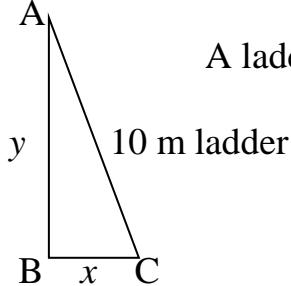


## COLLECTION OF RELATED RATE PROBLEMS.

1.



A ladder AC, 10m long, is leaning against a vertical wall AB.

The top of the ladder is sliding down the wall at 0.3m/s.

Find at what rate the bottom of the ladder is moving when  $x = 8$  m

2. The volume of liquid in a container is given by  $V = \frac{2\pi h^3}{3}$

where  $h$  is the depth in cm at time  $t$  seconds.

This container is being filled with a chemical at the rate of  $8 \text{ cm}^3$  per second.

Find the rate of increase of the depth of the liquid when the depth is 2 cm.

3. The volume,  $V$  of a spherical bubble is :  $V = \frac{4\pi r^3}{3}$

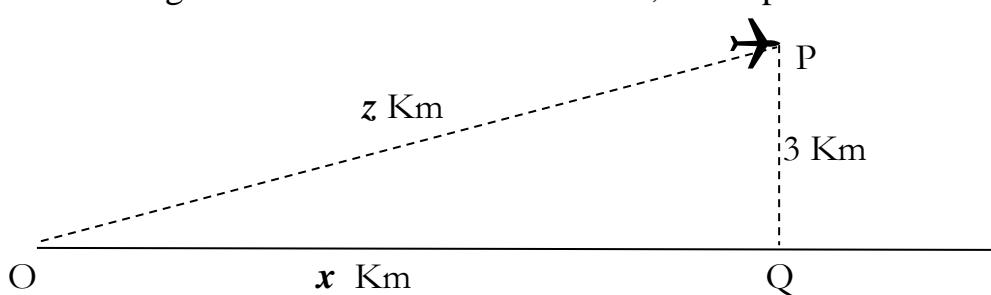
If the Volume is increasing at a rate of  $12 \text{ cm}^3/\text{sec}$  find the rate of increase of the radius when  $r = 1 \text{ cm}$ .

4. The volume of a spherical weather balloon, as it rises through the atmosphere, is increasing at a rate of  $2000 \text{ cm}^3/\text{min}$ .

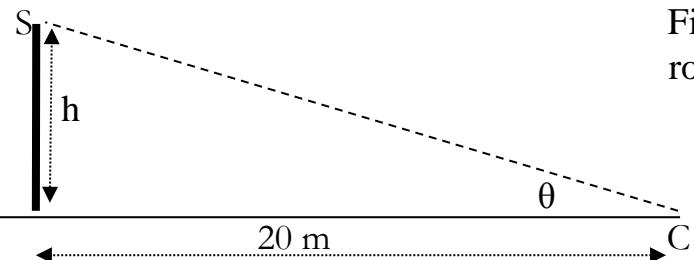
Find the rate of increase of the radius at the point when the radius  $r = 10 \text{ cm}$ .

5. A plane is flying **horizontally** at 200 Km/h at a height of 3 Km.

Find the rate at which the distance  $z$ , from the plane P to an observer at O, is increasing when the horizontal distance  $x$ , to the plane is 8 Km

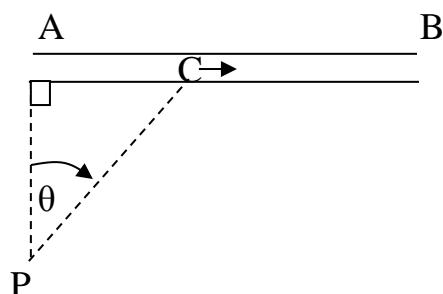


6. A stuntman at S, is being filmed by a camera at C, as he slides down a vertical metal pole at a constant rate given by  $\frac{dh}{dt} = -2 \text{ m/s}$



Find the rate at which the camera is rotating ( $\frac{d\theta}{dt}$ ) when the stuntman has descended to a height of 5 m above the ground.

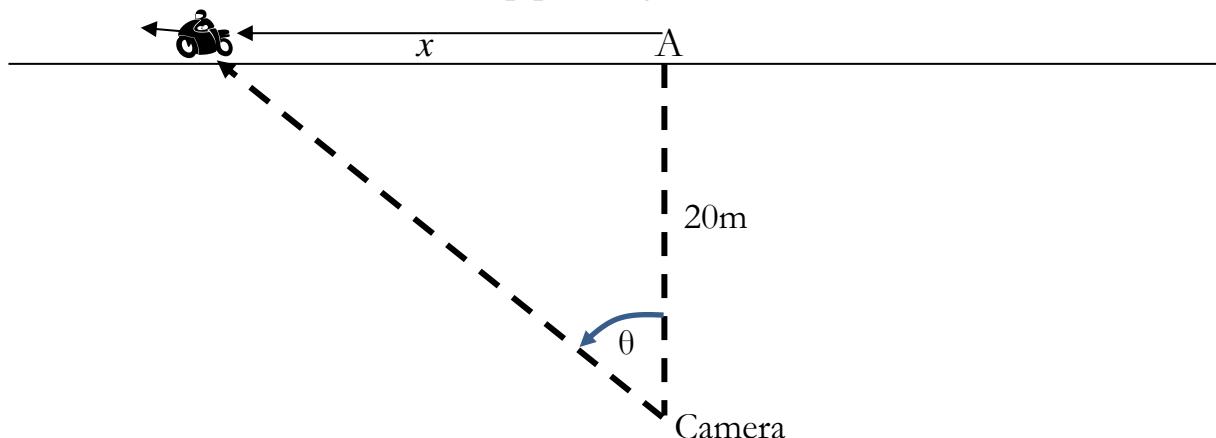
7. A car C is travelling from A to B along this road at a constant velocity of 30 m/s



The car is being filmed by a camera at P which is 40 metres from A. Find the rate of rotation of the camera in rads/sec when  $\theta = \pi/3$

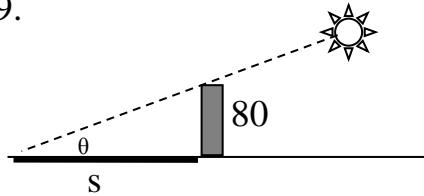
8. A TV camera is set up 20 metres from the side of a motorcycle racetrack as shown below.

The camera rotates so as to keep pointing at the rider as he races.



The speed of the rider on this straight section of the track is 45 m/s. Find the rate at which the camera is rotating at the instant the rider is 50 metres from A.

9.



The elevation of the sun is increasing at a rate :  $\frac{d\theta}{dt} = \frac{\pi}{9}$  rads per hour

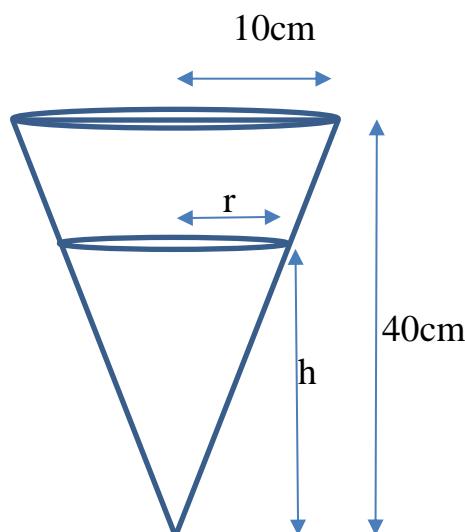
Find the rate at which the length of the building's shadow, S, is changing when  $\theta = \frac{\pi}{4}$ . The height of the building is 80 metres.

10. A large spherical balloon is being pumped up so that its surface area is increasing at a constant rate of  $0.5 \text{ m}^2$  per minute.

Calculate the rate at which the volume is increasing when the radius is 1.5 m.  
i.e. find  $\frac{dV}{dt}$  when  $r = 1.5 \text{ m}$

11. The cone starts off full of water.

Water is leaking out through a small hole in the bottom at a constant rate of  $2 \text{ cm}^3/\text{min}$ .



Find the RATE at which the circular top of the water is changing when the depth of water has reached 5cm.

Hints: Use simple proportion to find a relationship between r and h.

The surface area is  $S = \pi r^2$

The volume of a cone is  $V = \frac{\pi r^2 h}{3}$

You are given  $\frac{dV}{dt} = 2$

You need to find  $\frac{dS}{dt}$

12. A conical rain gauge with radius 90mm and depth 180mm is filled with water at a constant rate of 150 000mm cubed/s.

At what rate is the depth of the water increasing when the depth is 100mm?