CH02-2 Constant Net Force in 2D or 3D

Summary of Analytic Method

Theory

$$\vec{p}_f = \vec{p}_i + \vec{F}_{net}\,\Delta t$$

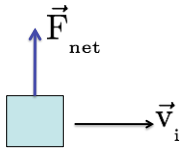$$\vec{p} = m\vec{v} \qquad \text{if } |\vec{v}| << c$$

$$\vec{v}_{avg} = \left(\frac{\vec{v}_i + \vec{v}_f}{2}\right)\Delta t$$
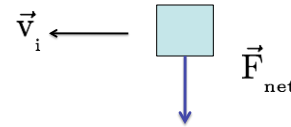
$$\vec{r}_f = \vec{r}_i + \vec{v}_{avg}\,\Delta t$$

Example – VPython spaceship

The spaceship has a velocity to the right when a thruster fires, exerting a constant force upward on the spaceship. What will be the path of the spaceship?
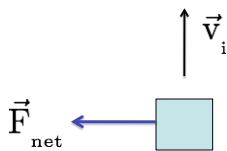

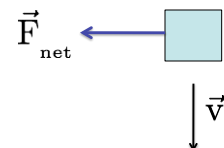## Example – VPython spaceship

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Parabolic Path

A constant net force with an initial velocity at a non-zero angle with respect to the net force results in a parabolic path.

The velocity is always tangent to the path. The net force is constant.

Ideal Projectile Motion
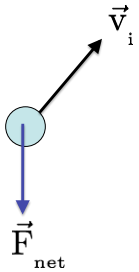
Near the surface of Earth,

$$\vec{F}_{grav,Earth\ on\ proj} = m\vec{g}_{Earth}$$

Where g is the gravitational field of Earth near its surface.

$$\vec{g}_{Earth} = \langle 0, -9.8, 0 \rangle \ N/kg$$

$$\left| \vec{g}_{Earth} \right| = 9.8 \ N/kg$$

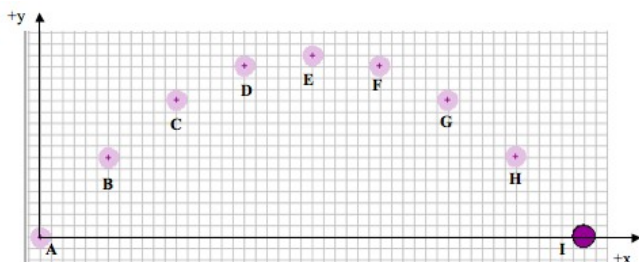
A baseball is tossed from a height of 1.5 m above the ground with an initial speed of 8 m/s at an angle of 53°. What will be its position and velocity 0.5 s after it is released?
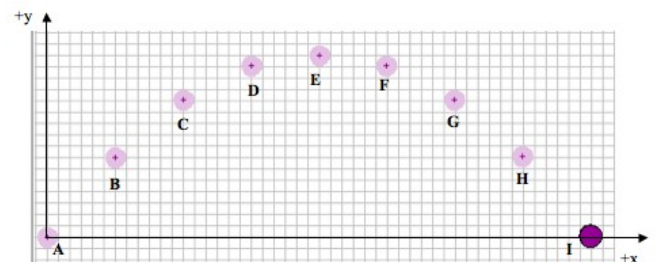
$$\vec{v}_i$$

$$\vec{F}_{net}$$

x-velocity and y-velocity

What can you say about the x-velocity of a projectile at all clock readings?
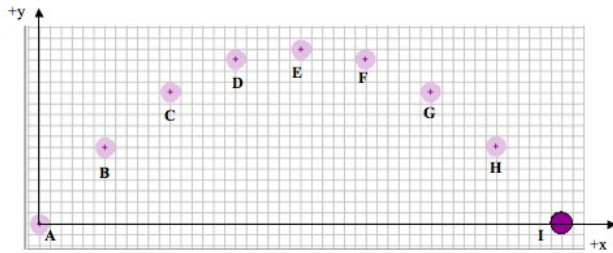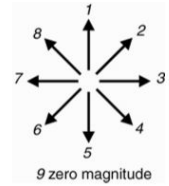
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x motion

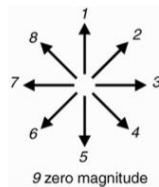## y motion

Velocity at the Peak

Poll

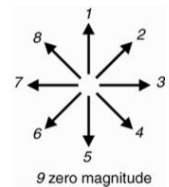What is the y-velocity of the a projectile at its peak?

Poll

What is the y-component of the net force on a projectile at its peak?

Poll

What is the y-component of the acceleration of a projectile at its peak?

Poll

You throw a baseball so that it leaves your hand horizontally in the +x direction with a speed of 10 m/s. What is the velocity of the baseball? (Sketch its direction.)

1. 0 m/s
2. 10 m/s
3. < 10, 0, 0 > m/s
4. < 10, 10, 0> m/s
5. < 0, 10, 0> m/s

General observations of 2D motion

The component of velocity that is **perpendicular** to the net force remains **constant**.

The component of velocity that is **parallel** to the net force **changes** at a constant rate, increasing in magnitude if in the direction of the net force and decreasing in magnitude if opposite the direction of the net force.
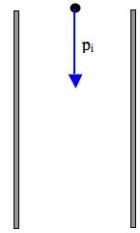
Poll

An electron travels between charged plates. There is a constant net force on the electron in the –x direction while it is between the plates. What is the path of the electron while between the plates?
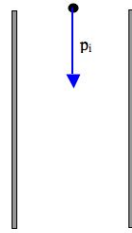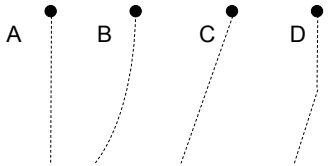
A   B   C   D

p_i

Poll

An electron travels between charged plates. There is a constant net force on the electron in the –x direction while it is between the plates. The y-velocity of the electron

1. is constant.
2. increases in magnitude.
3. decreases in magnitude.

p_i

Poll

An electron travels between charged plates. There is a constant net force on the electron in the –x direction while it is between the plates. The x-velocity of the electron

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p_i