Newton's gravitational law

Useful data

$G = 6.67 \times 10–11$ N m^2 kg^{-2}	Radius of the Moon = 1.64×10^6 m
Earth's mass = 5.97×10^{24} kg	Radius of the Earth = 6.37×10^6 m
Moon's mass = 7.34×10^{22} kg	Earth–Moon distance = 3.8×10^5 km
Sun's mass = 2.0×10^{30} kg	Earth–Sun distance = 1.5×10^8 km

1. You may sometimes find it difficult to get up from the sofa after watching a TV programme. Assuming the force of gravity acts between the centre of your body and the centre of the sofa, estimate the attraction between you and your sofa.

Answer = **Units =**

2. A gravitational field at a point in space is 50 N kg^{-1}. If an electron were placed at that point, what force and acceleration would it feel?

Answer = **Units =**

3. At what distance apart would two equal masses of 150 kg need to be placed for the force between them to be 2.0×10^{-5} N?

Answer = **Units =**

4. Calculate the gravitational pull of the Earth on each of the following bodies:

the Moon;

Answer = **Units =**

satellite A with mass 100 kg at a distance from the Earth's centre $4.2 \times 10_7$ m;

Answer = **Units =**

and satellite B mass 80 kg at a distance from the Earth's centre $8.0 \times 10_6$ m.

Answer = **Units =**

5. Show that the unit for *G*, the universal gravitational constant, can be expressed as $m^3\ s^{-2}\ kg^{-1}$.

Answer = **Units =**

6. Calculate the weight of an astronaut whose mass (including spacesuit) is 72 kg on the Moon?

Answer = **Units =**

What is the astronaut's weight on Earth?

Answer = **Units =**

Comment on the difference.

7. Show that the pull of the Sun on the Moon is about 2.2 times larger than the pull of the Earth on the Moon.

Answer = **Units =**

8. Why then does the Moon orbit the Earth?

Answer = **Units =**

The American space agency, NASA, plans to send a manned mission to Mars later this century. Mars has a mass 6.42×10^{23} kg and a radius 3.38×10^{6} m. G = 6.67×10^{11} N m^2 kg^{-2}

9. (a) The mass of a typical astronaut plus spacesuit is 80 kg. What would be the gravitational force acting on such an astronaut standing on the surface of Mars?

Answer = **Units =**

(b) State whether an astronaut on Mars would feel lighter or heavier than on Earth.

10. Two masses of 3.0 kg and 2.3 kg are separated by a distance of 9.0 m. A third mass of 2.3 kg is placed on the straight line between the first two masses at a distance of 3.0 m from the 3.0 kg mass. What is the net (resultant) force on the middle mass?

Answer = **Units =**