Section B

For Examiner's Use

Answer **two** questions from this section.

5 **(a)** **(i)** Define gravitational field strength.

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..... [1]

(ii) State Newton's law of gravitation and hence, using your definition in **(i)**, show that the gravitational field strength g at a distance R from a point mass M is given by

$$g = \frac{GM}{R^2}.$$

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..... [3]

(b) A neutron star has mass 5.2×10^{30} kg and radius 1.7×10^{4} m.

(i) Calculate the mean density of the star.

density = ... kg m^{-3} [3]

(ii) Suggest, with a reason, whether the density is likely to vary with distance from the centre of the star.

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..... [3]

(c) The mass of the star in **(b)** may be considered to be a point mass at its centre.

For Examiner's Use

(i) Calculate the gravitational field strength at the surface of the star.

field strength = ... $N\,kg^{-1}$ [2]

(ii) Determine the centripetal acceleration of a particle moving in a circular path of radius 1.7×10^4 m and with a period of rotation of 0.21 s.

acceleration = ... $m\,s^{-2}$ [3]

(iii) The star rotates about its axis with a period of 0.21 s.
Use your answers in **(i)** and **(ii)** to suggest whether particles on the surface of the star leave the surface owing to the high speed of rotation of the star.

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..... [2]

(d) A stream of protons is accelerating towards the star.
Suggest why this stream may be a source of X-ray radiation.

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..... [3]

[Turn over