# Physics I

## Velocity Calculus

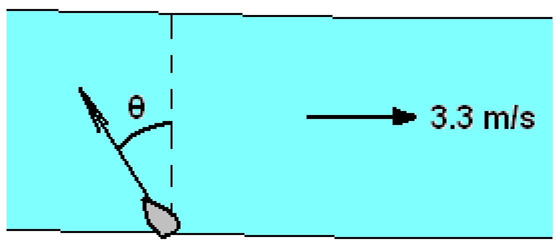
Definition of velocity in one dimension: $v = \frac{dx}{dt}$

Definition of acceleration in one dimension: $a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$

**Problem 1.-** A satellite in polar orbit moves towards the north at 8,550 m/s when it collides with another satellite in equatorial orbit, which at that point was moving towards the east at 8,250 m/s. Calculate the speed of the second satellite with respect to the first.

**Problem 2.-** An oil droplet of mass m is falling in air and experiences a drag force equal to –bv where b is a constant proportional to the viscosity of air. Calculate its terminal velocity and its kinetic energy when that velocity is reached.
[Ignore buoyancy]

**Problem 3.-** A person wants to cross a river with a motorboat that has a speed of 5.5 m/s, however, the water current has a speed of 3.3 m/s. Calculate the angle needed to get straight to the other side.




**Problem 4.-** A projectile with initial velocity $v_o$ enters a viscous fluid where the acceleration is given by: $a = -kv^2$, find the velocity as a function of time.

Useful integral: $\int \frac{dx}{x^2} = -\frac{1}{x} + C$

**Problem 5.-** An object dropped on Titan (Saturn's largest moon) is attracted to the surface with an acceleration equal to: $a = g_{\text{Titan}} - kv$

Where $g_{\text{Titan}} = 1.35 \frac{m}{s^2}$ is the acceleration due to gravity and $k = 0.033 s^{-1}$ is a resistance due to the viscosity of Titan's dense atmosphere.

Find the terminal velocity of the object.

**Problem 6.-** A small object falls with initial velocity $v_o$=1.5m/s in a viscous fluid where the acceleration is given by: $a = g - 25v$, find the terminal velocity and sketch the velocity as a function of time.

**Problem 7.-** If the position of a 2.5 kg particle is described by the vector:

$$\vec{r} = (t, 5\sin t)$$

Find the net force acting on the particle.

**Problem 8.-** A particle moves in a straight line following the equation:

$$x = 8t^2 + 5t + 1$$

Determine the position, velocity, and acceleration at t = 2.0 s.

**Problem 9.-** A particle follows a trajectory described by the equation:

$$x(t) = 25t^3 + 5t^2 + 20$$

Where t is the time in seconds, find the velocity and acceleration at t=2 seconds.

**Problem 10.-** A particle has a velocity described by the equation:

$$\mathrm{v(t)} = 5\mathrm{t}^3$$

Where t is the time in seconds, find the displacement from $\mathrm{t}_1 = 1$ to $\mathrm{t}_2 = 5$ seconds

**Problem 11.-** A particle follows a trajectory described by the equation:

$$x(t) = 1.5t^3 + 0.5t + 1$$

Where t is the time in seconds, find the velocity and acceleration as a function of time.

**Problem 12.-** The acceleration of a falling object in a viscous fluid is given by $a=Ae^{-bt}$, calculate the velocity as a function of time if the initial velocity is $V_o$

**Problem 13.-** A particle follows a trajectory described by the equation $x = 5 + 8t - t^2$

a) Calculate the instantaneous velocity of the particle.
b) Find at what time the velocity is zero.
c) Using the time calculated in (b) calculate the maximum value of *x*.

**Problem 14.-** The position of a particle is given by $x=10t^3+3$, $y=5t^2-14t$, where x and y are in meters and t is in seconds. Find the instantaneous acceleration of the particle at t=2 seconds.

**Problem 15.-** The position of a particle is given by $x=8t+3$, $y=9t^2-14t$. Find the average velocity of the particle between t=2s and t=5s.

**Problem 16.-** A particle follows a trajectory described by the equation:

$$x(t) = \frac{A}{t^2 + b}$$

Find the velocity as a function of time.