Accelerated Motion

There are times when being a whiz at physics can be a definite drawback.

- acceleration is the rate of change of velocity (how quickly the velocity is changing)
- for motion along a line

- v_f = final velocity
- v_i = initial velocity
- Δt = time interval

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

- acceleration due to gravity is 9.81 m/s^2 (down)

- When an object is moving in a straight line, a positive acceleration means that the object is speeding up and a negative acceleration means it is slowing down

- an acceleration of 3 m/s^2 means the object's speed is increasing by 3 m/s for every second of travel

Example

The Red Baron is flying at 23.6 m/s and begins to accelerate for 13.0 s. If his final speed is 43.0 m/s, determine his acceleration.

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

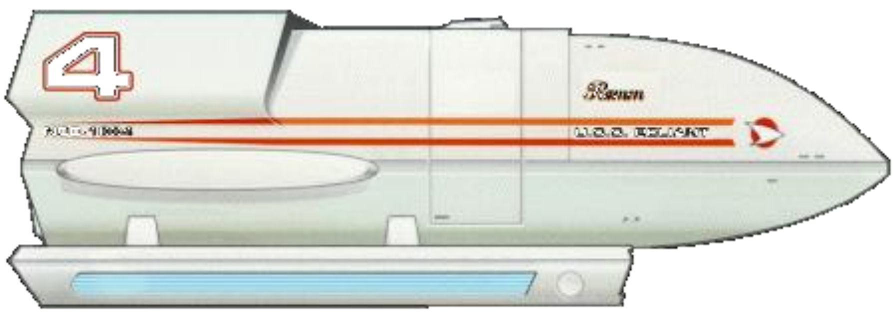
Sub. in the data

1.49 m/s^2

Example

A Starfleet Shuttlecraft is moving at 1600 m/s when it begins to accelerate at -12.9 m/s^2 for 30.0 s. Determine its final velocity (magnitude and direction).

a = -12.9 m/s^2



vi=1600 m/s

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

multiply both sides by Δt

add v_1 to both sides

Sub in the data with units

Final answer with units

vf = 1213 m/s = 1.21 x 10^3 m/s forward

Displacement and Acceleration

- d = vt will only work if the speed or velocity is not changing

$$\Delta \vec{d} = \frac{\vec{v}_f + \vec{v}_i}{2} \Delta t$$

Example

A racing car is moving at 22.5 m/s when it accelerates to 46.9 m/s in 3.44 s. Determine the magnitude of its displacement.

$$\Delta \vec{d} = \frac{\vec{v}_f + \vec{v}_i}{2} \Delta t$$

$$\Delta \vec{d} =$$

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- If the initial velocity, acceleration and time is known:

$$\Delta \vec{d} = \vec{v}_i \Delta t + \frac{1}{2}\vec{a}(\Delta t)^2$$

Example

- A racing car moving at 20.0 m/s accelerates at 4.55 m/s^2 for 8.66 s. Determine the magnitude of the displacement.

$$\Delta \vec{d} = \vec{v}_i \Delta t + \frac{1}{2}\vec{a}(\Delta t)^2$$

Example

- Homer drops a doughnut from the top of the reactor building. How far will the doughnut drop in 1.50 s?

Summarize the data!

$v_i = 0$

$a = 9.81\ m/s^2$

$d = ?$

$t = 1.50\ s$

$$\Delta \vec{d} = \vec{v}_i \Delta t + \frac{1}{2}\vec{a}(\Delta t)^2$$

v_i = 0 m/s so the equation simplifies to

Sub in the data

Example

- Calvin and Hobbes fire a rock straight up with an initial velocity of 46.0 m/s. How high is the rock after 4.00 s?

v_i = 46.0 m/s up

t = 4.00 s

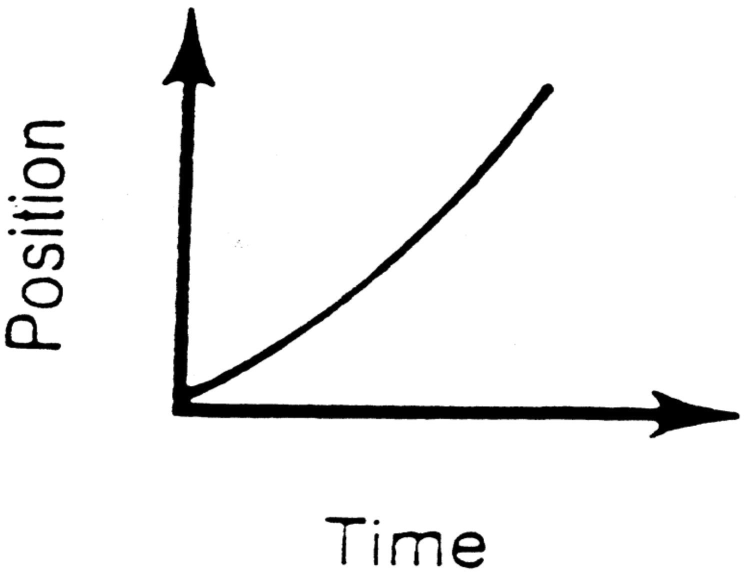
a = 9.81 m/s^2 down

Δd = ?

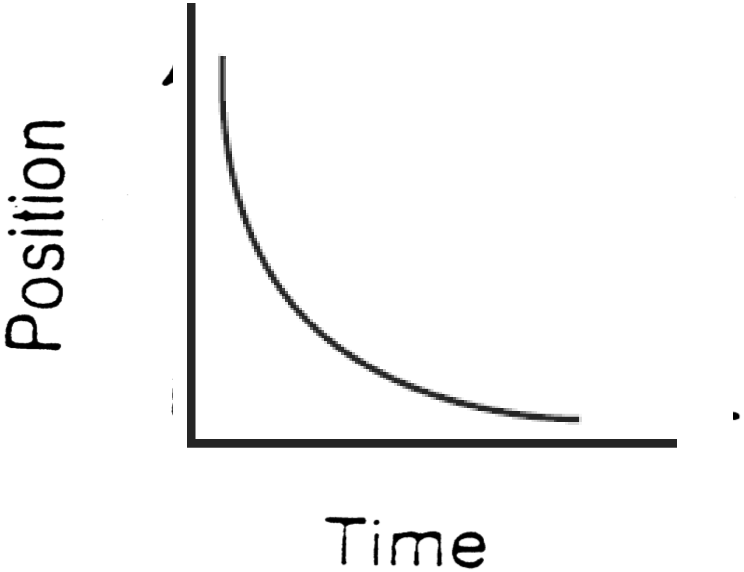
vectors in opposite direction must be given opposite signs.

$$\Delta \vec{d} = \vec{v}_i \Delta t + \frac{1}{2} \vec{a} \Delta t^2$$

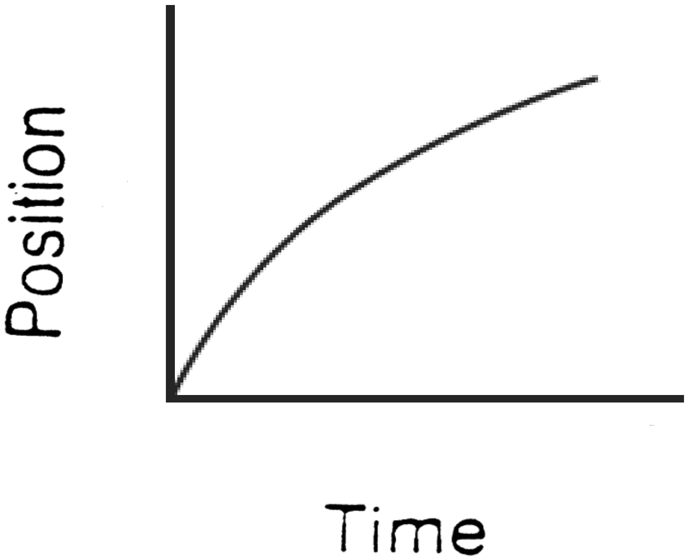
Graphs of Accelerated Motion



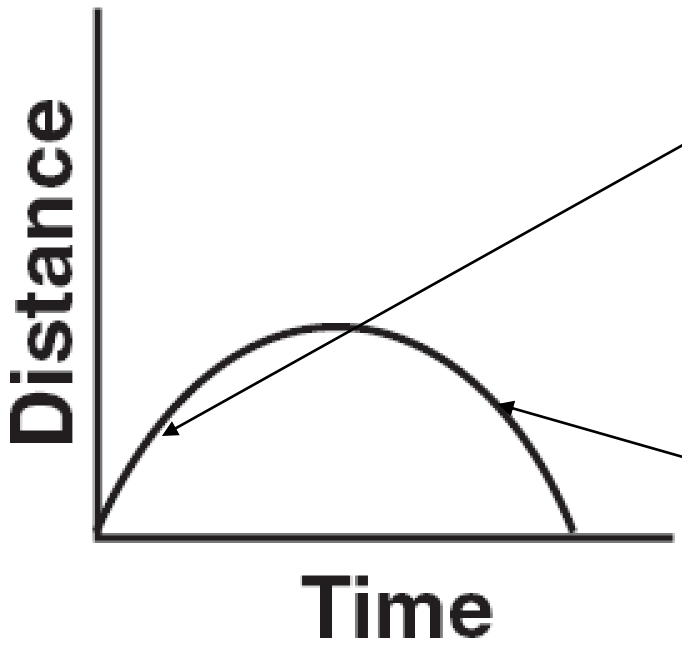
- Object is speeding up
- Moving a greater distance in the same time



- Object is slowing down
- approaching the reference point

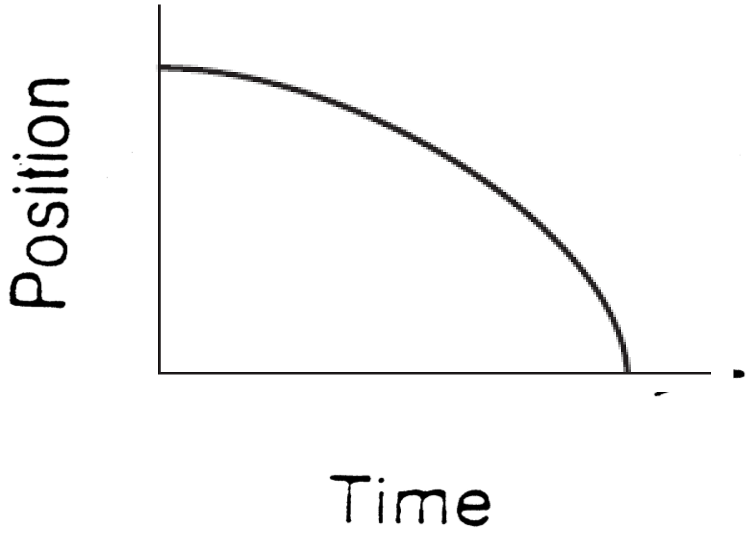


- Moving away from you
- Slowing down



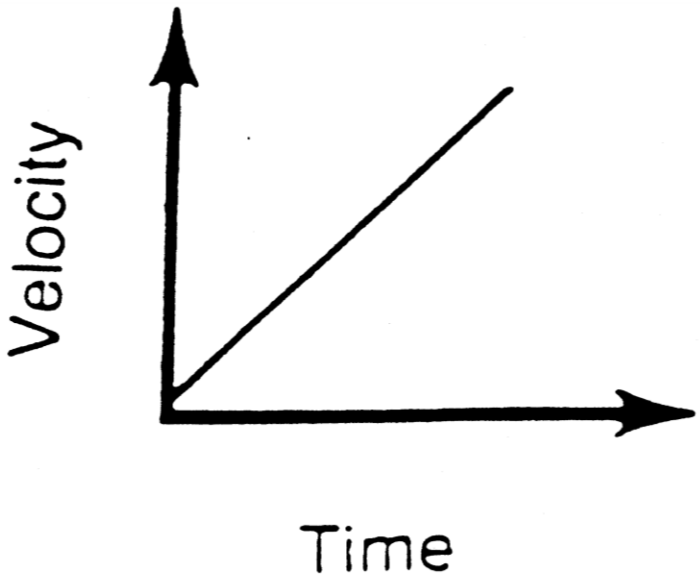
- Object is moving away from you and slowing down
- Then the object begins to come back and is speeding up

Example

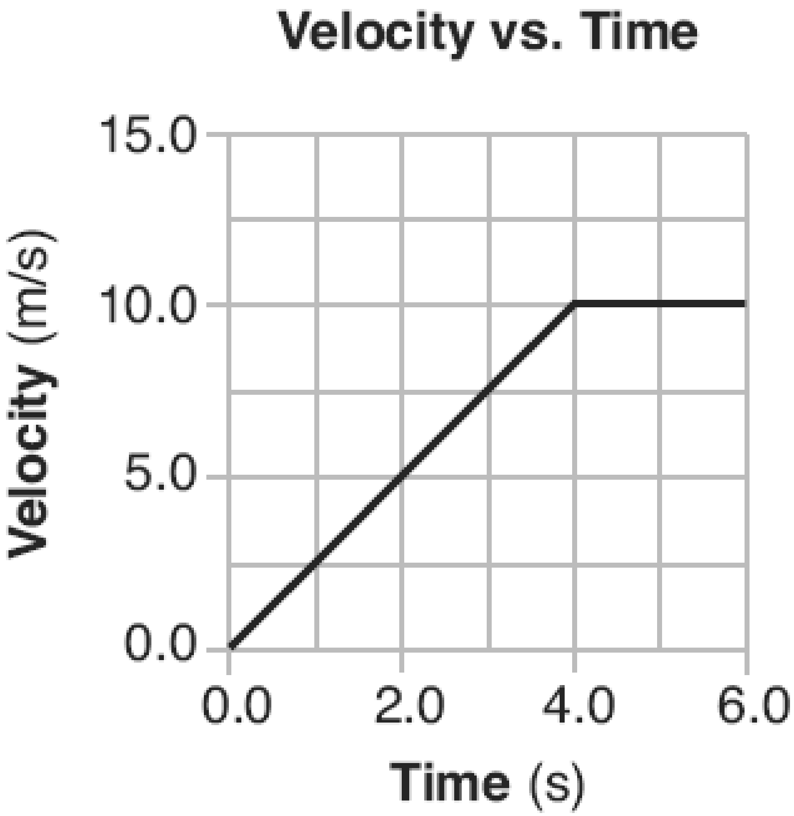


- Describe the motion of the object
- Starts away from you
- Moves towards you
- Speeds up

Velocity-time graphs

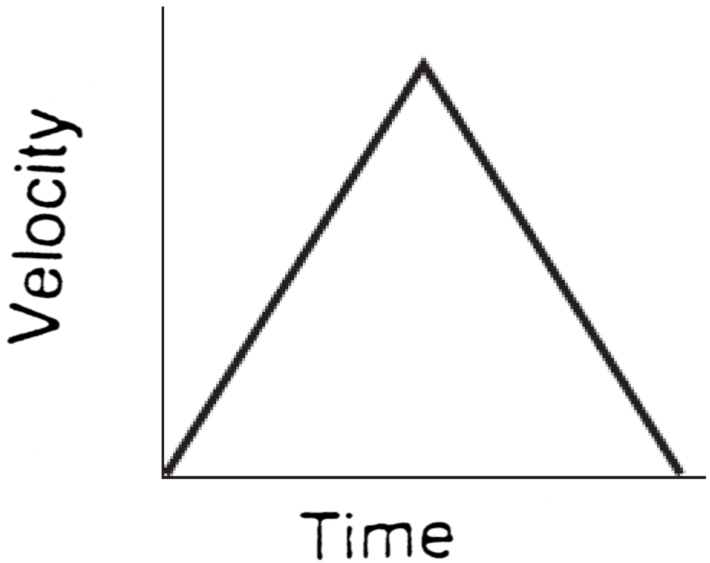


- object's speed increases
- slope of line = acceleration



- Accelerating for 4.0 s then uniform motion

Example



- Describe the motion

- Accelerates away from you
- Slows down but still moving away
- Because the velocity is still positive (if the velocity was negative, it would have changed direction).