A Level · OCR · Physics

13 mins 1 question

Structured Questions

Gravitational Fields

Gravitational Fields / Gravitational Field Lines / Gravitational Field Strength / Newton's Law of Gravitation

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Total Marks /13

1 (a) The International Space Station (ISS) orbits the Earth at a height of 4.1×10^5 m **above** the Earth's surface.

The radius of the Earth is 6.37×10^6 m. The gravitational field strength g_0 at the Earth's surface is 9.81 N kg^{-1}.

Both the ISS and the astronauts inside it are in free fall.

Explain why this makes the astronauts feel **weightless**.

[1]

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(1 mark)

(b) i) Calculate the value of the gravitational field strength g at the height of the ISS above the Earth.

g = ...N kg^{-1} **[3]**

ii) The speed of the ISS in its orbit is 7.7 km s^{-1}. Show that the period of the ISS in its orbit is about 90 minutes.

[2]

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(5 marks)

(c) Use the information in **(b)(ii)** and the data below to show that the root mean square (r.m.s.) speed of the air molecules inside the ISS is approximately 15 times smaller than the orbital speed of the ISS.

- molar mass of air = 2.9×10^{-2} kg mol^{-1}
- temperature of air inside the ISS = 20 °C

[3]

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(3 marks)

(d) The ISS has arrays of solar cells on its wings. These solar cells charge batteries which power the ISS. The wings always face the Sun.

Use the data below and your answer to **(b)(ii)** to calculate the **average** power delivered to the batteries.

- The total area of the cells facing the solar radiation is 2500 m^2.
    - 7% of the energy of the sunlight incident on the cells is stored in the batteries.
    - The intensity of solar radiation at the orbit of the ISS is 1.4 kW m^{-2} outside of the Earth's shadow and zero inside it.
    - The ISS passes through the Earth's shadow for 35 minutes during each orbit.

average power = ... W **[4]**

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(4 marks)