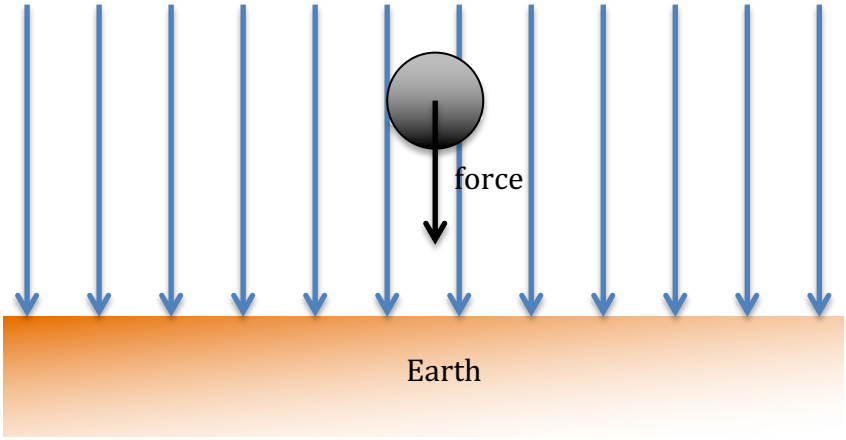
7.2 Gravitational field strength

Gravitational fields

videos

A field is a region of space in which an object experiences a force. Objects with mass produce a gravitational field. When another object with mass is in this field it will experience a force. Field lines show the direction of this force at any position. The spacing of field lines indicates the strength of the force. Field lines which are closer together indicate a stronger field.

Below is a diagram showing the field at the surface of the Earth. As the field lines are (on this scale) equally spaced, we say that the gravitational field is uniform.



(1) Draw field lines around the spherical mass below.

(2) What direction are the field lines pointing?

(3) What happens to the spacing of the field lines as you move away from the body? What does this tell you?

Gravitational field strength g

The gravitational field strength g is the force experienced by a unit test mass (e.g. 1kg) placed at that position.

$$g = \frac{F}{m}$$

(4) What are the units for g?

(5) If you convert your unit to base S.I. units (skip this if you haven't covered this), what do you notice?

Newtons's Law of Gravitation states that the force of attraction between two bodies with mass m_1 and m_2 is given by:

$$F = G\frac{m_1 m_2}{r^2}$$

where G=gravitational constant=$6.67 \times 10^{-11} m^3 kg^{-1} s^{-2}$*, r=centre to centre distance between the two masses*

(6) Using the definition of gravitational field strength, above (using $m_2 = 1kg$*), write down an expression for g.*

(7) The Earth has a mass of $6 \times 10^{24} kg$*. Calculate the value of g at the Earth's surface (i.e. at a radius* $r = 6.4 \times 10^6 m$).

(8) Using your value for g, you calculate above, what would a person with a mass of 80kg weigh at the Earth's surface?