2 **(a)** The gravitational potential ϕ at a distance x from a point mass M is given by the expression

$$\phi = -\frac{GM}{x}$$

where G is the gravitational constant.

Explain why gravitational potential is a negative quantity.

.....

.....

.....

..... [3]

(b) A planet of diameter 6.8×10^3 km has a mass of 6.2×10^{23} kg. The planet has no atmosphere and it may be assumed to be isolated in space.
The mass of the planet may be considered to be a point mass at its centre.

A meteorite collides with the planet. This causes a rock of mass 2.8 kg to be thrown up from the surface of the planet with a speed of $3.8 \times 10^3\,\text{m s}^{-1}$.

(i) Calculate the gravitational potential at the surface of the planet.

gravitational potential = ... J kg^{-1} [1]

(ii) Use energy considerations, and your answer in **(b)(i)**, to determine whether the rock returns to the surface of the planet or travels out into space.

[3]

[Total: 7]

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