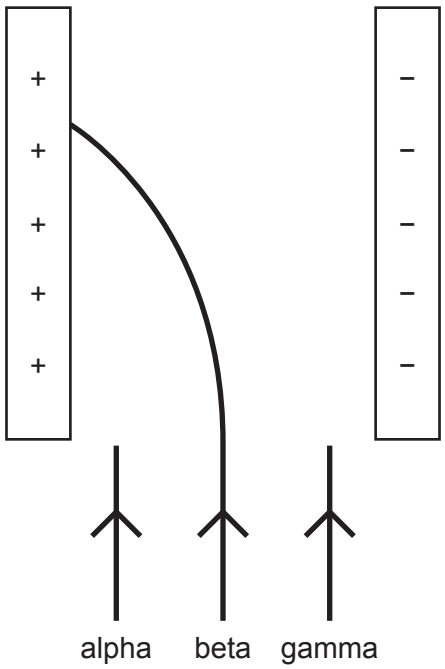

Fig. 12.1

[2]

(b) Beta particles are released when carbon-14 ($^{14}_{6}C$) decays into an isotope of nitrogen.

Use the correct nuclide notation to complete the decay equation for carbon-14.

$$^{14}_{6}C \rightarrow \begin{matrix}\cdots\cdots\cdots \\ \cdots\cdots\cdots\end{matrix} N + \begin{matrix}\cdots\cdots \\ \cdots\cdots\end{matrix} \beta$$

[2]

(c) At room temperature, nitrogen is a gas, water is a liquid and carbon is a solid.

(i) Explain why a gas can be compressed and a solid cannot be compressed.

.....

.....

..... [1]

(ii) Suggest if water can be compressed.

Give a reason for your answer.

.....

.....

..... [1]

(iii) A sample of nitrogen gas is held in a container with a fixed volume.

The temperature of the nitrogen is increased.

Explain the effect that increasing the temperature of the gas has on the pressure in the gas.

Use ideas about molecules in your answer.

.....

.....

.....

.....

.....

..... [3]

[Total: 11]

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

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.).