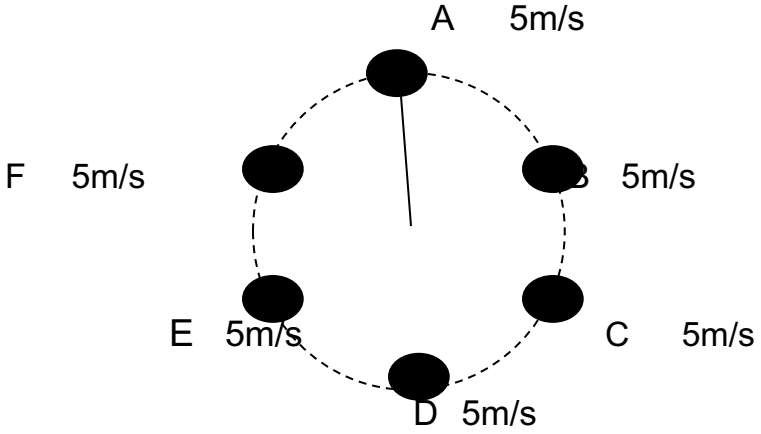
PENANG SANGAM HIGH SCHOOL
YEAR 12 PHYSICS
WEEK 19

Strand	Mechanics
Sub Strand	Circular motion
Content Learning Outcome	At the end of the lesson students should be able to • Apply Newton's 2nd Law of Motion, to solve problems with objects moving in uniform circular motion.

CIRCULAR MOTION

a. The speed of a mass moving around in circular motion remains the same. At the different positions shown the speed is the same.

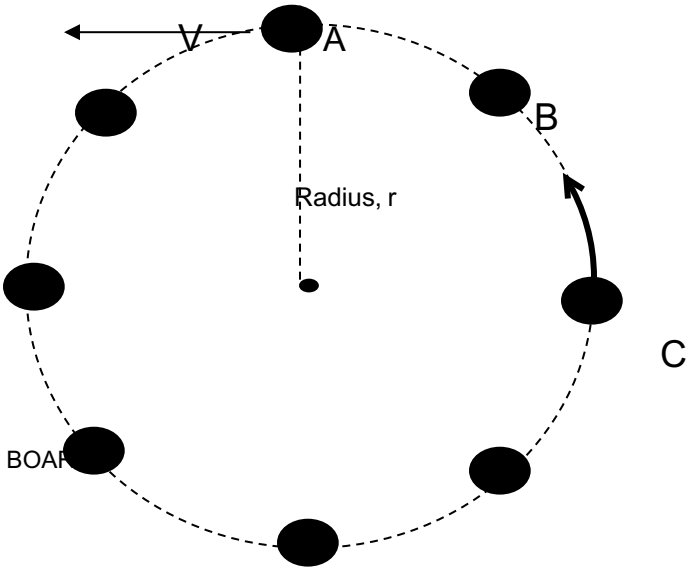


b. The velocity of the mass keeps on changing due to the changing direction of the velocity. The direction of velocity is 90^0 (perpendicular to the radius at that point)

To draw the direction of velocity

a. join that point to centre ie this is the radius
b. Draw a line 90^0 to the radius. This is the direction of velocity

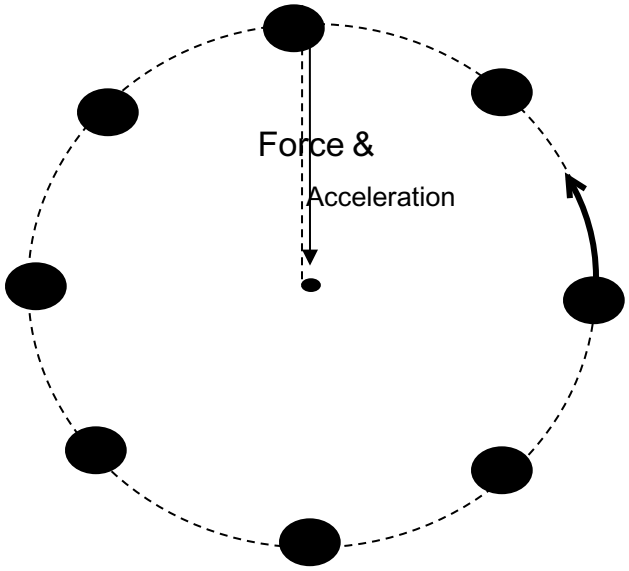
draw direction of velocity at points A to E. I have already drawn the direction at point A



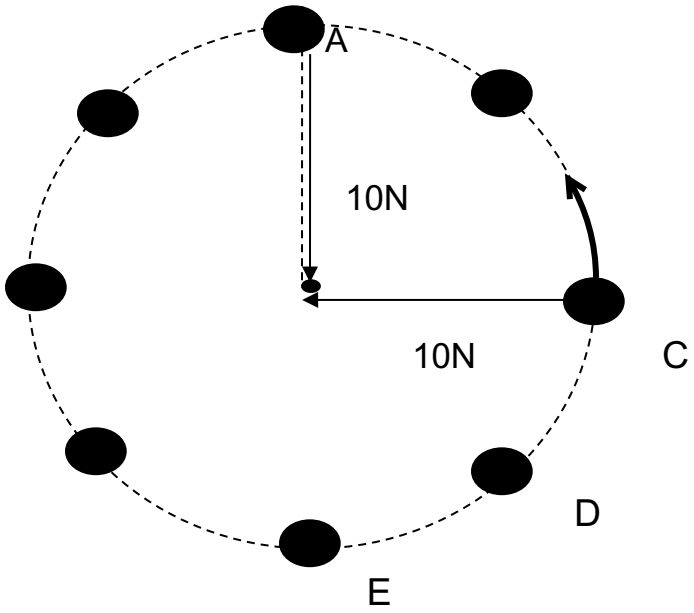
D

c. The change in velocity, acceleration and the force is towards the centre. The acceleration and the force also keeps on changing due to the changing direction. The size remains the same.

The diagram below shows the direction of acceleration and force



An object moves in circular motion as shown. at positions A and C the speed is 3m/s and the force is 5N



TRUE/FALSE

1. The speed at A is equal to speed at C
2. The velocity at A is same is velocity at C
3. The force at A is equal to the force at C

The period T is the time taken for one complete swing (turn, revolution, vibration). It is related to the frequency and is given by the formula

$$T=\frac{1}{F}$$ OR $$F=\frac{1}{T}$$

Where T is the period in seconds and F is the frequency in hertz.

The velocity is given by the formula

$$V=\frac{2\ r}{T}$$

Where V is the velocity in m/s, r is the radius of the path in m, and T is the period in seconds.

The acceleration is called centripetal acceleration, a_c, and force is called centripetal force and are given by the formula

$$a=\frac{v^2}{r}$$ **and** $$F=\frac{mv^2}{r}$$

Where m is the mass of the object in kg

Note :

1. **The object moves in circular motion because the force and velocity are 90^0 to each other.**
2. **The work done when the object moves around in circular motion is 0J.**

1. A 2kg mass is swung around in circular motion and it takes 0.25s to make one complete turn at a radius of 0.4m. find

   a. Period of motion b. velocity

   c. acceleration d. force

2. A 0.5kg mass moves in circular motion with a velocity of 6m/s at a radius of 0.8m. find the

   a. Period b. acceleration c. force

3. The frequency of an object moving around in circular motion is 50hz. The radius of the path is 0.6m. find

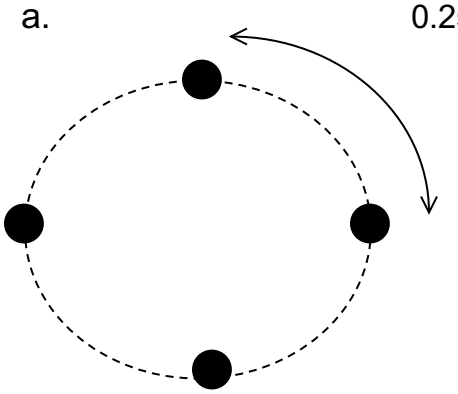
   a. The period b. the velocity

Note : sometimes the period will not be given directly. We will have to find the time for one complete swing first.

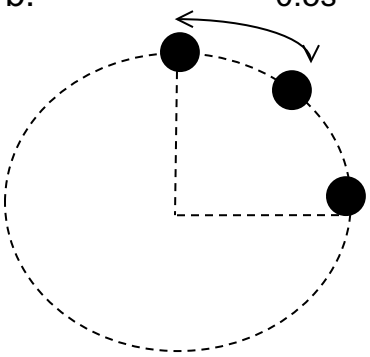
Eg. An object moves around in circular motion at a radius of 0.3m. the object makes 4 turns in 0.28s. Find the velocity of the mass.

1. Find the period of the following

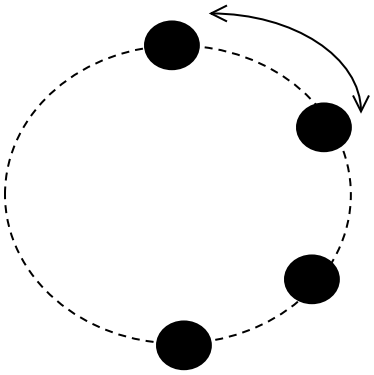
a. 0.2s



b. 0.5s



c. 0.6s



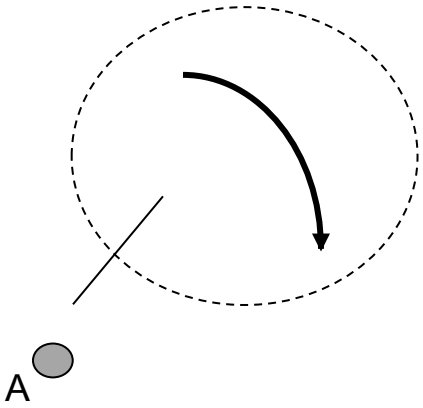
c. An object makes 2 revolutions in 0.8s

d. An object makes 4 revolutions in 5s

e. An object moving at 200 r.p.m (revolutions per minute)

1. An object of mass 0.4kg makes 50 revolutions in 2 minutes at a radius of 0.6m. Find
   a. The period b. the velocity c. acceleration

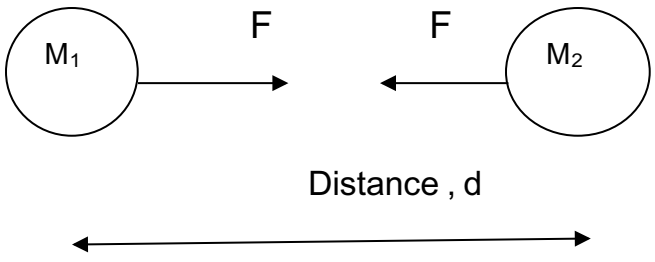
2. An object moves around in circular motion as shown



The strings breaks when the mass was at A. Draw the direction the mass will go.

NEWTONS LAW OF UNIVERSAL GRAVITATION

Every mass attracts every other mass with a force directly proportional to the product of the masses and inversely proportional to the square of the distances between them.

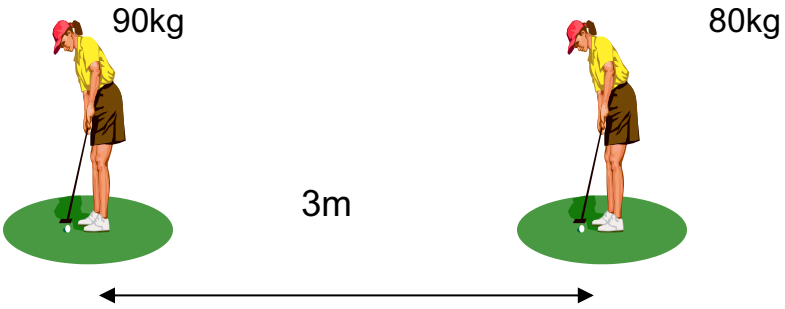


$$F=\frac{G M_1 M_2}{d^2}$$

Note : G is the gravitational constant 6.67 x 10^{-11} N m^2/kg^2, M_1 and M_2 are the masses in kg, d is the distance from the centre of one mass to the centre of another mass in m.

Find the force of attraction between the masses

1.



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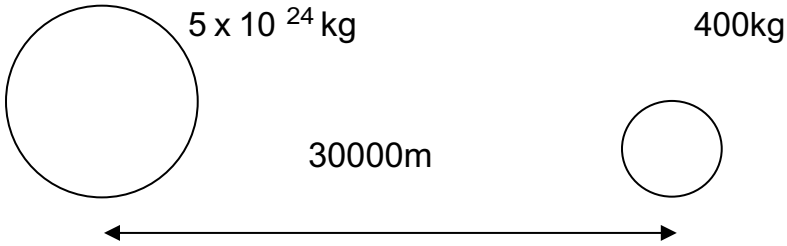

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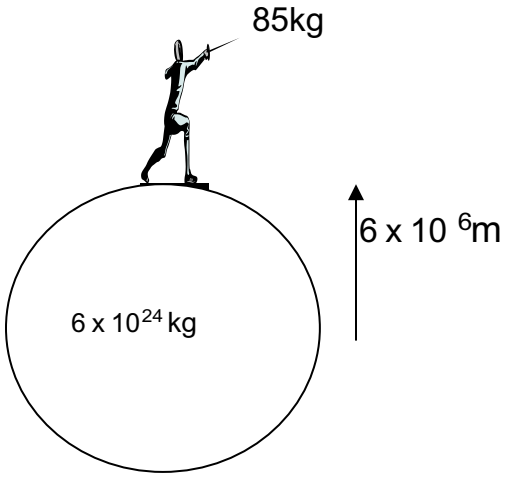
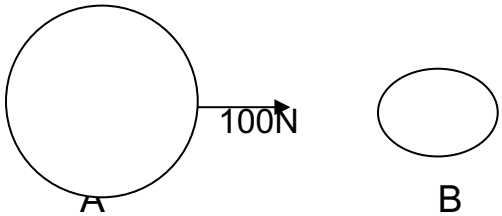


5.



A has twice the mass as B. the force on A due to B is 100N. find the force on B due to A

The radius of the earth is 6×10^{6} m and its mass is 6×10^{24} kg.

This information will be given in the information

Draw diagram first and put in all the distances in meters first

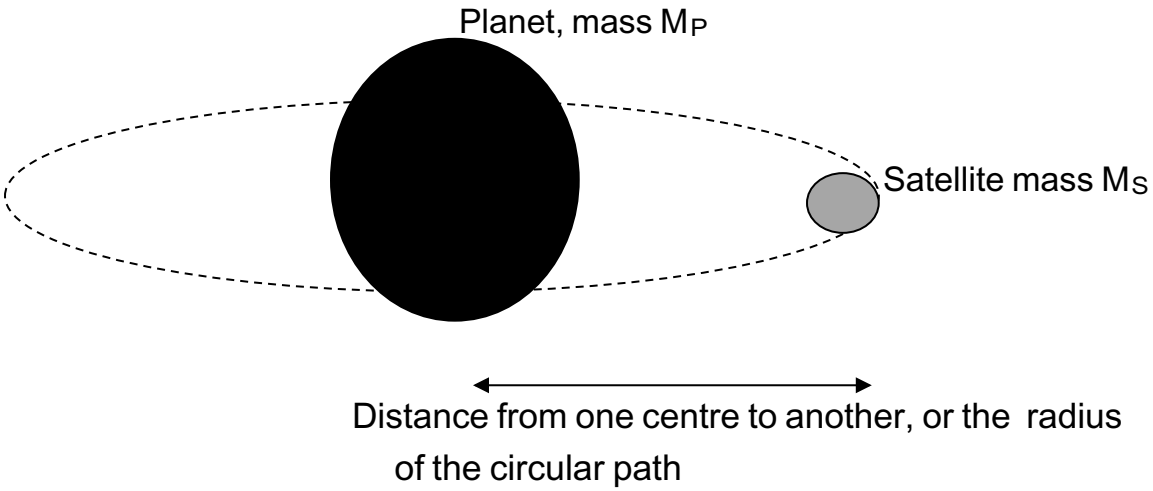
1. A 200kg satellite floats 50000m from the surface of the earth. Find the force of attraction between the two masses.

2. An astronaut of mass 95kg floats 70000km from the surface of the earth, find the force of attraction between the two masses.

Satellites

A satellite is a smaller mass moving around a bigger mass in circular motion . There are two types of satellites

a. Man made eg weather satellites
b. Natural satellites eg moon is a satellite of earth, earth is a satellite of the sun.

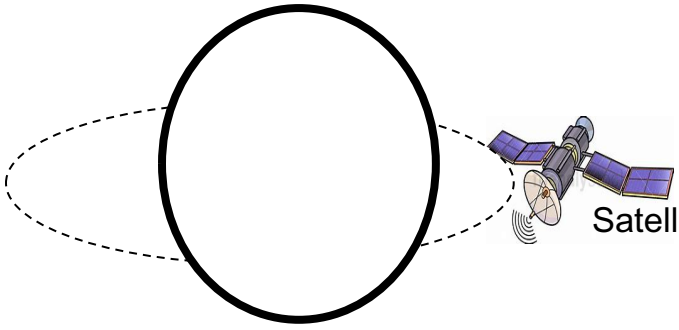


There are two forces acting on the satellite. Both are equal

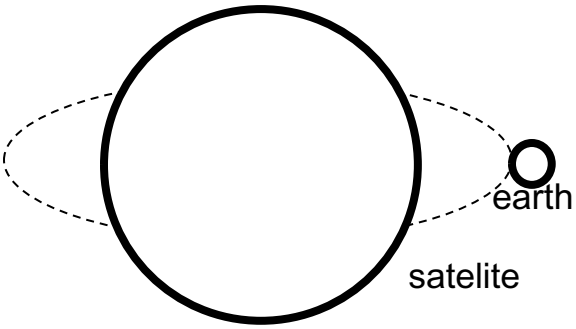
1. Gravitational force F_G between the two masses
2. Centripetal force F_C acting on the satellite

The velocity of the satellite can be found using the formula

Where M_p is the mass of the planet and not the satellite.(a satellite moves around the bigger mass or the. Planet. Use this formula when the mass of the planet is given



Earth (planet)



sun - planet

Depending on the question if the period of the satellite is given we can also use this formula to find the speed of the satellite.

$$V=\frac{2\ r}{T}$$

The radius of the earth is 6 x 10^{6} m and its mass is 6 x 10^{24} kg.

This information will be given in the information sheet and not with the question in the paper

1. A satellite orbits 80000m from the surface of the earth. Find
   a. The velocity of the satellite b. period of the satellite c. satellites acc

2. A 100kg satellite orbits 1500km from the surface of the earth. Find its velocity

3. A small satellite orbits 90000m from the surface of the moon. If the moons mass is 7.38 x 10^{22}kg and its radius is 837000m, find
   a. The velocity of the satellite b. the period of the satellite

4. A very small satellite orbiting at a radius of 9×10^{7}m from a planet takes 25 days to make one complete turn around a planet. Find
   a. Period of satellite in seconds. B. velocity of satellite c. planets mass