3 (a) Define *gravitational potential* at a point.

……

…….. [2]

(b) The neutral point is the point where the gravitational field strength due to Earth is equal in magnitude and opposite in direction to the gravitational field strength due to the Moon.

The gravitational potentials at the Earth's and Moon's surfaces are -62.3×10^6 J kg^{-1} and -3.90×10^6 J kg^{-1} respectively.

A 10.0 kg mass projected from the Earth's surface needs 6.10×10^8 J of kinetic energy to just reach the neutral point from the Earth. The effects of air resistance may be neglected.

(i) Determine the gravitational potential at the neutral point.

gravitational potential = …… J kg^{-1} [2]

(ii) Determine the minimum kinetic energy needed to send a 1.4 kg rock from the surface of the Moon to the surface of the Earth.

minimum kinetic energy =…… J [3]

(c) Two stars of mass *M* and *2M*, a distance of *3R* apart, rotate in circles about their common centre of mass O.

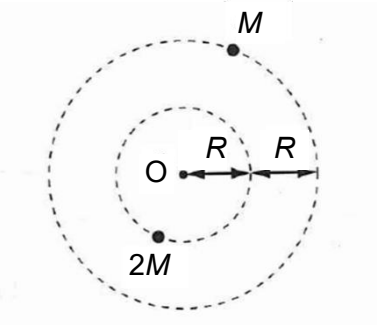

Fig 3.1

The period of this binary star system is 3.42 x 10^5 s. The value of *M* is 3.14×10^{30} kg.

(i) Explain why the two stars experience the same magnitude of centripetal force.

……

……

…… [2]

(ii) Determine the distance *R*.

R = …… m [3]

[Total: 12 marks]