Weight and Circular Motion

Now for something a bit more attractive — the force of gravity. Enjoy...

Weight and Mass are Not the Same

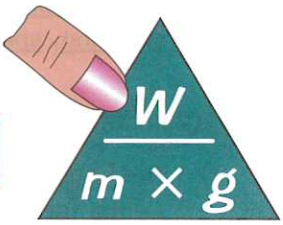
1) Mass is just the amount of 'stuff' in an object. For any given object this will have the same value anywhere in the universe.
2) Mass is a scalar quantity. It's measured in kilograms with a mass balance (an old-fashioned pair of balancing scales).
3) Weight is the force acting on an object due to gravity (the pull of the gravitational force on the object). Close to Earth, this force is caused by the gravitational field around the Earth.
4) Weight is a force measured in newtons. You can think of the force as acting from a single point on the object, called its centre of mass (a point at which you assume the whole mass is concentrated).
5) Weight is measured using a calibrated spring balance (or newton meter).

Gravity attracts all masses, but you only notice it when one of the masses is really big (like a planet).

Weight Depends on Mass and Gravitational Field Strength

1) You can calculate the weight of an object if you know its mass (m) and the strength of the gravitational field that it is in (g):

Weight (N) = mass (kg) × gravitational field strength (N/kg)



2) Gravitational field strength varies with location. It's stronger the closer you are to the mass causing the field (and more massive objects create stronger fields).
3) This means that the weight of an object changes with its location.

EXAMPLE: What is the weight, in newtons, of a 2.0 kg chicken on Earth (g = 10 N/kg)?

Calculate the weight on Earth using the equation for weight given above.

$W = m \times g = 2.0 \times 10 = 20$ N

Remember — the mass of the chicken is the same on every planet, it's the weight of the chicken that changes.

The chicken has a weight of 16 N on a mystery planet. What is the gravitational field strength of the planet?

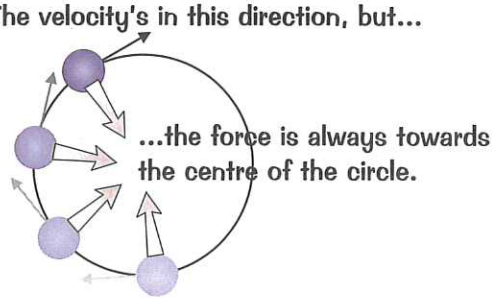
1) Rearrange the weight equation for g.
2) Substitute the values in.

$g = W \div m$
$= 16 \div 2.0 = 8.0$ N/kg

Circular Motion — Velocity is Constantly Changing

1) Velocity is both the speed and direction of an object (p.145).
2) If an object is travelling in a circle (at a constant speed) it is constantly changing direction, so it is constantly changing velocity. This means it's accelerating.
3) This means there must be a resultant force (p.181) acting on it.
4) This force acts towards the centre of the circle.
5) This force that keeps something moving in a circle is called a centripetal force.

It's pronounced sen-tree-pee-tal.



I don't think you understand the gravity of this situation...

Remember that weight is a force due to gravity and that it changes depending on the strength of the gravitational field the object is in. Gravity can cause circular motion (in things like moons and satellites).

Q1 Calculate the weight in newtons of a 25 kg mass:
a) on Earth ($g \approx 10$ N/kg) b) on the Moon ($g \approx 1.6$ N/kg) [4 marks]

Weight and Circular Motion

Warm-Up

State whether each of the following statements are true or false.

1) The acceleration of an object in free fall on Earth is 10 m/s^2. _____

2) The weight of an object is the same everywhere. _____

3) The mass of an object is the same everywhere. _____

4) The weight of an object on the moon is smaller than on Earth. _____

1 An astronaut weighs herself on Earth and on the Moon. Grade 4-6

a) State what is meant by weight.

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[1]

b) On Earth, the astronaut has a mass of 65 kg. Calculate her weight on Earth.
Use the equation:

weight = mass of object × gravitational field strength

Weight = ... N

[2]

c) She wears her spacesuit which has a mass of 80 kg. On the Moon, the astronaut and the spacesuit have a combined weight 232 N. Calculate the gravitational field strength of the Moon at its surface.

Gravitational field strength = ... Unit .....

[3]

[Total 6 marks]

2 Does a satellite orbiting the Earth at 3.07 x 10^3 m/s have a constant velocity? Explain your answer. Grade 6-7

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[Total 2 marks]