Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6811986498

COMBINED SCIENCE **5129/21**

Paper 2 Theory **October/November 2023**

1 hour 45 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 **20** pages. Any blank pages are indicated.

[Turn over

1 Fig. 1.1 is the speed–time graph for a ball falling from the top of a tower.

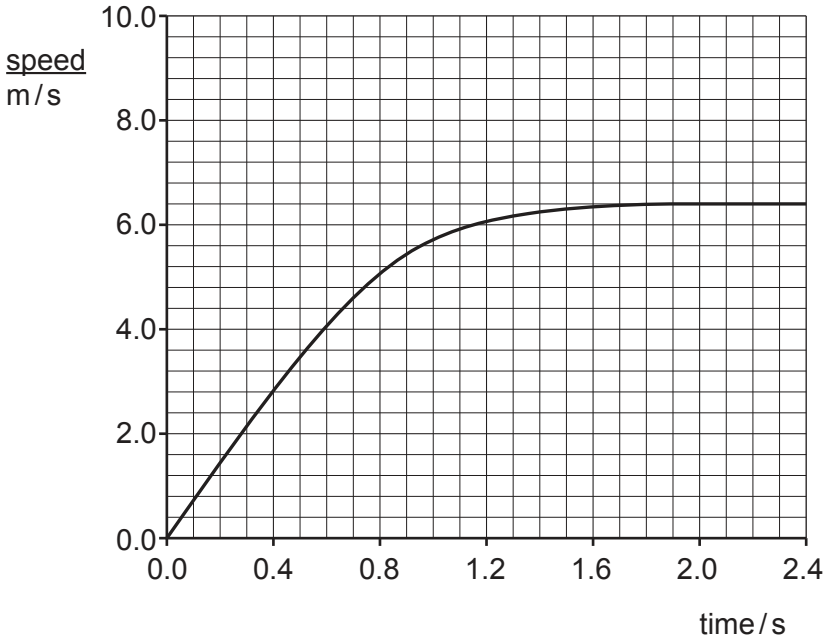

Fig. 1.1

(a) On Fig. 1.1, use:

(i) the letter **A** to label part of the graph that shows constant non-zero acceleration [1]

(ii) the letter **B** to label part of the graph that shows changing acceleration. [1]

(b) Calculate the distance travelled by the ball between 2.0 s and 2.4 s.

distance = ... m [2]

[Total: 4]

2 The boxes on the left contain specialised cells and tissues found in plants.

The boxes on the right contain functions of plant cells and tissues.

Draw **one** straight line from each structure to its function.

Each function can be used once, more than once or not at all.

structure	**function**
guard cells	transports sucrose
palisade mesophyll	controls size of stomata
phloem	produces glucose
root hair cell	transports mineral ions
spongy mesophyll	absorbs water
xylem	

[6]

3 Ammonia, NH_3, is produced by the reaction between nitrogen and hydrogen.

The equation for the reaction is:

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

[A_r: H, 1; N, 14]

(a) (i) Calculate the relative molecular mass M_r of ammonia.

M_r = ... [1]

(ii) Complete the following sentences.

51 g of ammonia is produced from ..... g of nitrogen.

34 g of ammonia is produced from ..... g of hydrogen.

[2]

(b) (i) Complete Fig. 3.1 to show the outer electrons in a molecule of ammonia.

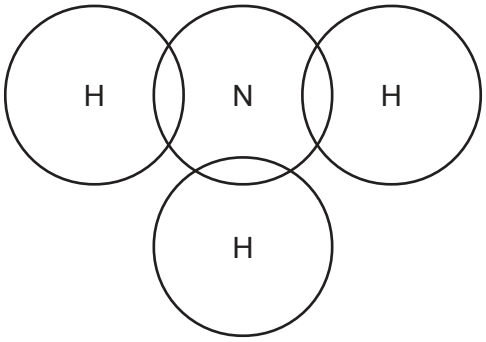

Fig. 3.1

[1]

(ii) Explain why ammonia has a low boiling point.

.....

.....

..... [1]

[Total: 5]

4 A wooden block of mass 1.6 kg is attached by a length of string to a weight as shown in Fig. 4.1.

When the block is released, there is a resultant force of 8.0 N to the right in the string.

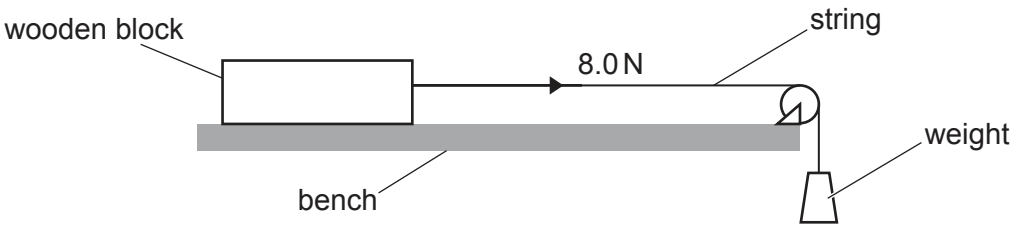

Fig. 4.1

(a) Calculate the acceleration of the block when it is released. State the unit of your answer.

acceleration = ... unit ..... [3]

(b) There is a frictional force of 2.0 N to the left acting against the block as it moves.

The block moves 0.75 m along the bench.

Calculate the work done against this frictional force.

work done = ... J [2]

[Total: 5]

5 **(a)** Use words from the list to complete the sentences about the circulatory system.

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

arteries	**brain**	**capillaries**	**heart**	
thick	**thin**	**valves**	**veins**	**villi**

Blood is pumped round the body by the ..... .

Blood under high pressure flows through vessels called ..... .

These vessels have ..... walls to withstand the high pressure of the blood.

When blood is flowing under low pressure, the vessels contain ..... to prevent blood flowing backwards.

[4]

(b) Fig. 5.1 is an electron micrograph of a pathogen being engulfed by a blood cell.

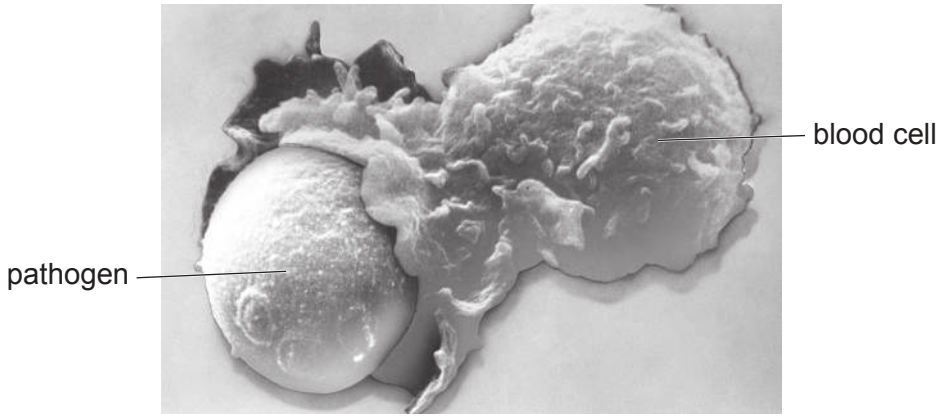

Fig. 5.1

(i) Name the type of blood cell shown in Fig. 5.1.

..... [1]

(ii) Name **one** other type of blood cell.

..... [1]

[Total: 6]

6 Sodium, Na, reacts with bromine, Br_2, to form sodium bromide, NaBr.

(a) (i) Construct a balanced symbol equation for the reaction.

..... [1]

(ii) State the type of bonding in sodium bromide.

..... [1]

(b) Table 6.1 shows some observations when aqueous solutions of sodium bromide are mixed with different chemicals, **X**, **Y** and **Z**.

Table 6.1

chemical	observation
X	orange solution formed
Y	no change
Z	cream precipitate formed

(i) Suggest the name of a halogen that is chemical **X**.

..... [1]

(ii) Suggest the name of a halogen that is chemical **Y**.

..... [1]

(iii) Suggest the name of a compound that is chemical **Z**.

..... [1]

[Total: 5]

[Turn over

7 **(a)** A weight of 12.0 N is placed at the end of a beam as shown in Fig. 7.1.

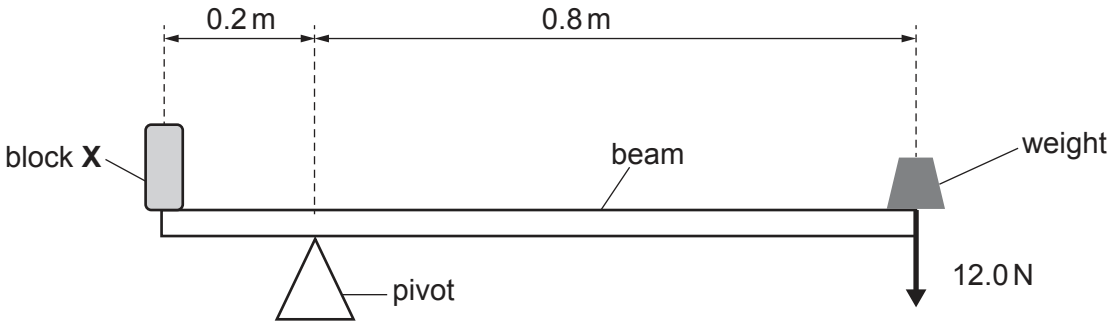

Fig. 7.1

Calculate the mass in kg of block **X** that balances the beam.

Assume that the beam has negligible mass.

Gravitational field strength g = 10 N / kg.

mass = ... kg [3]

(b) The block absorbs infrared radiation.

This causes its temperature to rise.

(i) State the name of **one** renewable source of energy that gives out infrared radiation.

..... [1]

(ii) The block is then wrapped in thermal insulation and placed in a cold room.

State and explain what happens to the temperature of the block.

.....

.....

..... [2]

[Total: 6]

Question 8 begins over the page

8 **(a)** During exercise, the heart rate increases.

State **two** reasons why there is an increase in heart rate during exercise.

reason 1 .....

.....

reason 2 .....

[2]

(b) Fig. 8.1 shows the heart rate of a student over a period of twenty minutes before and after three weeks of training.

The period includes:

- five minutes of resting
- ten minutes of running quickly
- five minutes of resting after running.

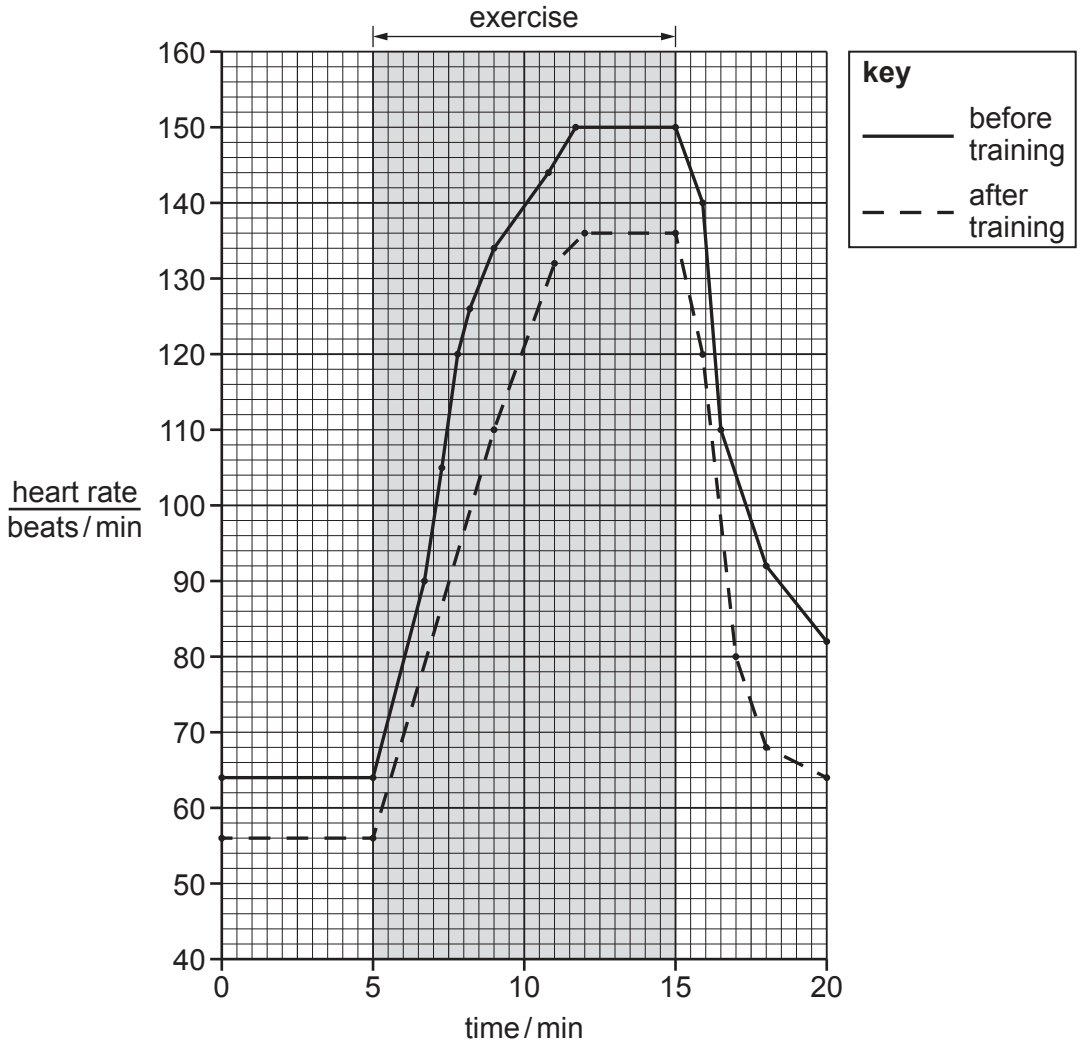

Fig. 8.1

(i) State the maximum heart rate of the student before training for three weeks.

maximum heart rate = ... beats / min [1]

(ii) Describe **two** effects, shown in Fig. 8.1, of the training on the heart rate of the student.

1 .....

.....

2 .....

..... [2]

[Total: 5]

9 During an earthquake, two types of seismic wave are transmitted through the Earth.

State the names of these two types of seismic wave.

Describe the difference between these two types of seismic wave and compare how they transfer energy.

You may draw a labelled diagram if it helps you with your description.

.....

.....

.....

.....

.....

.....

..... [4]

10 Soluble magnesium sulfate is prepared from the reaction between insoluble pieces of magnesium carbonate and an aqueous acid.

(a) Use words from the list to complete the sentences to describe how a pure sample of magnesium sulfate is prepared.

crystallisation **equal** **excess** **filtrate**

melting **nitric** **residue** **sulfuric**

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

An ..... amount of magnesium carbonate is added to

aqueous ..... acid.

The mixture is filtered.

The ..... is gently heated until ..... occurs.

[4]

(b) State the effect on the rate of reaction of using magnesium carbonate powder instead of pieces of magnesium carbonate.

..... [1]

(c) Name the gas produced when magnesium carbonate reacts with an aqueous acid.

..... [1]

(d) State the ion responsible for making aqueous solutions acidic.

..... [1]

[Total: 7]

11 Fig. 11.1 shows the human male reproductive system.

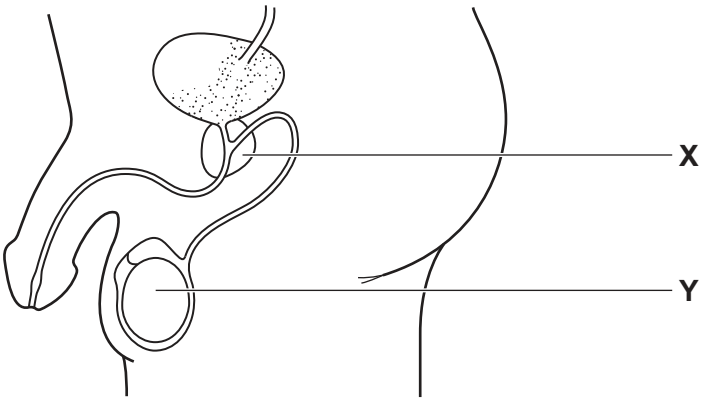

Fig. 11.1

Two structures on Fig. 11.1 are labelled **X** and **Y**.

(a) (i) State **one** function of structure **X**.

.....

..... [1]

(ii) State **one** function of structure **Y**.

.....

..... [1]

(b) Table 11.1 compares the features of a female and a male gamete.

Complete the comparisons in Table 11.1.

One comparison has been completed for you.

Table 11.1

feature	female gamete	male gamete
type of nucleus	haploid	haploid
relative size of cell	very large	.....
numbers produced per month	.....	millions
method of movement	cannot move by itself	.....

[3]

[Total: 5]

12 Clean, dry air is a mixture of gases.

(a) **(i)** Describe the motion of the gas particles in air.

.....

..... [1]

(ii) State the percentage of oxygen in clean, dry air.

..... [1]

(b) State **two** substances found in air that are products of the incomplete combustion of alkanes in petrol.

substance 1 .....

substance 2 .....
[2]

(c) Cars in the future may be powered by hydrogen-oxygen fuel cells.

Describe one advantage of using hydrogen-oxygen fuel cells instead of petrol engines in cars.

.....

..... [1]

[Total: 5]

13 Resistors R_1, R_2, and R_3 are connected in a circuit as shown in Fig. 13.1.

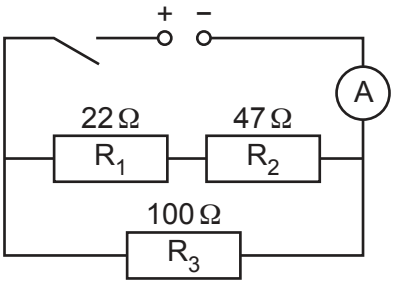

Fig. 13.1

- Resistor R_1 has a resistance of 22 Ω.
- Resistor R_2 has a resistance of 47 Ω.
- Resistor R_3 has a resistance of 100 Ω.

(a) Calculate the combined resistance of the resistors that are connected in series.

combined resistance = ... Ω [1]

(b) The current in R_3 is 0.045 A.

The current reading on the ammeter is 0.11 A.

Calculate the current in R_1.

current = ... A [1]

(c) Fig. 13.2 shows the electrical symbols of three circuit components **A**, **B** and **C**.

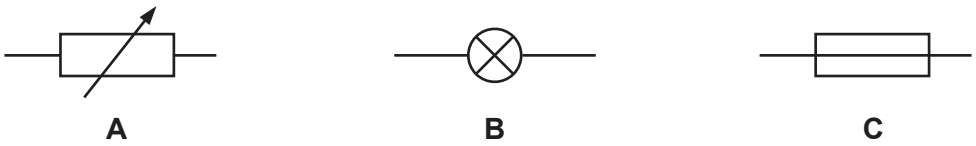

Fig. 13.2

(i) State the name of component **A** and the name of component **B**.

A .....

B .....
[2]

(ii) Component **C** is a fuse.

Describe how a fuse protects a circuit from a high current.

.....

..... [1]

[Total: 5]

14 (a) Draw **three** lines from the box on the left to three of the boxes on the right to make three correct statements about the carbon cycle.

As part of the carbon cycle, …

… anaerobic respiration adds carbon dioxide to the atmosphere.

… combustion adds carbon dioxide to the atmosphere.

… decomposers add carbon dioxide to the atmosphere.

… fossil fuels need carbon dioxide when used as an energy source.

… plants remove more carbon dioxide from the atmosphere by photosynthesis than they add by respiration.

[3]

(b) Suggest **two** reasons why scientists insert the human insulin gene into the DNA of bacteria.

reason 1 .....

.....

reason 2 .....

..... [2]

[Total: 5]

15 Table 15.1 shows the electronic configuration of five elements, **A**, **B**, **C**, **D** and **E**.

The letters are not the symbols of the elements.

Table 15.1

element	electronic configuration
A	2
B	2,1
C	2,8,1
D	2,8,7
E	2,8,8

Use the information in Table 15.1 to answer parts **(a)** to **(d)**.

(a) Explain why the elements **B** and **C** are in the same group of the Periodic Table.

.....

..... [1]

(b) State the letter of an element that forms an ion with a charge of –1.

..... [1]

(c) Explain why elements **A** and **D** are in different periods of the Periodic Table.

.....

..... [1]

(d) State the letter of an element that is a noble gas.

..... [1]

[Total: 4]

16 A Geiger-Muller tube is used to detect background radiation.

(a) Explain what is meant by 'background radiation'.

.....

.....

.....

..... [2]

(b) State the name of **one** other method of detecting radiation that can detect alpha-particles.

..... [1]

[Total: 3]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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.).