Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

PHYSICS **5054/21**

Paper 2 Theory **May/June 2025**

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 **20** pages. Any blank pages are indicated.

[Turn over

1 Fig. 1.1 shows a skydiver falling vertically through the air.

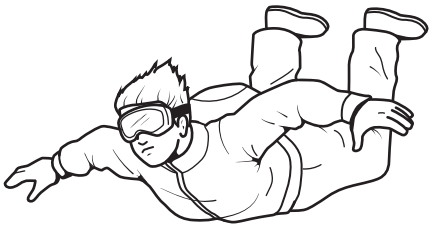

Fig. 1.1

In the first part of the fall, her speed increases and her acceleration decreases.

In the second part of the fall, her speed is constant.

(a) On Fig. 1.2 sketch the speed–time graph for the skydiver.

On your graph, mark **one** point where the speed of the skydiver is increasing with an A and **one** point where the speed of the skydiver is constant with a B.

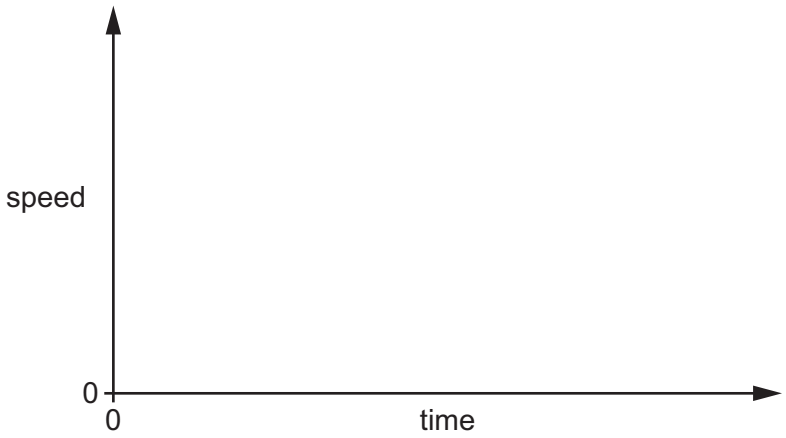

Fig. 1.2

[2]

(b) Explain how the graph shows that the acceleration decreases as the speed increases.

.....

.....

..... [1]

(c) During the first part of the fall, there is a resultant vertical force acting downwards on the skydiver.

(i) One of the vertical forces acting on the skydiver is her weight.

State the name of the other vertical force that acts on the skydiver.

..... [1]

(ii) Explain why the resultant vertical force eventually becomes zero.

.....

.....

.....

..... [2]

(d) At one instant, the vertical force on the skydiver is 400 N downwards.

At the same instant, the wind causes an additional horizontal force of 100 N to the right to act on the skydiver.

Draw a vector diagram to determine the resultant of the 400 N vertical force and the 100 N horizontal force. Place an arrow on all of the forces to show their directions.

Determine the magnitude (size) of this resultant force and its direction to the vertical.

magnitude of resultant = ... N

direction = ...° to vertical
[3]

[Total: 9]

2 **(a)** State the principle of moments.

.....

.....

..... [2]

(b) An airline passenger wishes to check the weight of a suitcase that he carries as hand luggage onto an aeroplane.

He uses a uniform plank of wood, pivoted at its centre, as shown in Fig. 2.1.

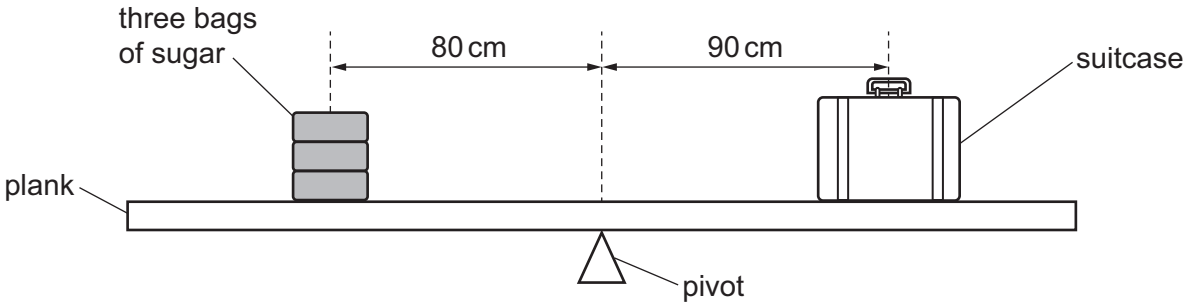

Fig. 2.1

The plank is balanced with the suitcase on one side of the pivot and three bags of sugar, each of mass 2.0 kg, on the other side.

The distances are shown on Fig. 2.1.

(i) Calculate the weight of **one** bag of sugar.

weight = ... N [1]

(ii) The maximum weight of a suitcase that can be carried onto the aeroplane is 67 N.

Determine whether the weight of the suitcase exceeds the maximum allowed.

Show a calculation in your answer.

.....

..... [2]

(c) A tall bus is tested for stability.

Fig. 2.2 shows the bus on a slope.

The centre of gravity of the bus is marked.

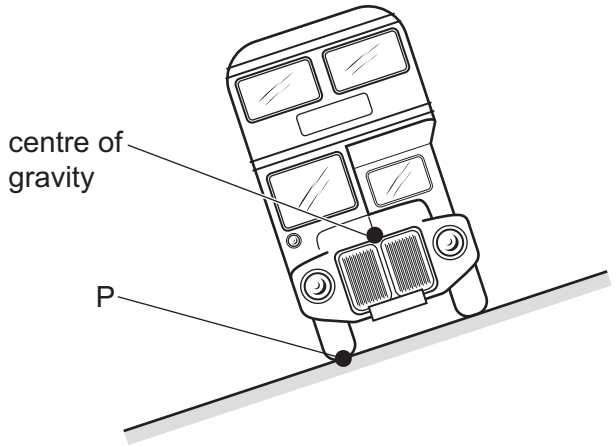

Fig. 2.2

(i) State what is meant by the 'centre of gravity' of an object.

.....

..... [1]

(ii) When the slope is made very steep, the bus falls over by rotating about point P.

Explain why the bus falls over.

.....

.....

.....

..... [2]

[Total: 8]

3 A battery, a pulley and a motor are used to lift a load as shown in Fig. 3.1.

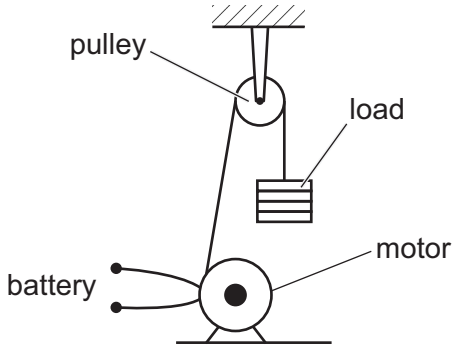

Fig. 3.1

(a) Describe the transfers between energy stores that occur as the load is lifted.

.....

.....

.....

..... [3]

(b) The efficiency of the motor, pulley and load system is less than 100%.

(i) By comparing the input energy and the useful output energy, explain why the efficiency is less than 100%.

.....

..... [1]

(ii) Explain how the principle of conservation of energy applies in lifting the load.

.....

.....

..... [2]

(c) The input power to the motor is 15 W. The motor is used for 20 s. The efficiency of the motor is 60%.

Calculate the energy supplied to the load.

energy = ... J [2]

[Total: 8]

4 **(a)** Evaporation of water from the surface of the skin causes cooling.

(i) Describe, using ideas about particles, how evaporation causes cooling.

.....

.....

..... [2]

(ii) State **one** difference between evaporation and boiling.

.....

..... [1]

(b) When a refrigerator is switched on, cooling coils placed at the top of the space inside the refrigerator become cold. This causes a convection current which cools the air inside the refrigerator. The refrigerator is shown in Fig. 4.1.

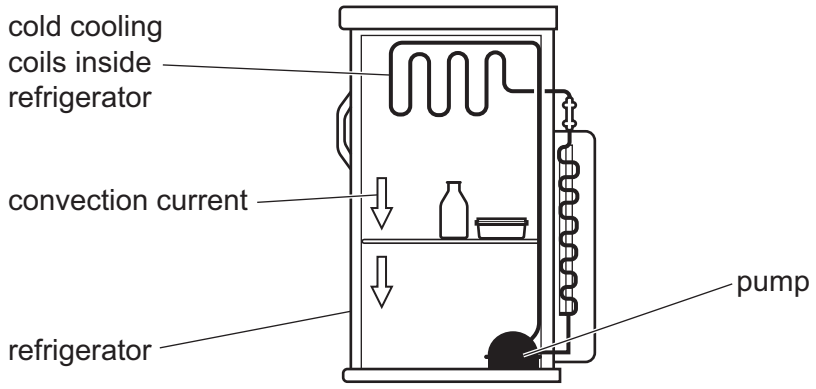

Fig. 4.1

(i) Explain how the cooling coils cause a convection current in the air inside the refrigerator.

.....

.....

..... [2]

(ii) The food in the refrigerator is initially at a temperature of 20.0 °C. The food has a mass of 3.6 kg and a specific heat capacity of 3000 J / (kg °C).

Calculate the final temperature of the food after 160 000 J of thermal energy is removed from it.

final temperature = ... °C [2]

[Total: 7]

5 **(a)** Fig. 5.1 is a diagram showing the arrangement of air particles as a longitudinal wave passes through them.

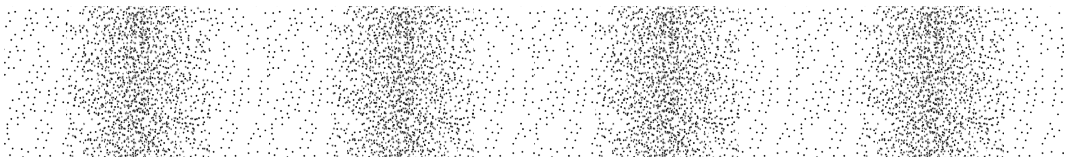

Fig. 5.1

(i) On Fig. 5.1, mark the centre of a compression with the letter C, and mark the centre of a rarefaction with the letter R. [1]

(ii) Describe the difference between a compression and a rarefaction.

.....

.....

..... [1]

(b) In a ripple tank, a water wave is produced by a wooden bar moving up and down on the surface of water.

(i) The wooden bar makes 45 complete oscillations in 1.0 minute.

Calculate the frequency of the wave produced.

frequency = ...Hz [1]

(ii) The frequency of the water wave is increased by moving the wooden bar up and down more quickly.

State what happens to the speed and what happens to the wavelength of the wave produced.

speed .....

wavelength .....
[2]

(iii) The crests of the water wave move into the shallow region shown in Fig. 5.2.

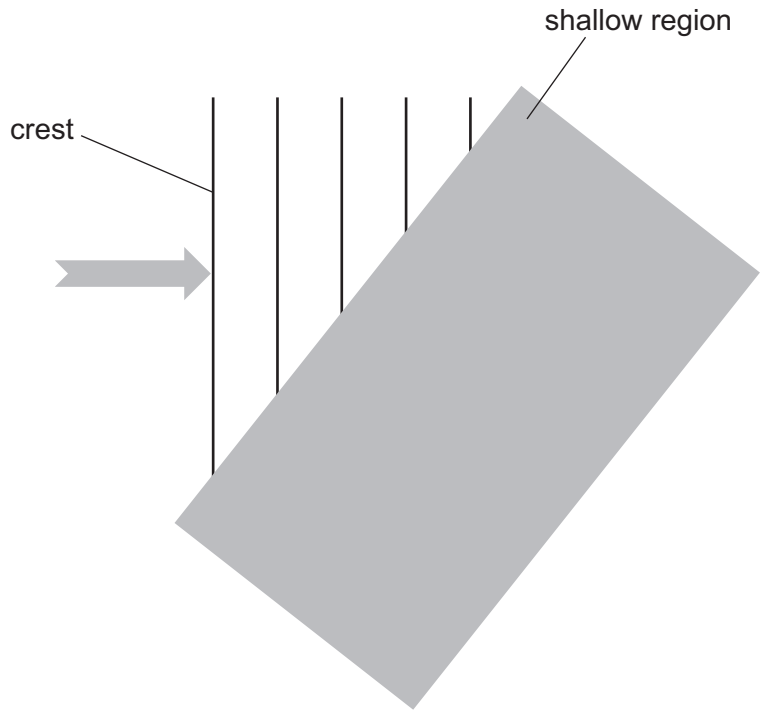

Fig. 5.2

On Fig. 5.2, draw the crests in the shallow region. [2]

(c) Describe what is meant by the diffraction of a water wave.

.....

.....

..... [1]

[Total: 8]

6 A student sets up a circuit to determine the resistance of a length of wire.

The circuit contains a battery of unknown e.m.f., a length of a wire used to make a resistor X, an ammeter, a voltmeter and a variable resistor R.

(a) Fig. 6.1 shows part of the circuit diagram.

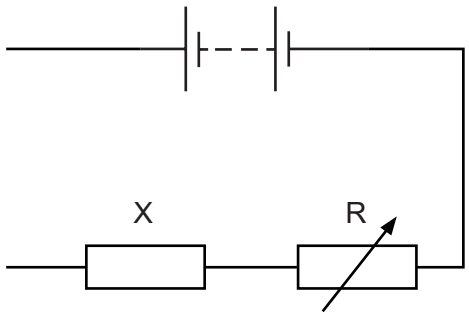

Fig. 6.1

(i) On Fig. 6.1, complete the circuit diagram by adding **one** voltmeter and **one** ammeter in suitable places to allow the determination of the resistance of X. [1]

(ii) Explain how X and R act as a variable potential divider.

.....

.....

.....

..... [2]

(b) The student determines the resistance of the resistor X for five different lengths of the wire making it. The lengths of wire range from 20 cm to 60 cm. The type of wire and the cross-sectional area of the wire are kept constant.

Fig. 6.2 shows a graph of the results.

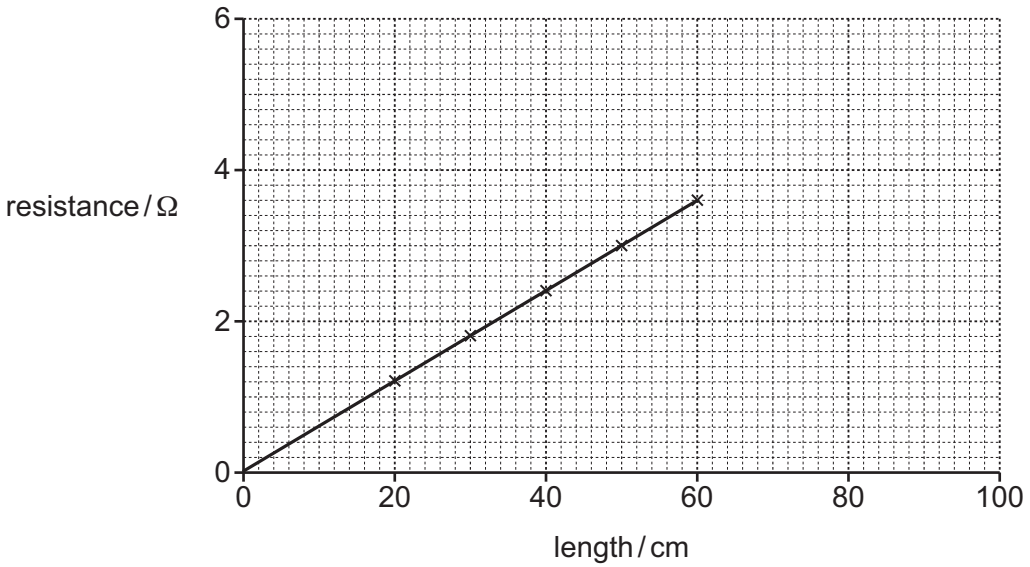

Fig. 6.2

(i) State the relationship between the resistance of the wire and the length of the wire.

..... [1]

(ii) Calculate the current in a 90 cm length of the wire when there is a potential difference (p.d.) of 9.0 V across it.

Show your working.

current = ...A [3]

(iii) The p.d. across the wire making the resistor X is kept constant for all the measurements of resistance.

Describe the relationship between the current in the wire and the length of the wire.

.....

..... [2]

(c) State how the resistance of a wire depends upon the cross-sectional area of the wire.

..... [1]

[Total: 10]

7 Fig. 7.1 shows an alternating current (a.c.) power supply connected to a transformer.

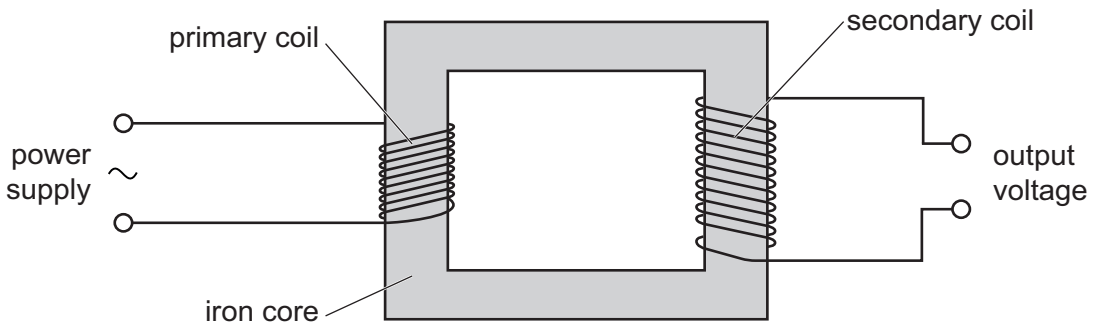

Fig. 7.1

(a) Explain how an alternating current in the primary coil produces an alternating output voltage.

.....

.....

.....

.....

..... [3]

(b) A student uses a voltmeter set on a 0–10 V range to measure the input and output voltages. She obtains the values shown in Table 7.1.

Table 7.1

input voltage / V	output voltage / V
1.2	2.4
2.3	4.6
4.8	9.6
6.4	no reading

(i) Suggest why no output voltage reading is obtained with this voltmeter when the input voltage is 6.4 V.

.....

..... [1]

(ii) The number of turns on the primary coil is 48.

Calculate the number of turns on the secondary coil.

number of turns = ... [2]

(c) The student uses an oscilloscope to display an alternating output voltage from the transformer.

Fig. 7.2 shows the front of the oscilloscope before it is connected to the transformer.

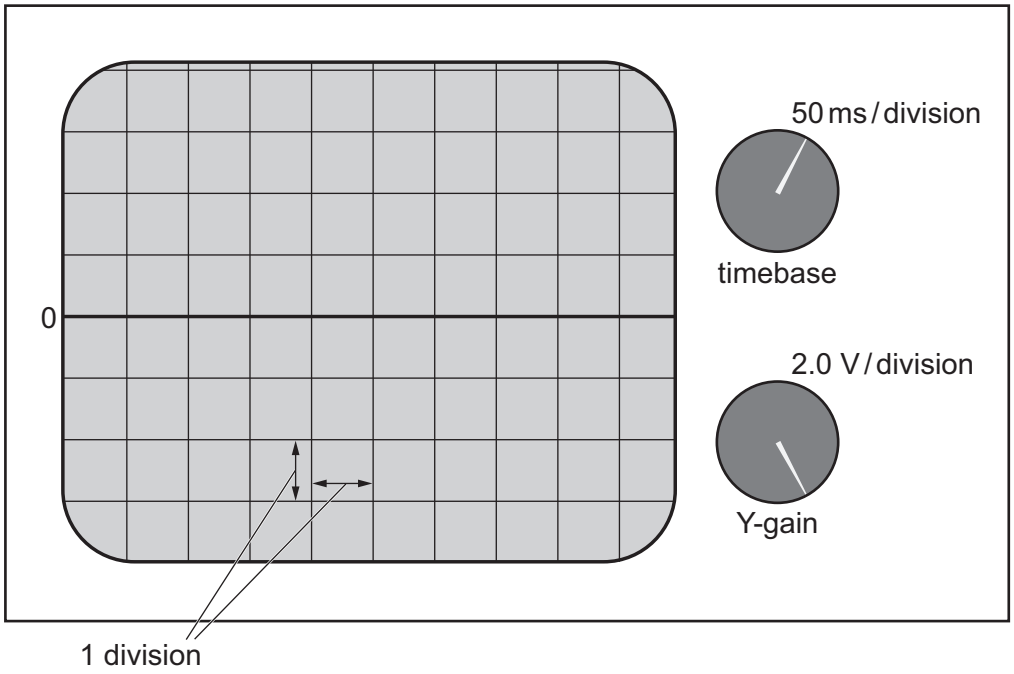

Fig. 7.2

When the oscilloscope is connected to the output of the transformer, a trace representing the alternating output voltage is displayed on the screen.

(i) On Fig. 7.2, draw a trace representing an alternating output voltage on the screen. [1]

(ii) Describe how to use the trace to measure the maximum value of the output voltage.

.....

.....

.....

..... [2]

[Total: 9]

8 Plutonium-239 ($^{239}_{94}Pu$) is an isotope that is used as the fuel in some nuclear reactors.

(a) State the names of the types of particles found in a nucleus of plutonium-239, and state how many there are of each type.

.....

.....

..... [2]

(b) Fig. 8.1 shows the nuclear fission process that occurs within the fuel rods of the nuclear reactor.

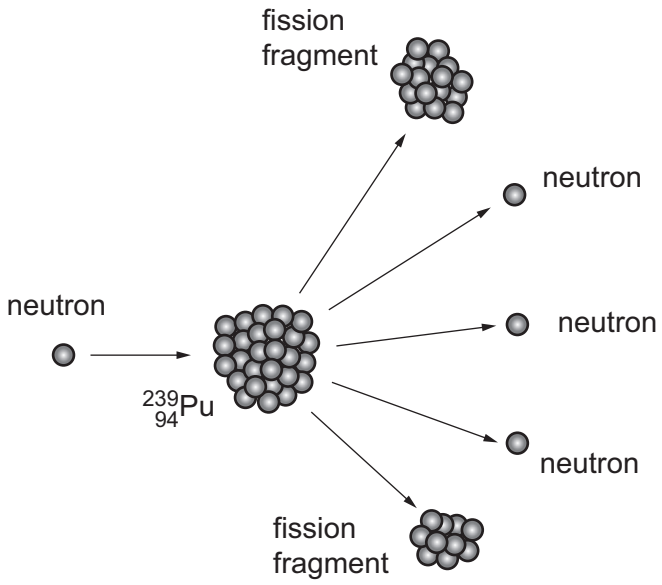

Fig. 8.1

(i) Explain how the fission process produces a chain reaction.

.....

.....

.....

..... [2]

(ii) Explain how control rods are used to increase and decrease the rate of the chain reaction in a nuclear reactor.

.....

.....

.....

..... [2]

(c) Plutonium-239 decays by the emission of an alpha particle (α-particle).

State **two** differences between an alpha particle and a beta particle (β-particle).

difference 1 .....

.....

difference 2 .....

..... [2]

(d) Alpha particles from the radioactive source are detected in a cloud chamber or with a spark counter.

(i) Draw a labelled diagram of **either** a cloud chamber **or** a spark counter.

Label the position of the radioactive source with an S.

[2]

(ii) State what causes the tracks in a cloud chamber **or** state what causes the sparks in a spark counter.

.....

..... [1]

[Total: 11]

9 **(a)** The life cycle of a star begins with a large cloud of dust and gas which collapses.

Five later stages of the life cycle of a **very** massive star are:

black hole **protostar** **red supergiant** **stable star** **supernova**

Place these stages in Table 9.1 in the order in which they occur.

Table 9.1

earlier time

cloud of dust and gas
.....
.....
.....
.....
.....

later time

[2]

(b) The original collapse of the cloud of dust and gas that formed the Sun was caused by an inward force.

(i) State the name of the inward force.

..... [1]

(ii) Further collapse is prevented by an outward force. The Sun will remain in the stable stage of its life cycle for a few billion years.

Describe what causes the outward force.

.....

..... [1]

(c) One of the first supernovas ever observed is known as SN185. It was formed from the explosion of a star in the Milky Way galaxy.

The remnants of SN185 are at a distance of 8200 light-years from Earth.

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

.....

..... [1]

(ii) State the time that passed between the explosion that formed SN185 and the electromagnetic radiation from the explosion reaching Earth.

..... [1]

(iii) A recently observed supernova is SN2014J.

The remnants of SN2014J are 12 million light-years from Earth, outside the Milky Way.

There is **no** redshift seen in the electromagnetic radiation from the remnants of SN185 but a large redshift is seen in the electromagnetic radiation from the remnants of SN2014J.

Explain this difference.

.....

.....

.....

..... [2]

(d) Most of the atoms found in the early Universe were hydrogen and helium.

The Universe now contains atoms of heavier elements.

Explain how the heavier elements are formed.

.....

.....

..... [2]

[Total: 10]

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