3 A space technology company launches nanosatellites into space. The mass of each nanosatellite is 80 kg, and it is launched near Earth's equator to a height of 1.5×10^3 km above Earth's surface. The radius of Earth is 6.4×10^3 km and the mass of Earth is 6.0×10^{24} kg.

(a) **(i)** A nanosatellite is launched from Earth's surface using a propulsion system that supplies 3.0×10^9 J of energy to the nanosatellite.

Assuming that there is negligible air resistance and no loss of mass, calculate the kinetic energy of the satellite when it reaches a height of 1.5×10^3 km.

kinetic energy = ……... J [3]

(ii) Another nanosatellite is currently in a circular orbit about Earth at the height of 1.5×10^3 km above Earth's surface.

Calculate the magnitude of centripetal force required for the nanosatellite to stay in this orbit.

centripetal force = ……... N [2]

(b) Fig. 3.1 shows the variation of the gravitational potential with distance from the centre of Earth. The radius of Earth, R_E is indicated in Fig. 3.1.

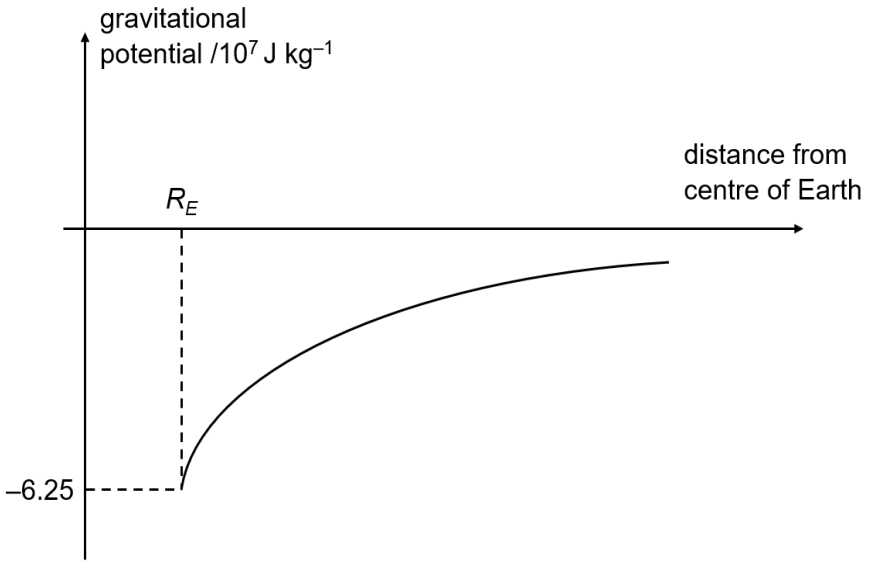

Fig 3.1

(i) State what is meant by *gravitational potential*.

……

……

…… [1]

(ii) Using Fig. 3.1, explain why the gravitational force acting on the nanosatellite due to Earth is an attractive one.

……

……

…… [2]

(iii) By referring to Fig. 3.1, calculate the escape velocity of the nanosatellite.

escape velocity = ……..... km s^{-1} [2]

[Total: 10]