Section B

Answer **two** questions from this Section.

For Examin Use

6 **(a)** **(i)** Define *gravitational potential* at a point.

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.....[2]

(ii) The gravitational potential ϕ at a distance r from an isolated point mass m is given by the expression

$$\phi = -\frac{Gm}{r}$$

where G is the gravitational constant.

Explain why gravitational potential is negative.

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.....[2]

(b) The Earth may be assumed to be an isolated uniform sphere with its mass M concentrated at its centre. A satellite of mass m orbits the Earth in a circular path of radius R.

For the satellite in its orbit, show that

(i) its kinetic energy E_K is given by

$$E_K = \frac{GMm}{2R},$$

[3]

For Examiner's Use

(ii) its total energy E_T is given by

$$E_T = -\frac{GMm}{2R}.$$

[2]

(c) The Earth has radius 6.4×10^6 m and mass 6.0×10^{24} kg.

A satellite has mass 850 kg and orbital radius 7.2×10^6 m.

(i) Use an expression in **(b)** to determine the speed of the satellite.

speed = ... $m\,s^{-1}$ [3]

(ii) Determine quantitatively whether the satellite could be in a geostationary orbit.

[4]

(d) The satellite in **(c)** gradually loses energy due to small resistive forces.
Suggest why many such satellites eventually 'burn up' in the Earth's atmosphere.

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.....[4]