2   Fig 2.1 shows the variation with the distance d from the centre of the Moon of the gravitational potential ϕ between the surface of the Moon and the surface of the Earth.

Point P is on the surface of the Moon. Point Q, at a distance x from the center of the Earth, is where the gravitational potential due to the Earth and the Moon is the highest.

mass of Moon $= 7.4 \times 10^{22}$ kg

mass of Earth $= 6.0 \times 10^{24}$ kg
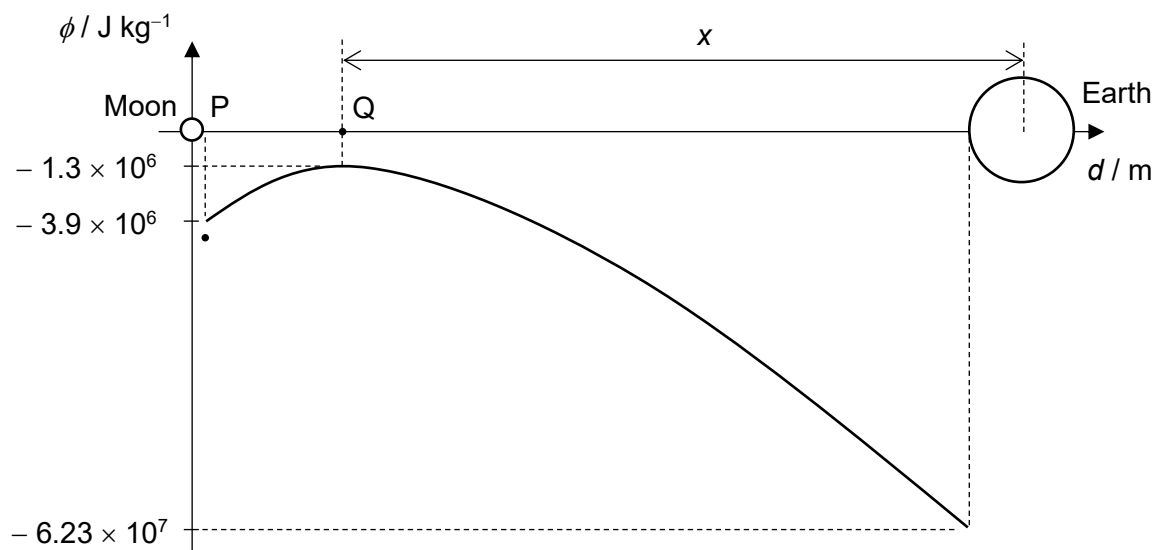
Earth-Moon distance $= 3.8 \times 10^8$ m

Fig. 2.1 (not drawn to scale)

(a) State what is meant by *gravitational potential* at a point.

....

.... [2]

(b) Show that *x* is approximately 3.4×10^8 m.

$$x \ = \ \text{..........................} \ \text{m} \qquad [2]$$

(c) A research company plans to launch a satellite of 520 kg that orbits around the Earth to observe the Moon.

In order to observe the Moon continuously, the satellite has an orbital period of 27 days such that it is always in between the Earth and the Moon as shown in Fig. 2.2.
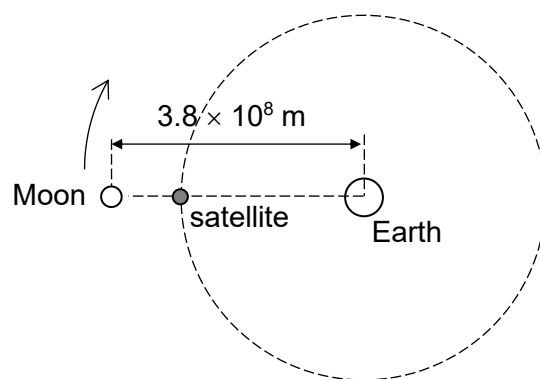
Fig. 2.2 (not drawn to scale)

(i) When the satellite is in orbit, the resultant force acting on the satellite due to the Moon and the Earth is 1.22 N.

Show that the distance of the satellite from the Earth is approximately 3.2×10^8 m.

[2]

(ii) Hence, determine the gravitational potential at the location of the satellite due to the Earth and the Moon.

gravitational potential   =   J kg^{-1} [3]
....

(d) An instrument is to be launched from the satellite to the Moon while it is in orbit.

A student claims that the minimum energy required to send the instrument to the Moon is the product of the mass of the instrument and the difference in gravitational potential on the surface of the Moon and at the position of the satellite.

Comment on the statement.

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....

....

[1]

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