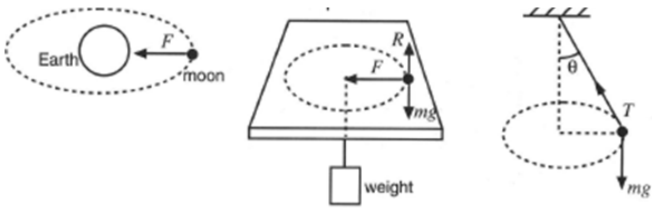
Circular Motion

HORIZONTAL Uniform Circular Motion

- For uniform circular motion, there is NO WORK done by the centripetal force since the direction of the force is always perpendicular to the direction of displacement.

Examples:



Conditions:
- Constant ω and constant r
- $\Sigma F_{VERTICAL} = 0$
- $\Sigma F_{HORIZONTAL} = F_c = ma_c$

Problem-solving:
- Draw the FBD (all individual forces) for the object undergoing circular motion. (do NOT draw the centripetal force)
- Locate the centre of the circular motion.
- Resolve the forces.
- Determine the force(s) that is(are) directed to the centre of the circular motion. These force(s) provides for centripetal force.
- Apply $\Sigma F_{HORIZONTAL} = F_c = ma_c$
- Manipulate the equation and solve for the unknown.

- For some questions in order to solve, will need to use $\Sigma F_{HORIZONTAL} = F_c = ma_c$ and $\Sigma F_{VERTICAL} = 0$, then solve simultaneously.

Basic Terminology

Angular displacement, $\theta = \frac{s}{r}$

Angular velocity, $\omega = \frac{\Delta\theta}{\Delta t} = \frac{2\pi}{T} = 2\pi f$

Linear velocity, $v = r\omega$

Centripetal acceleration, $a = \frac{v^2}{r} = r\omega^2$

Centripetal force, $F = ma_c = \frac{mv^2}{r} = mr\omega^2$

Using Newton's Laws to explain why an **<u>object</u>** moving in a constant speed **<u>in a circle experiences a resultant force towards the centre of the circle</u>**.

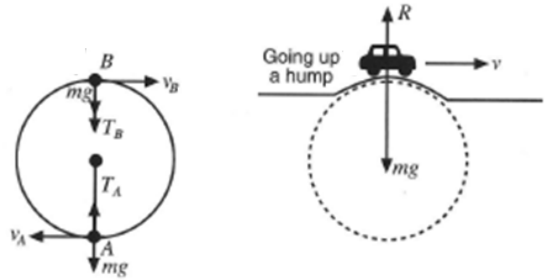
- Since object experiences a constant change in direction of motion, by N1L, there must be a resultant force on it.

- Given the tangential speed remains constant, by N2L, the resultant force must act perpendicular to the velocity, hence in the radial direction, towards the centre of the circle.

VERTICAL Circular Motion

- Most examples of vertical circular motion are non-uniform, since the speed and angular velocity are not constant.
- Uniform vertical circular motion are usually forced to rotate at constant ω (e.g. ferris wheel)

Examples:



Conditions:
- $\Sigma F_{VERTICAL} = F_c = ma_c$

Problem-solving:
- Draw the FBD (all individual forces) for the object undergoing circular motion. (do NOT draw the centripetal force)
- Locate the centre of the circular motion.
- Resolve the forces.
- Determine the force(s) that is(are) directed to the centre of the circular motion. These force(s) provides for centripetal force.
- Apply $\Sigma F_{VERTICAL} = F_c = ma_c$
- Manipulate the equation and solve for the unknown.

- For some questions in order to solve, will need to use conservation of energy
  $KE_{top} + GPE_{top} = KE_{bottom} + GPE_{bottom}$
  (if there are no frictional forces)