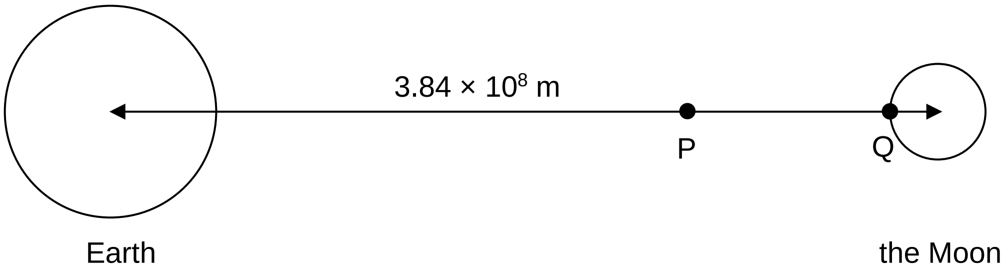
2 Earth's only natural satellite is called "the Moon" and is the only other place in the solar system besides Earth where humans have set foot.

Fig 2.1 provides some astronomical data for the Earth and the Moon.



Astronomical Data:	
Mass of the Earth:	5.98×10^{24} kg
Mass of the Moon:	7.35×10^{22} kg
Radius of the Earth:	6.38×10^{6} m
Radius of the Moon:	1.74×10^{6} m
Distance from the centre of the Earth to the centre of the Moon:	3.84×10^{8} m

Fig 2.1

(a) Define *gravitational potential*.

…………………………………………………………………………………………

…………………………………………………………………………………………

……………………………………………………………………………………… [2]

(b) Show that the gravitational potential at point Q on the surface of the Moon due to both the Earth and the Moon is -3.86×10^{6} J kg^{-1}.

[2]

(c) The table in Fig 2.2 shows the values of the gravitational potential between the surface of the Earth and the surface of the Moon.

The distances are measured from the surface of the Earth.

Distance from surface of Earth / 10^8 m	**Gravitational Potential / 10^6 J kg^{-1}**	**Remarks**
0.00	-62.5	At the surface of the Earth
1.99	-1.97	---
2.00	-1.96	Point P
2.01	-1.95	---
3.40	-1.28	Neutral point
3.76	-3.86	Point Q on the surface of the Moon

Fig 2.2

(i) Using data from Fig 2.2, estimate the magnitude of the gravitational field strength at point P, at a distance of 2.00×10^8 m from the surface of the Earth.

magnitude of gravitational field strength = …………………… N kg^{-1} [2]

(ii) Hence, calculate the linear speed of an object which is in circular orbit around the Earth at point P.

speed = …………………… m s^{-1} [2]

(d) A spacecraft is launched from the Earth to the moon.

Using the data in Fig 2.2, estimate the minimum kinetic energy with which this spacecraft of mass 1000 kg would need to be launched in order to reach the surface of the Moon.

Neglect any energy losses from air resistance in the Earth's atmosphere.

kinetic energy = ……………………………… J [2]

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