

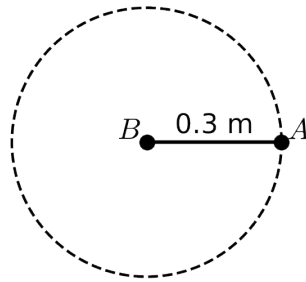
## 1D Objects Moving in Vertical Circles

Why the speed of an object moving in a vertical circle is not constant:

The two components of the acceleration for motion in a vertical circle of radius  $r$ :

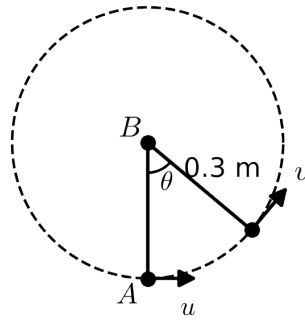
Why the sum of kinetic and potential energy stays constant:

1. A particle of mass  $0.4\text{ kg}$  is attached to one end  $A$  of a light rod  $AB$  of length  $0.3\text{ m}$ . The rod is free to rotate in a vertical plane about  $B$ . The particle is held at rest with  $AB$  horizontal. The particle is released. Calculate:



- a) the speed of the particle as it passes through the lowest point of the path
- b) the tension in the rod at this point.

2. A particle of mass  $0.4\text{ kg}$  is attached to one end  $A$  of a light rod  $AB$  of length  $0.3\text{ m}$ . The rod is free to rotate in a vertical plane about  $B$ . The rod is hanging vertically with  $A$  below  $B$  when the particle is set in motion with a horizontal speed of  $u\text{ m s}^{-1}$ . Find:



- a) an expression for the speed of the particle when the rod is at an angle  $\theta$  to the downward vertical through  $B$
- b) the minimum value of  $u$  for which the particle will perform a complete circle.

3. A particle A of mass 0.4 kg is attached to one end of a light inextensible string of length 0.3 m. The other end of the string is attached to a fixed point B. The particle is hanging in equilibrium when it is set in motion with a horizontal speed of  $u \text{ m s}^{-1}$ . Find:
- an expression for the tension in the string, in terms of  $u$ , when it is at an angle  $\theta$  to the downward vertical through B
  - the minimum value of  $u$  for which the particle will perform a complete circle.

Conditions for performing complete vertical circles:

- a particle on the end of a light rod:
- a small bead threaded on a smooth circular wire:
- a particle on the end of a light inextensible string: