Name: ____________________

Period: ____________________

Velocity and Acceleration

Speed vs. Velocity

Velocity is speed with direction.

Example: A person walks 4 m/s—speed (no direction).

20 m/s north ↑ Same speed; ***different velocities*** because they have ***different directions***. ← 20 m/s west

Velocity changes when direction changes.

Scalars vs. Vectors

Vectors require direction; Scalars only need magnitude (how big).

Remember: **Speed** is a **Scalar; Velocity** is a **Vector.**

Vectors require magnitude (how much) and direction, often vectors can cancel each other out (not acceleration, though).

12 m/s west
Magnitude Direction

Speed: 12 m/s.
Velocity: 12 m/s west.

Acceleration

Acceleration is how fast you change velocity OR how much the velocity changed in a certain amount of time.
An object accelerates when it changes speed OR changes direction!

Acceleration (in m/s²) → $a = \frac{\Delta V}{\Delta T}$ ← Change of Velocity (in meters/sec); ← Change of Time (in seconds)

Acceleration equal change of velocity divided by change of time.

$$\Delta V = V_{final} - V_{initial}, \text{ so, } a = \frac{V_{final} - V_{initial}}{\Delta T}$$

Finding ΔV.

Δ always = *final – initial*.
$\Delta V = V_{final} - V_{initial}$ OR
Final velocity – Initial velocity.

If ΔV is positive the object is speeding up.

If ΔV is negative the object is slowing down (*see below*).

Ex. A plane starts at rest and ends up going 200 m/s in 10 secs. Calculate its acceleration.

Step 1: Variables
$V_i = 0$ m/s (at rest)
$V_f = 200$ m/s
T = 10 sec
a = ________

Step 2: Formula
$a = \frac{\Delta V}{\Delta T}$

Step 3: Put in numbers and solve
$$a = \frac{\Delta V}{\Delta T} = \frac{V_f - V_i}{\Delta T} = \frac{200 - 0}{10}$$
$$a = \frac{200}{10} = 20$$

Step 4: Add units
$a = 20 \text{ m/s}^2$ ← *Pos. means speeding up*

Ex. A race car starts at 40 m/s slows to 10 m/s in 5 seconds. Calculate the car's acceleration.

Step 1: Variables
$V_i = 40$ m/s
$V_f = 10$ m/s
T = 5 sec
a = ________

Step 2: Formula
$a = \frac{\Delta V}{\Delta T}$

Step 3: Put in numbers and solve
$$a = \frac{\Delta V}{\Delta T} = \frac{V_f - V_i}{\Delta T} = \frac{10 - 40}{5}$$
$$a = \frac{-30}{5} = -6$$

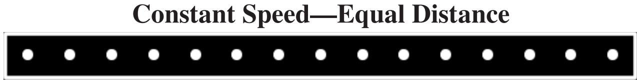
Step 4: Add units
$a = -6 \text{ m/s}^2$ ← *Neg. means slowing down*

Negative acceleration means an object is slowing down OR speeding up in the negative direction. Slowing down is also called "deceleration".

Distance and Acceleration

An object that is accelerating will travel farther each second.

Constant Speed—Equal Distance



Points are equal distance, so velocity is constant. Since the velocity is constant, the initial and final velocity are equal and the acceleration equals zero.

Positive Acceleration—Increasing Distance

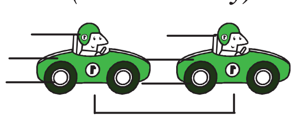
The distance between the points is increasing, so velocity is increasing. The object is accelerating: traveling faster each second and covering more distance every second.

Measuring Acceleration

To measure an object's acceleration you need to measure the object's velocity before and after the acceleration.

If the object starts at rest you know that $V_i = 0$m/s. If the object stops you know that $V_f = 0$m/s.

Measure V_i (Initial Velocity)



4 m in 1 sec

$$V_i = \frac{\Delta D}{\Delta T} = \frac{4\text{ m}}{1\text{ sec}}$$
$$V_{initial} = 4\text{ m/s}$$

Measure ΔT (Time it took to Accelerate)

Accelerates for 2 seconds So ΔT = 2 sec →

$$a = \frac{V_f - V_i}{\Delta T} = \frac{8 - 4}{2}$$
$$V_{initial} = \frac{4}{2} = 2\text{ m/s}^2$$

Measure V_f (Final Velocity)

8 m in 1 sec

$$V_f = \frac{\Delta D}{\Delta T} = \frac{8\text{ m}}{1\text{ sec}}$$
$$V_{final} = 8\text{ m/s}$$

Name: ______________________

Period: ______________________

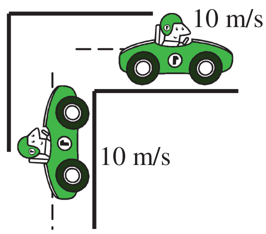
Speed (S) or Velocity (V)	Scalar (S) or Vector (V)
___A bike goes 25 m/s toward main street.	___ 40 mph toward Dallas.
___A person walks 4 mph.	___ 3 m/s^2 to the left.
___A plane flies 200 m/s.	___ 10 meters up the hill.
___A bird flies 100 mph due south.	___ 12 meter per sec^2.
	___ Direction matters.
	___ No direction is needed

Mass, Time, Distance, Velocity, or Acceleration?

___ 2 hrs	____5 sec	____8 kg
___ 3 m/s	____9 mph	____4 m/s^2
___ 6 mph/sec	____12 m	____1 in

Accelerating? Yes, No, or Maybe?

___ At constant velocity.
___ Going 5 m/s then going 3 m/s.
___ A car going around a corner. (*see graphic at right*).
___ At constant speed.
___ Stopping.
___ A car at rest.

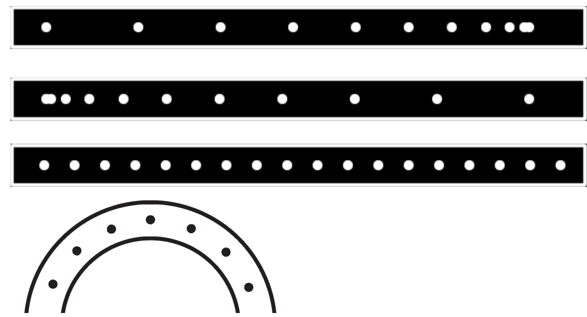


Object A

Object B

Object C

Object D



Choose which of the above applies to the following

____ Constant speed.	____ Distance increases
____ Positive acceleration.	____ Starts at rest.
____ At constant velocity.	____ Is stopping.
____ Accelerating.	____ Constant direction.
____ Decelerating.	____ Negative acceleration.
____ Acceleration = 0.	____ $V_i = V_f$

Object A accelerates at 10 m/s^2; Object B accelerates at 5 m/s^2.

___ Which one will go faster?
___ Which one will take more time to reach a high speed?
___ If they start at rest, which one will reach 40 m/s first?
___ Which one goes farther (longer distance)?
___ Which one will be 100m away sooner?

Give what you know for the following: (V_i, V_f, or a)

An object at constant velocity.
An object that is stopping.
An object that accelerates from rest.
An object at rest.

A person starts running from 2 m/s to 6 m/s in 2 seconds. Calculate the person's acceleration.

Variables:

Formula:

Solve:

A dragster's top acceleration is 60 m/s^2. If it starts from rest at the starting line, how fast will it be going after 3 seconds?

Variables:

Formula:

Solve:

A plane stops from 250 mph in 25 seconds. Calculate the planes acceleration.

Variables:

Formula:

Solve:

A car travels 30 m in 5 seconds. After accelerating for 3 seconds, it travels 20 m in 2 seconds. Calculate the car's acceleration.

1) Find V_i.

2) Find V_f.

3) Calculate a.

Name: ____________________

Period: ____________________

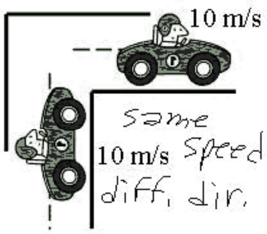
Speed (S) or Velocity (V)	Scalar (S) or Vector (V)
V A bike goes 25 m/s toward main street.	V 40 mph toward Dallas.
S A person walks 4 mph.	V 3 m/s² to the left.
S A plane flies 200 m/s.	V 10 meters up the hill.
V A bird flies 100 mph due south.	S 12 meter per sec².
	V Direction matters.
	S No direction is needed

Mass, Time, Distance, Velocity, or Acceleration?

T 2 hrs	T 5 sec	m 8 kg
V 3 m/s (S)	V 9 mph	a 4 m/s²
a 6 mph/sec	D 12 m	D 1 in

Accelerating? Yes, No, or Maybe?

- N At constant velocity.
- Y Going 5 m/s then going 3 m/s.
- Y A car going around a corner. (see graphic at right).
- M At constant speed. (if dir. changes)
- Y Stopping.
- N A car at rest.



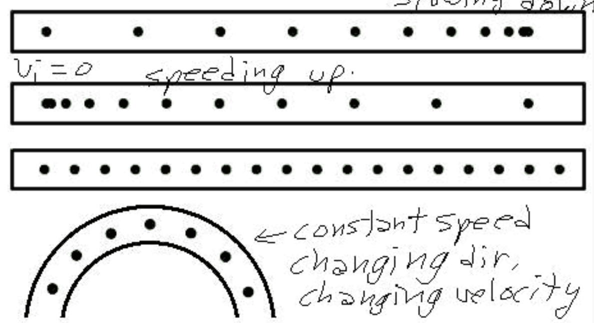
same speed diff. dir.

Object A — slowing down, neg. accel

Object B — $V_i = 0$, speeding up.

Object C

Object D — ← constant speed, changing dir., changing velocity



Choose which of the above applies to the following

C+D Constant speed.	B Distance increases
B Positive acceleration.	B Starts at rest.
C At constant velocity.	A Is stopping.
A, B, D Accelerating.	A, B, C Constant direction.
A Decelerating.	A Negative acceleration.
C Acceleration = 0.	C $V_i = V_f$

Object A accelerates at 10 m/s²; Object B accelerates at 5 m/s².

- Both Which one will go faster?
- B Which one will take more time to reach a high speed?
- A If they start at rest, which one will reach 40 m/s first?
- both Which one goes farther (longer distance)? (A does it first)
- A Which one will be 100m away sooner?

Give what you know for the following: (V_i, V_f, or a)

- An object at constant velocity. $a = 0$ $V_i = V_f$
- An object that is stopping. $V_f = 0$
- An object that accelerates from rest. $V_i = 0$
- An object at rest. $a = 0$ $V_i = V_f = 0$

A dragster's top acceleration is 60 m/s². If it starts from rest at the starting line, how fast will it be going after 3 seconds?

Variables:
$a = 60\ m/s^2$
$V_i = 0$
$t = 3\ sec$
$V_f =$ ___

Formula:
$a = \frac{V_f - V_i}{t}$

Solve:
$60 = \frac{V_f - 0}{3}$
$3(60) = V_f$
$180 = V_f$
$V_f = 180\ m/s$

A person starts running from 2 m/s to 6 m/s in 2 seconds. Calculate the person's acceleration.

Variables:
$V_i = 2\ m/s$
$V_f = 6\ m/s$
$t = 2\ sec$
$a =$ ___

Formula:
$a = \frac{V_f - V_i}{t}$

Solve:
$a = \frac{6-2}{2} = \frac{4}{2}$
$= 2\ m/s^2$

A plane stops from 250 mph in 25 seconds. Calculate the planes acceleration.

Variables:
$V_i = 250\ mph$
$V_f = 0$
$t = 25\ sec$
$a =$ ___

Formula:
$a = \frac{V_f - V_i}{t}$

Solve:
$a = \frac{0 - 250}{25} = \frac{-250}{25}$
$= -10 \frac{mph}{sec}$

A car travels 30 m in 5 seconds. After accelerating for 3 seconds, it travels 20 m in 2 seconds. Calculate the car's acceleration.

1) Find V_i. $= \frac{\Delta D}{T} = \frac{30m}{5sec} = 6\ m/s$

2) Find V_f. $= \frac{\Delta D}{T} = \frac{20m}{2sec} = 10\ m/s$

3) Calculate a. $a = \frac{V_f - V_i}{t} = \frac{10 - 6}{3} = \frac{4}{3}$
$= 1.33\ m/s^2$