4 **(a)** Explain why gravitational potential is always negative whereas electric potential can have positive and negative values, given that both potentials are zero at infinity.

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.... [3]

(b) Fig. 4.1 shows how the gravitational potential ϕ from the surface of a planet varies with distance r from the centre of the planet.
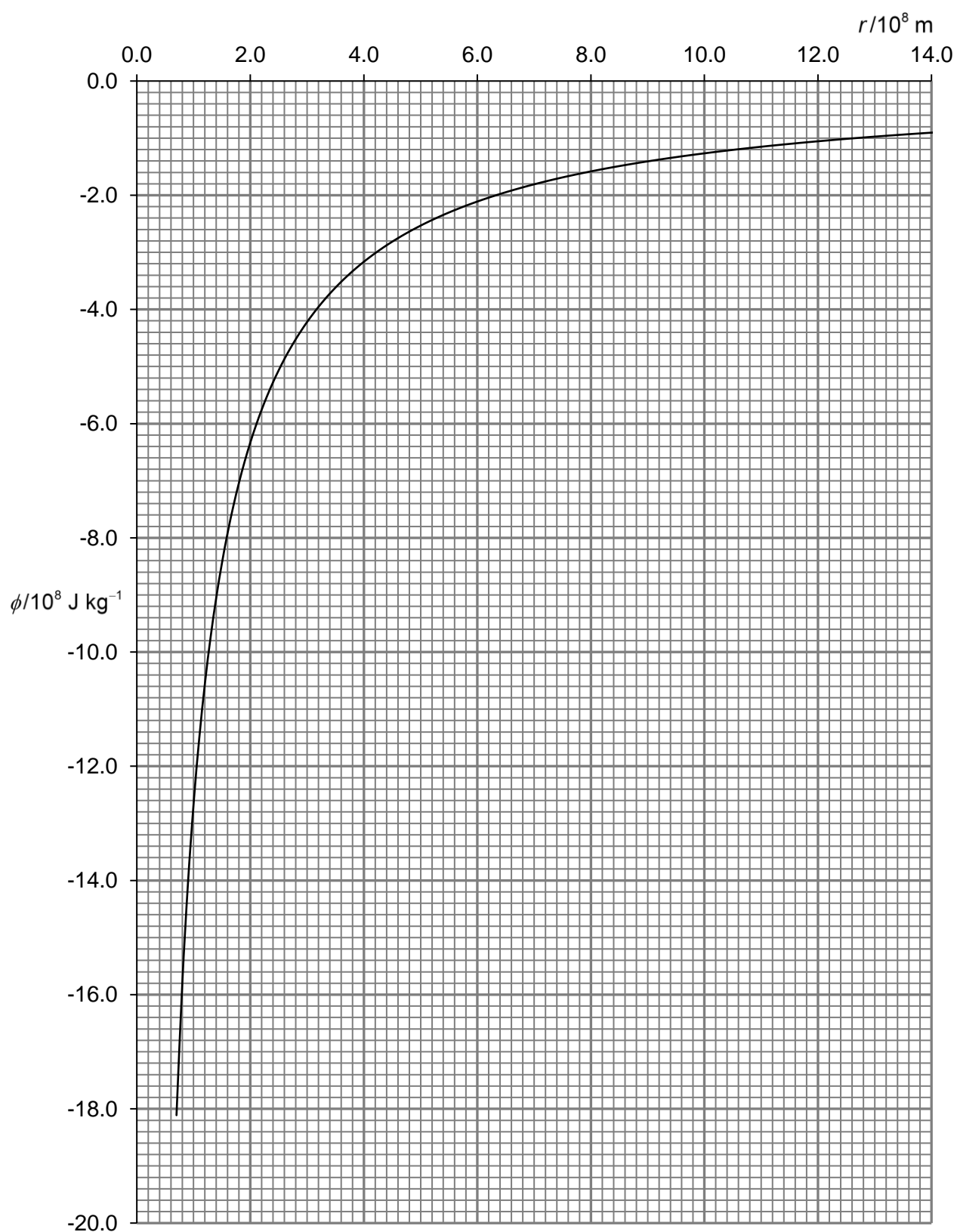

Fig. 4.1

(i) A moon orbits the planet. The mass of the moon is 1.48×10^{23} kg and its orbital radius is 1.07×10^{6} km.

Using Fig 4.1, calculate

1. the orbital speed of the moon,

orbital speed = ... m s^{-1} [2]

2. the total energy of the moon.

total energy = ... J [2]

(ii) A rock is projected vertically upwards with a speed of 45 km s^{-1} from the surface of the planet. The resistive forces on the rock by the planet's atmosphere are negligible.

Using Fig 4.1,

    1. show, with clear working, that the rock will not escape the planet,

[2]

    2. determine the maximum distance of the rock from the surface of the planet.

distance = ... m   [1]