Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

9960050225

PHYSICS **5054/22**

Paper 2 Theory **May/June 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.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s^2).

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

DC (CE/SW) 316499/4

1 Fig. 1.1 shows the speed–time graph for a car travelling on a straight horizontal road.

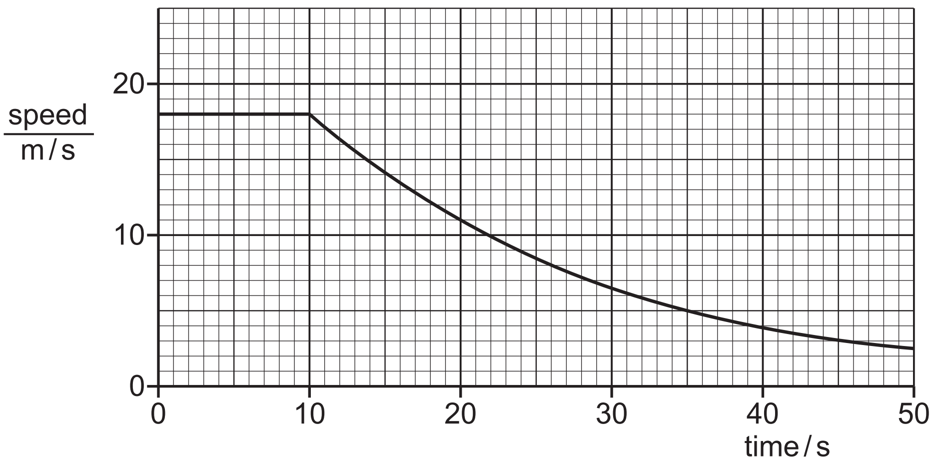

Fig. 1.1

(a) Describe the motion of the car shown in Fig. 1.1.

....

....

....

.... [2]

(b) At time t = 10 s the engine of the car is switched off. The brakes are not applied.

(i) Name **two** forces that act on the car to cause the change in motion after t = 10 s.

1 ....

2 ....

[1]

(ii) Suggest why Fig. 1.1 is a curve after t = 10 s.

....

....

.... [1]

(c) Between t = 10 s and t = 20 s the speed of the car changes from 18 m/s to 11 m/s.

The mass of the car is 1200 kg.

(i) Calculate the change in momentum of the car in this time.

Give the unit of your answer

momentum change = ... unit .... [2]

(ii) Calculate the average resultant force exerted on the car during this time.

average resultant force = ... N [2]

[Total: 8]

2 Fig. 2.2 shows a rider on an electric scooter.

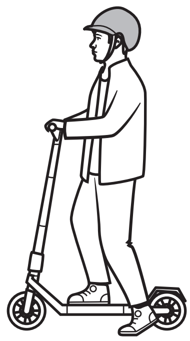

Fig. 2.2

The scooter contains a battery and a motor to drive the back wheel.

(a) **(i)** State the name of the energy store in the battery.

.... [1]

(ii) Describe, in terms of work done, the stages of energy transfer from the energy store in the battery to the kinetic energy of the scooter.

....

....

....

.... [2]

(b) The total mass of the scooter and the rider is 70 kg.

Calculate the total kinetic energy of the rider and scooter when the scooter has a speed of 4.0 m / s.

kinetic energy = ... J [2]

(c) The battery is marked ‘energy capacity 0.35 kilowatt-hour (kW h)’.

(i) Define what is meant by a kilowatt-hour.

....

.... [1]

(ii) The scooter stops working because the battery is totally discharged (flat). This means that there is no more energy stored in the battery.

The battery is then recharged using a 70 W power supply.

Calculate the time taken to fully recharge the battery.

time = ... hours [2]

[Total: 8]

3 A fixed mass of gas in a glass tube is trapped by a seal at one end of the tube and by a column of mercury. The mercury is free to move within the tube.

The tube is rotated slowly from the vertical as shown in Fig. 3.1 to the horizontal as shown in Fig. 3.2. The volume of the gas increases and its temperature remains constant.

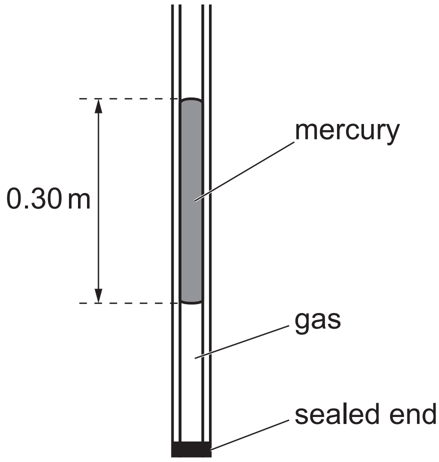

Fig. 3.1 (not to scale)

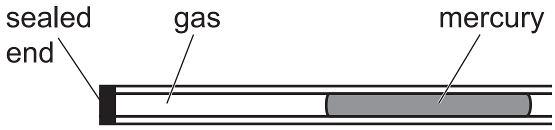

Fig. 3.2 (not to scale)

(a) **(i)** Describe why rotating the tube changes the pressure of the gas in the sealed end.

....

....

.... [1]

(ii) Explain, using ideas about particles, why the pressure of the gas decreases when its volume increases.

....

....

....

.... [3]

(b) In Fig. 3.1 the length of the mercury column is 0.30 m.

The density of mercury is 14 000 kg / m^3.

Atmospheric pressure is 1.0×10^5 Pa.

Calculate the pressure of the gas in the tube.

pressure = ... Pa [3]

(c) The pressure of a different sample of gas changes at constant temperature.

Fig. 3.3 shows one point, marked X, on a graph of pressure against volume for the gas sample.

At X the pressure of the gas is P_0 and its volume is V_0.

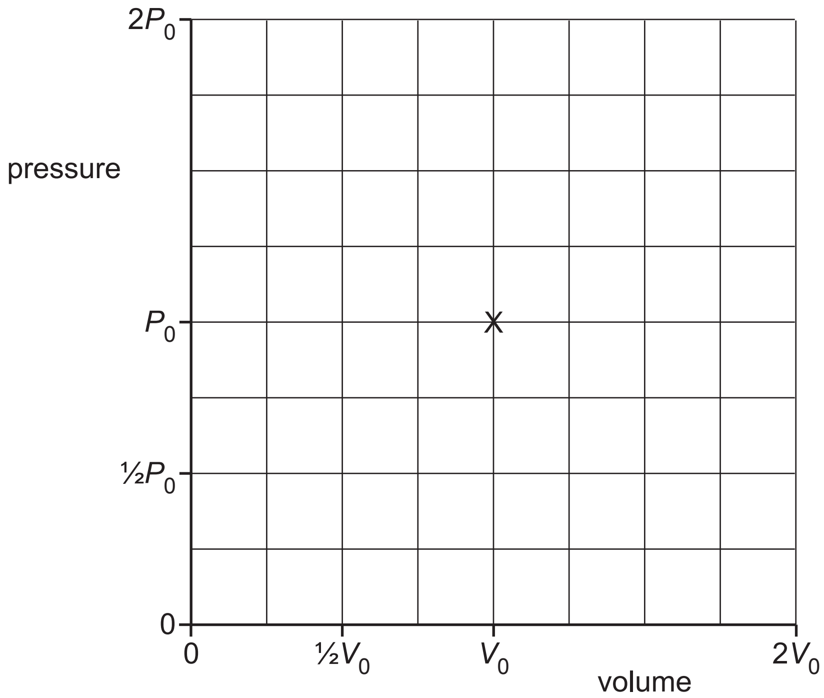

Fig. 3.3

On Fig. 3.3, sketch the graph as the pressure of the gas decreases from $2P_0$ to $½P_0$. [2]

[Total: 9]

4 Fig. 4.1 shows the particles (atoms) at one instant in a sample of iron at a temperature below its melting point.

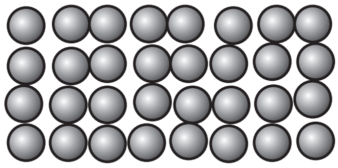

Fig. 4.1

(a) (i) State the lowest possible temperature on the Celsius scale and on the Kelvin scale.

Celsius scale .... °C Kelvin scale .... K [1]

(ii) The temperature of the solid increases. The sample remains a solid.

Describe how the motion of the particles changes.

....

.... [2]

(iii) The solid melts.

State what happens to the internal energy and the temperature of the solid as it melts.

internal energy ....

temperature ....
[2]

(b) A student:

- places a 300 g piece of iron in boiling water until the iron is at a temperature of 100 °C
- removes the iron from the water and places it immediately into 100 g of water at 25 °C.

The iron cools and the water warms until both reach the same temperature, 44 °C.

The specific heat capacity of water is 4.2 J / (g °C). No energy is lost to the surroundings.

(i) Calculate the change in energy (internal energy) of the water as it warms up.

change in energy = ... J [2]

(ii) Calculate the specific heat capacity of iron.

specific heat capacity = ... J / (g °C) [2]

[Total: 9]

5 Water waves are transverse waves.

(a) Underline **two** other examples of transverse waves.

seismic P-waves **seismic S-waves** **sound** **X-rays** [1]

(b) Fig. 5.1 shows a wooden bar and a glass block in a ripple tank. The depth of water in the tank is less than the height of the glass block.

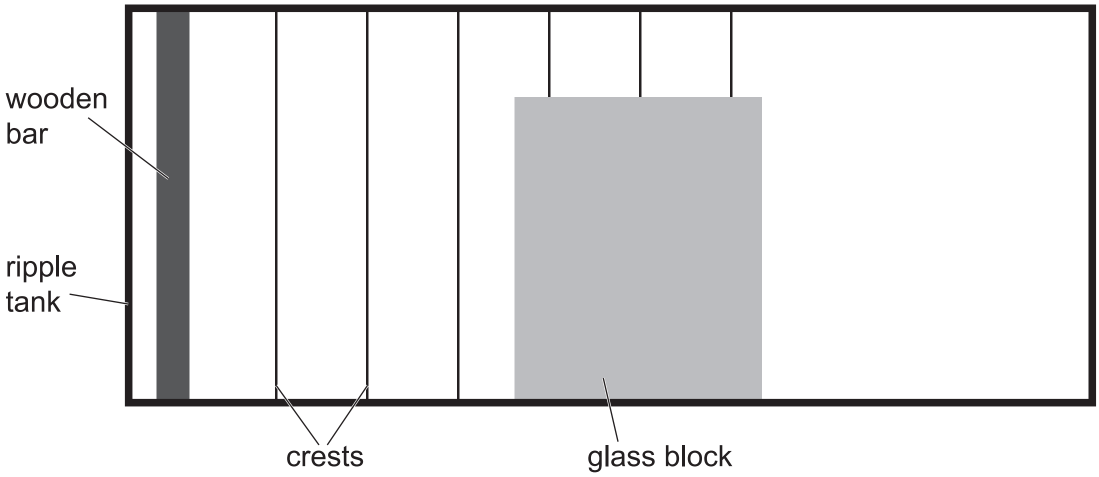

Fig. 5.1 (not to scale)

The wooden bar moves up and down once every 0.15 s to create the crests.

(i) The speed of the water wave is 27 cm / s.

Calculate the frequency and the wavelength of the wave.

frequency = ... Hz

wavelength = ... cm [3]

(ii) The wave diffracts at the right-hand edge of the glass block.

On Fig. 5.1 draw **two** crests after they pass the glass block to show the diffraction. [2]

(iii) Describe how a wave with a smaller wavelength is made with the wooden bar.

....

.... [1]

(iv) Describe how a decrease in wavelength affects the diffraction.

....

.... [1]

[Total: 8]

6 Fig. 6.1 shows an electric circuit containing a filament lamp, a resistor R, a 12 V battery and five meters.

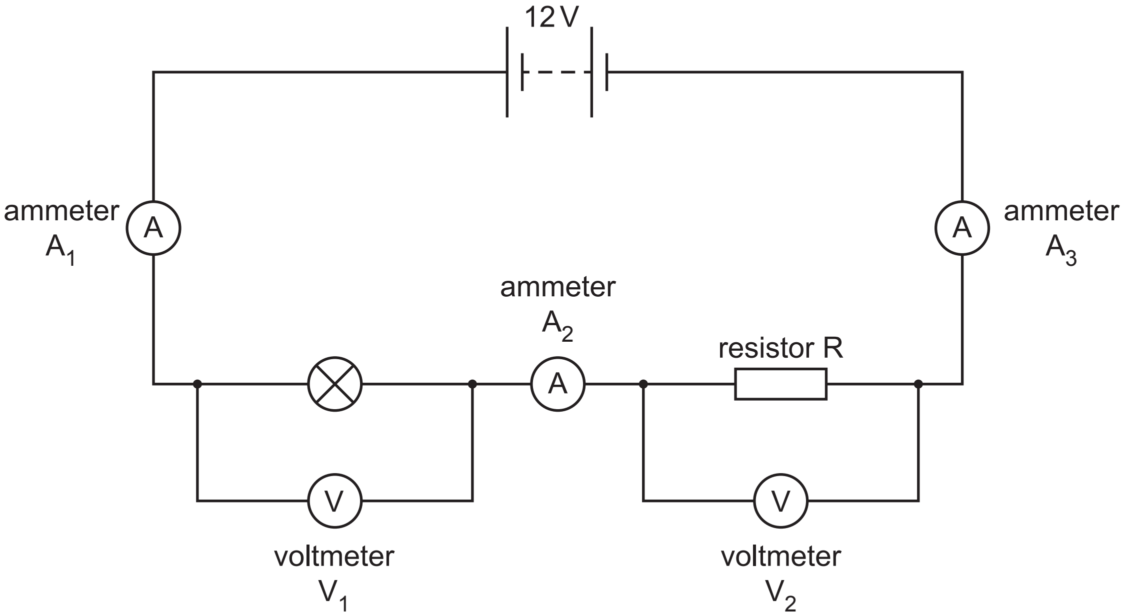

Fig. 6.1

(a) (i) The reading on ammeter A_1 is 0.25 A.

The reading on voltmeter V_1 is 3.0 V.

Determine the readings on the other meters.

reading on ammeter A_2 = ... A

reading on ammeter A_3 = ... A

reading on voltmeter V_2 = ... V
[2]

(ii) Calculate the resistance of resistor R.

resistance of resistor R = ... Ω [2]

(iii) The resistor obeys Ohm's law.

State Ohm's law.

....

....

.... [2]

(b) Fig. 6.2 shows the current–voltage graph for the filament lamp.

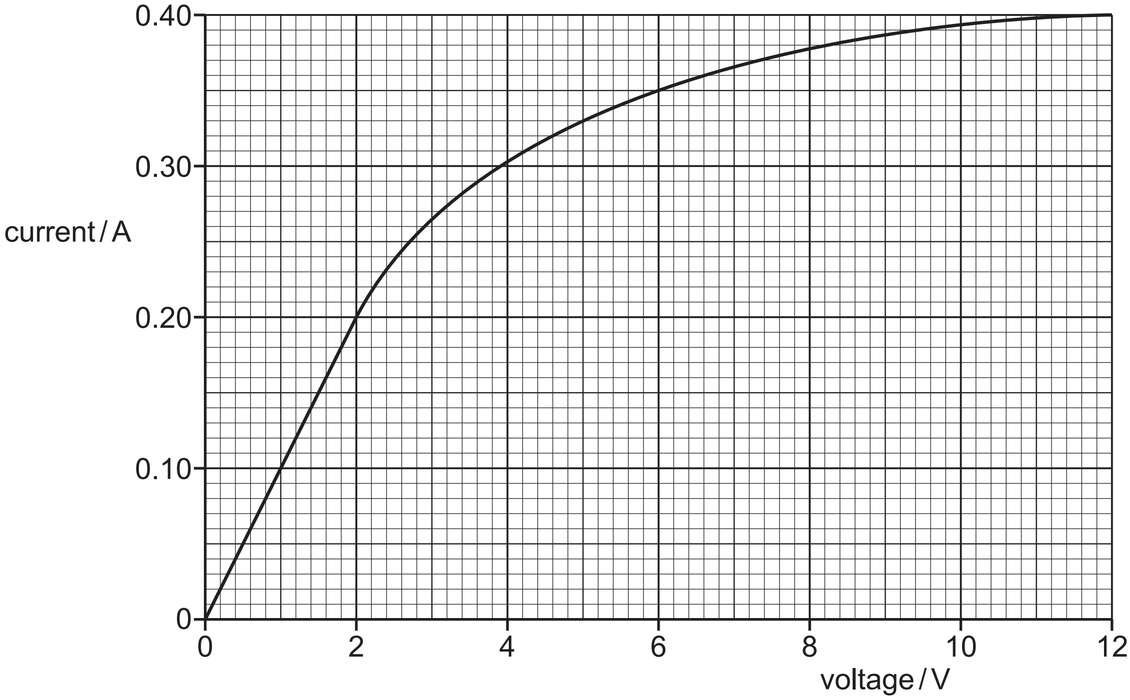

Fig. 6.2

The battery in Fig. 6.1 is replaced with a different battery which has a different e.m.f. (electromotive force).

The voltage across the lamp increases to 6.0 V.

Use data from the graph to determine the e.m.f. of the second battery.

Show your working.

e.m.f. = ... V [3]

[Total: 9]

7 **(a)** Ultraviolet radiation is one component of the electromagnetic spectrum.

(i) State the name of **two** components of the electromagnetic spectrum that have a smaller wavelength than ultraviolet radiation.

1 ....

2 ....
[1]

(ii) State **one** useful application of ultraviolet radiation.

.... [1]

(iii) Exposure to ultraviolet radiation from the Sun damages the eyes.

State **one** type of damage to the eye caused by ultraviolet radiation.

.... [1]

(b) Fig. 7.1 shows a ray of light. The ray passes into a semi-circular block of glass at A and leaves the glass at B, travelling along the surface to C.

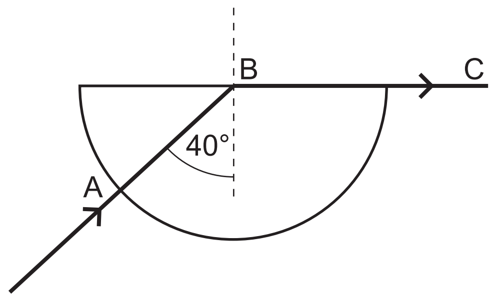

Fig. 7.1

(i) State the name given to the angle of incidence marked as 40°.

.... [1]

(ii) Calculate the refractive index of the glass.

refractive index = ... [2]

[Total: 6]

8 Fig. 8.1 shows a step-down transformer used to operate an electric bell.

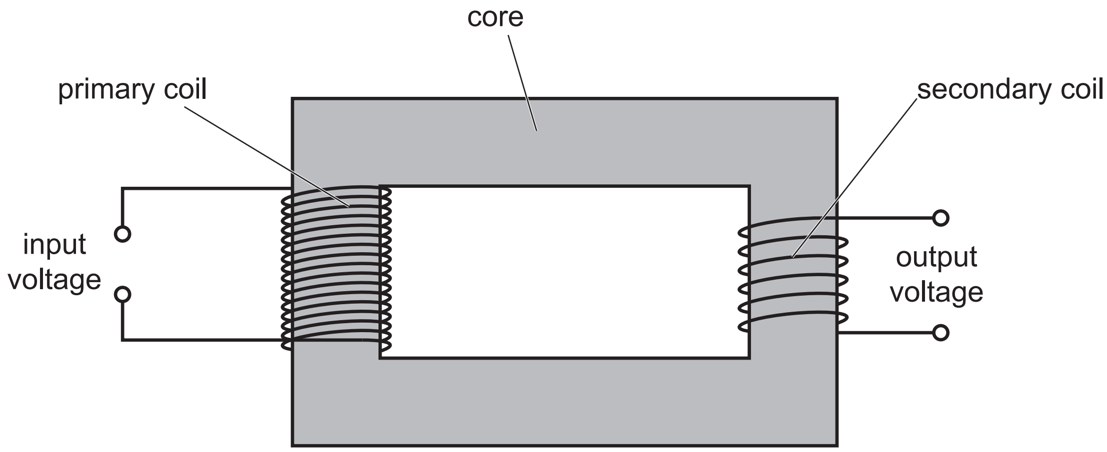

Fig. 8.1

(a) State the material used for the core of the transformer.

.... [1]

(b) A current in the primary coil produces a magnetic field in the core.

Explain how an alternating voltage is produced in the secondary coil.

....

....

....

.... [3]

(c) The transformer has 4600 turns on the primary coil which is connected to a mains supply of 230 V.

An output of 5.0 V is used to operate the bell.

Calculate the number of turns needed on the secondary coil.

number of turns = ... [2]

(d) State one change that can be made to the transformer shown in Fig. 8.1 so that it can be used as a step-up transformer.

....

.... [1]

[Total: 7]

9 A radioactive source emits α-particles, β-particles and γ-radiation.

(a) **(i)** State which type of radiation produces the strongest ionising effect.

.... [1]

(ii) State which type of radiation is deflected most by a magnetic field.

.... [1]

(b) Fig. 9.1 shows a Geiger-Müller (G.M.) tube and counter. A radioactive source is placed 10 cm from the G.M. tube.

In Fig. 9.2 a piece of metal 5 mm thick is placed between the source and the G.M. tube. The readings on the counter have been corrected for background radiation and show the count rate due to the source.

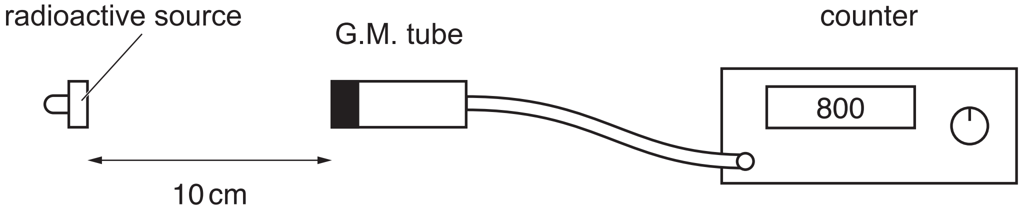

Fig. 9.1

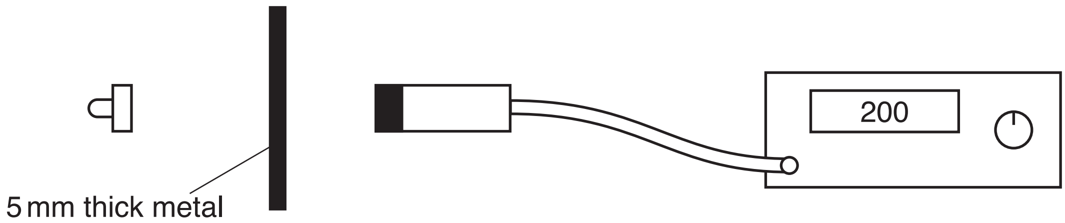

Fig. 9.2

(i) Explain how the readings show that the source emits β-particles and γ-radiation.

....

....

....

.... [3]

(ii) State why the readings **cannot** be used to show that the source emits α-particles.

....

.... [1]

(c) Describe **one** way that a radioactive source is moved safely in a school laboratory.

....

.... [1]

[Total: 7]

10 **(a)** Astronomical distances are measured in light-years.

(i) State what is meant by ‘a light-year’.

....

.... [1]

(ii) The Sun is one star in the Milky Way galaxy.

State the approximate diameter of the Milky Way galaxy.

diameter of Milky Way = ... light-years [1]

(b) There are several stages in the life cycle of a star.

(i) Complete Fig. 10.1 to show the stages that a **massive** star goes through after it has used up most of the hydrogen at the centre of the star.

Use words from the following list:

nebula **neutron star** **protostar** **red giant** **supernova** **white dwarf**

massive star (much larger than our Sun)

↓

red supergiant

↓

....

↓

.... and black hole or ....

Fig. 10.1

[2]

(ii) State the stage in the life cycle of a star where heavy elements are formed.

.... [1]

Question 10 continues over the page.

(c) Current scientific understanding is that the universe began 14 billion years ago in an event known as the Big Bang.

Explain **one** observation that supports the Big Bang Theory.

observation ....

....

explanation ....

....

....

....

....

....

[4]

[Total: 9]