Linear Motion

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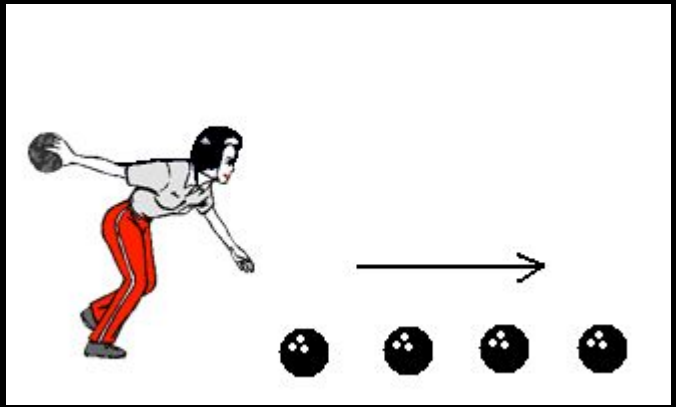
P. 6



Concepts:

- Kinematics vs. Dynamics
- Reference Frames
- Distance vs. Displacement
- Scalars vs. Vectors
- Speed vs. Velocity
- Acceleration
- Objects in motion
- Freefall
- Thrown

Kinematics vs. Dynamics

Kinematics

How things move

Ex.: velocity, acceleration, and position

Dynamics

Why things move

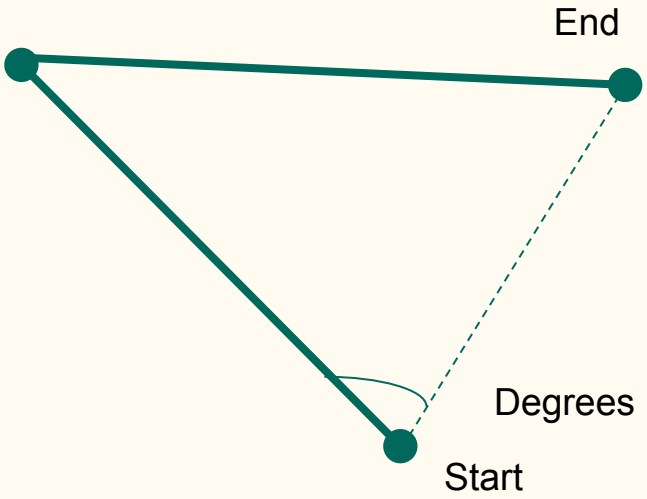
Ex.: torque, forces, and effect on motion

Reference Frames

- Position, speed, and acceleration values are meaningless without a specific reference frame.
  - Ex: There is a person running 50 km/h on train.
  - The train is moving 80 km/hr.
  - To someone watching the train move, the person running is actually moving 50 km/hr + 80 km/hr = 130 km/hr.
  - Ex: If I say I live 20 km from school, I don't know in which direction or from where.
- Lab Reference
  - What is relative to the room we are sitting in.

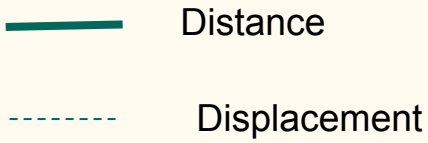
Distance

- Scalar
- Measurement of the path taken



Displacement

- Vector
  - Includes direction
- Measurement of a straight line from the starting point to the end point and angle.



Scalars

vs.

Vectors

- Scalars are measurements that *only* include magnitude.
- Temperature, speed, mass, and volume are all scalar quantities.
- They're scalar because they don't include a direction.
  - Temperature is *30 degrees Celsius,* not *30 degrees Celsius right*.

- Vectors, on the other hand, include both magnitude and direction.
- Acceleration, displacement, and velocity are all vector quantities.
- A temperature's increase or decrease can be a vector quantity. If the temperature changed 20 degrees, you'd want to know if it was up or down.

Speed vs. Velocity

- Speed and velocity are both movements to describe how an object is moving.
  - Speed describes how quickly or slowly it takes an object to cover a distance.
    - Velocity, on the other hand, describes how far displaced an object becomes in a given time frame.

Average speed is calculated as **Distance traveled/Time passed**
Average velocity is calculated as **Displacement/Time passed**

Speed and velocity are calculated in *meters/second.*

Acceleration

Acceleration by definition is changing a speed or direction of an object.

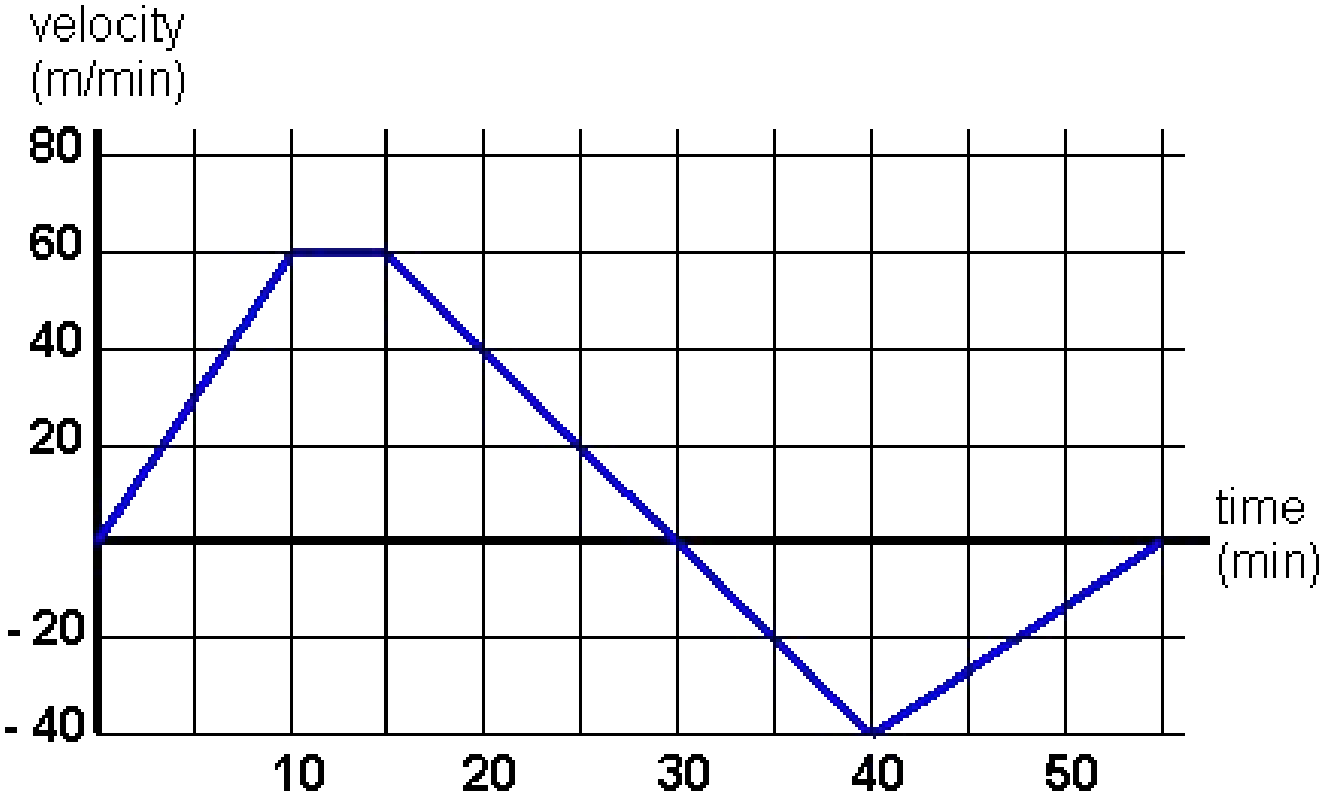
$$a = \Delta V / \Delta t$$

Velocity is measured in meters per second (m/s). Time is measured in seconds (s). This means the units for acceleration is meters per second squared (m/s^2).

If the instantaneous velocity of an object is zero, does it mean that the instantaneous acceleration is zero?

If the instantaneous acceleration is zero, does it mean that the instantaneous velocity is zero?

- **Acceleration** is a vector quantity that is defined as the rate at which an object changes its velocity.



Freefall

All objects fall at the same rate in a vacuum --Galileo

remember the video Mr. Fulmer showed us of the feather and the tennis ball falling?
The reason both objects hit the ground at the same time was because there is no air resistance in a vacuum. Mass is not relevant in free fall because the downward acceleration against the ground is the same.

Motion of Free Falling Objects

Gravity of Earth ($9.81 m/s^2$) = g

V = Velocity, x = Distance, t = Time, a = Acceleration

$$\mathbf{V = a * t}$$

$$\mathbf{x = (a * t^2) / 2}$$

Equations to find the velocity or distance of objects in free fall.

Free Fall Concepts

- A free falling object's acceleration is always -9.81m/s^2 (on earth), the '-' sign indicating downward acceleration.
- If an object is dropped (not thrown) its initial velocity will be 0m/s
- If an object is propelled up at a perfect vertical direction, the velocity at which is is thrown will be equal in magnitude and opposite in sign to the velocity it has when it reaches the same height. A ball thrown upwards at +20m/s will have a downwards velocity of -20m/s when it returns to the same height.

Thrown Objects

- Instead of 0m/s for dropped objects, the initial velocity will be equal to the speed at which the object was thrown
  - A ball thrown in any direction at 5m/s will have an initial velocity of 5m/s

Common Mistakes:

Distance Vs. Displacement; Distance is a scalar while direction is a vector

Watch negative positive signs when computing freefall or thrown objects.
It doesn't matter which is which, just be consistent.

Acceleration is how quickly velocity changes and is measured in m/s^2.

How to think about Free Response Questions:

First, understand what the problem is asking. What variable is being called for? What variables do you already know?

Then, choose an equation. Choose one appropriate for what you're looking for, which can include modifying equations.

Substitute in what you know. Make sure to keep your units in line! Don't forget to put your final answer in the correct units.

& watch out for negatives and positives!

Multiple choice questions

Question 1:

A ship is sinking and trying to find the quickest way to reach an island in the distance that it passed by a while ago. The crew knows they sailed 250 m straight past the island, turned 30° Northeast, travelled another 300 m, and then turned ninety degrees towards East and travelled 450 m. What is the quickest way back to the island?

What is the distance the boat travelled away from the island?

Answer: 57.59 m 29.75°NW

Question 2:

Ms. Hazlett sees you leaving the senior parking lot during Step.

To reach your car, she moves from 100 m away to 1 m away in 35 seconds.

What is her average velocity?

Answer: 2.82 m/s

Question 3:

Which quantities are vectors?

Temperature

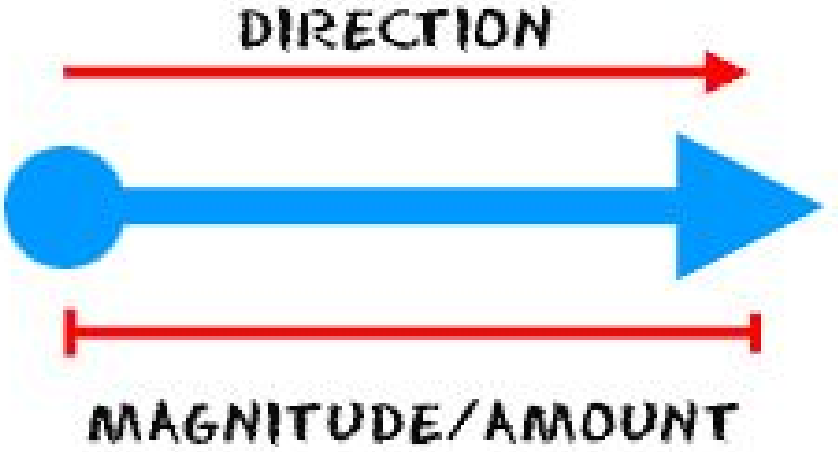
Velocity

Weight

Speed

Acceleration

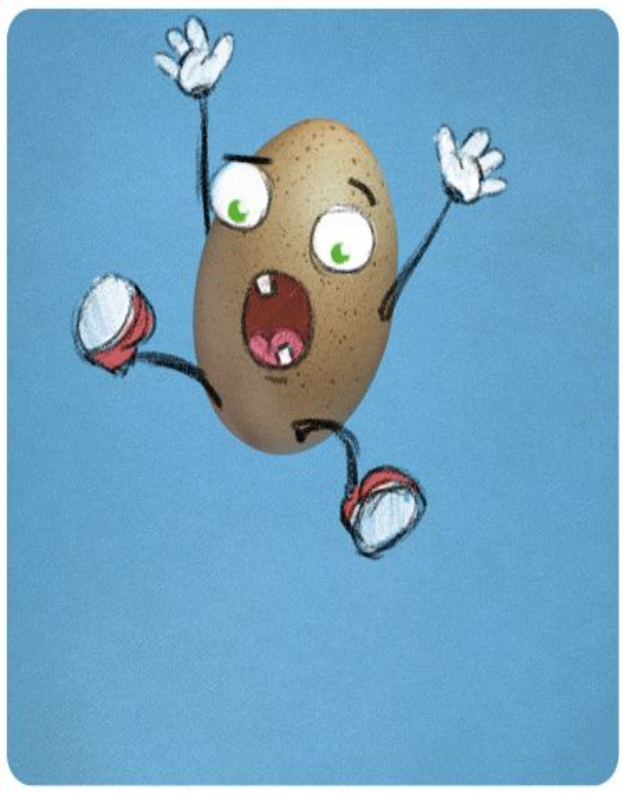
Mass



Question 4:

Mr. Fulmer drops an egg of the top of a 100 m tall building to hit a student on the head. How fast is the egg going after 3 seconds?

Ans: 44.10 m



Question 5;

How fast is the egg going when it hits the student?

Ans: 44.29 m/s