Kinematics Review Checklist

Vectors and Scalars

1.1.0A – Give examples of vectors and scalars; and recognize the difference between them. ☐

What two parts does a vector have? Which of these parts comprises a scalar?

magnitude and direction | magnitude only

Which of the following are vectors? Which are scalars?

(a) distance	(d) velocity
(b) displacement	(e) acceleration
(c) speed	(f) time

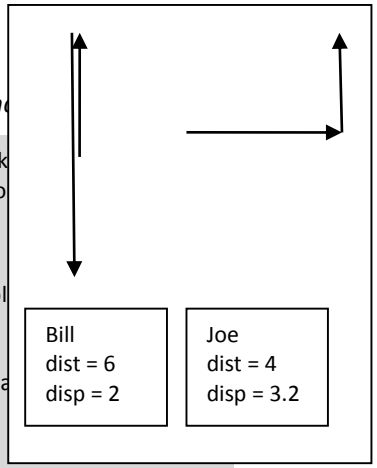
a. scalar	d. vector
b. vector	e. vector
c. scalar	f.. scalar

Distance and Displacement

1.1.1A – Explain the difference between distance and

Two men leave the same house at the same time. Bill walk
then four blocks south. Joe walks three blocks east, then o

- Sketch a diagram of the their paths.
- Which man travels the greater distance?
- Which man finishes his trip with the greater displ



Bill
dist = 6
disp = 2

Joe
dist = 4
disp = 3.2

Explain how it is possible for a person to travel a great dista
final displacement of zero.

It must start and end in the same place

Two people travel from New York City to Boston. One person travels by plane, the other by car. Which person probably travels the greater distance during this trip? Compare the displacements of the two people assuming that they both start at JFK Airport and finish at Logan Airport.

Same displacement – driver probably travels much greater distance.

1.1.1B – Interpret graphs of distance or displacement vs. time. Use the graphs to determine average speed; displacement; or distance traveled. ☐

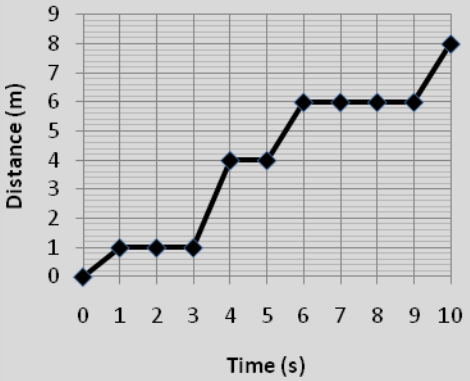
The graph below shows the distance traveled by an object as a function of time.

During what time interval(s) was…

The object
3 - 4 s
speed greatest?

The ob
1 – 3, 4 -5, 6 – 9 s

How far did the object travel between 3 a
5 m
conds?



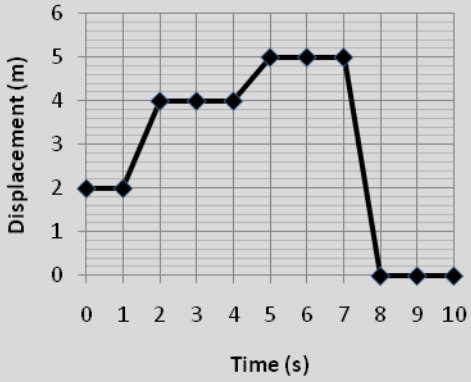
The graph below shows an object's displacement as a function of time.

What
direct
west
l during the time interval 7 to 8 seconds?

How f
travel
6 m
bject and 8 seconds?

What was the object's average
2 m/s
ng the time int
seconds?

What is
0 m
s final position



Speed and Velocity

1.1.1C – Explain the difference between speed and velocity. Use equation to determine average speed or velocity.

Two cars leave the same house at the same time. During the same interval of time: the first car travels three blocks east then three blocks west; while the secon

The first car has a greater average speed by a velocity of 0. The second car has a greater average velocity.

ce!)

- Which car had the greater average velocity? (look at displacement!)

A cat moves 15 meters east in 5 seconds. What was its average speed?

3 m/s

A fish swims 20 meters south in 10 seconds. What was its average velocity?

2 m/s south or -2 m/s

A jogger takes a three mile run. The first mile takes him 10 minutes to complete, the second mile takes him 11 minutes to complete, and the third takes him 9.5 minutes to complete. Determine his average speed.

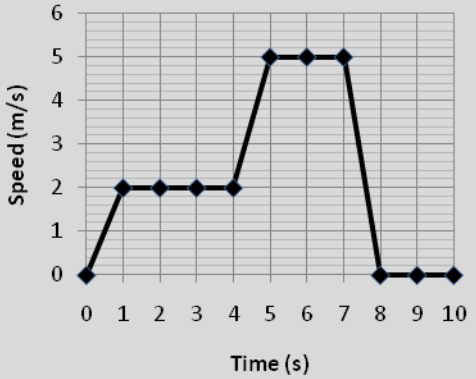
0.1 mi/min

An object begins with a speed of 6 meters per second and speeds up to 10 meters per second in 4.0 seconds. What is the object's average speed during these 4.0 seconds?

8 m/s

1.1.1D – Interpret graphs of speed or velocity vs. time. Use the graphs to determine average speed; acceleration; displacement; or distance traveled.

The graph below shows the speed of an object as a function of time.



During what time interval(s) was…

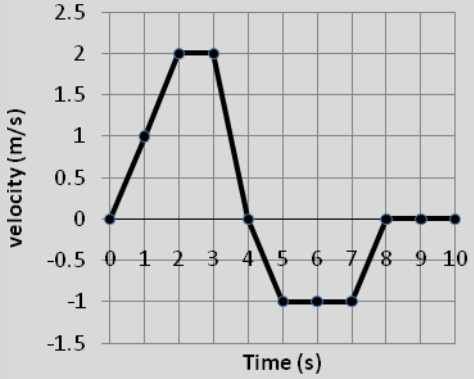
Th 5 -7 s ed gre

Th eleration gre 7 – 8 s

Th 8 – 9 s noving?

How far did the object tra 0 and 4 sec 7 m

The graph below shows an object's velocity as a function of time.



Wh 2 m/s bject's spe conds?

Du e interval wa 4 – 8 s noving to the left?

What was the object's ave uring the tim o 2 seconds? 1.5 m/s

Wh bject's acc ing the interval 3 to 4 seconds? -2 m/s^2

Na 2 -3, 5 – 7, 8 – 10 s wh

Acceleration

1.1.1E – Explain the difference between velocity and acceleration. Use equations to determine acceleration; starting velocity; ending velocity; or time. Understand what the terms "from rest"; "comes to a stop"; "comes to rest" mean in terms of kinematics.

An object begins from rest and reaches a velocity of +10 meters per second while accelerating for 4.0 seconds. Determine the acceleration of the object.

2.5 m/s^2

A car moving at 2.0 meters per second speeds up at a rate of 5.0 meters per $second^2$ for 4.0 seconds. What is the final speed of the car?

22 m/s

An object begins with a velocity of 20 meters per second west and comes to a stop within 4.0 seconds. Determine the direction and magnitude of the acceleration that acted upon this object.

5 m/s^2 east

An object with a velocity of 6.0 meters per second north accelerates south at a rate of 5.0 meters per $second^2$ for 3.0 seconds. What is the final speed of the object? In which direction is the object moving after 3.0 seconds?

9 m/s south

Kinematics Equations

1.1.1F – Use equations to determine distance; displacement; speed; velocity; acceleration; or time.

How far does an object travel if it starts from rest and accelerates at a rate of 2.0 meters per $second^2$ for 6.5 seconds?

42.25 m

What is the final speed of a cart that begins with a velocity of +3.0 meters per second if it accelerates at a rate of +1.5 meters per $second^2$ while traveling +25 meters?

9.2 m/s

At what rate does an object accelerate if it changes its speed from 3.0 meters per second to 5.0 meters per second while traveling a distance of 4.0 meter?

2 m/s^2

How long does it take for an object to reach a velocity of 2.0 meters per second north if it begins with a velocity of 8.0 meters per second south and accelerates north at a rate of 4.0 meters per $second^2$?

2.5 s

Freefall and Vertically Thrown Objects

1.1.2 – Explain the behavior of objects in freefall (in the absence of air resistance.). Understand the terms "dropped" and "maximum height".

What speed will a ball reach if it falls from rest for 3.0 seconds?

29.43 m/s

How far will a dropped object have fallen after 2.0 seconds?

19.62 m

What maximum height will an object reach if it thrown directly upward with a speed of 15 meters per second? How long will it take to reach this height?

11.5 m

What is the height of an object that is thrown upward with a speed of 20 meters per second 1.5 seconds after it is thrown?

19 m

An object is thrown directly upward with a speed of 25 meters per second. How long will it take to come back to the position from which it was released?

5.1 s

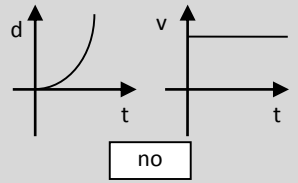
How long does it take for an object that is dropped from the top of a 45 meter high building to reach the ground?

3.03 s

One-Dimensional Kinematics Graphs

1.1.3A – Relate graphs of: distance/displacement vs. time; speed/velocity vs. time; and acceleration vs. time

Which sets of graphs could describe the motion of the same object?



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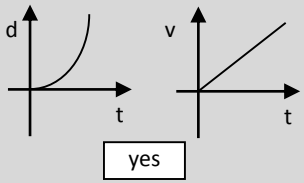

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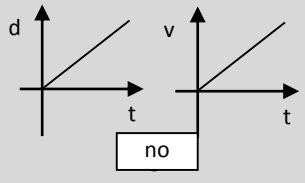

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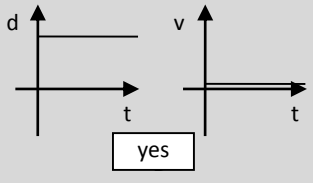

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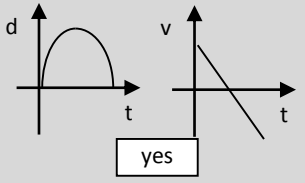

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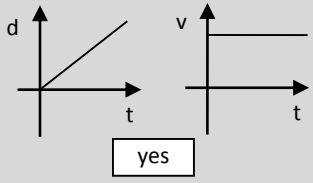

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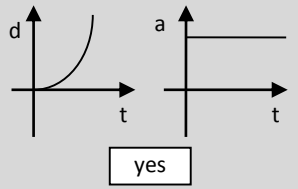

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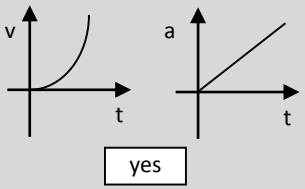

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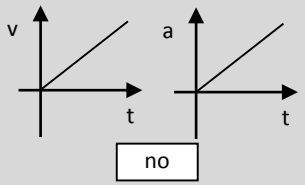

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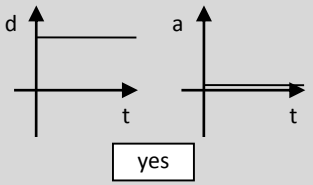


yes

1.1.3B – Identify graphs of distance/displacement, speed/velocity, or acceleration that describe specific conditions.

Which graph would best represent…

(a) speed vs. time for an unmoving object B

(b) displacement vs. time for an object moving with a constant speed C

(c) speed vs. time for a decelerating object D

(d) distance vs. time for an object with increasing speed E

(e) velocity vs. time for an object with a constantly increasing displacement A

(f) acceleration vs. time for an object that is moving at a constant spee B

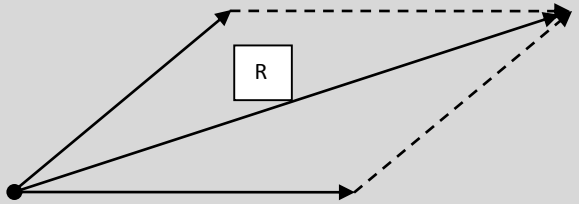
(g) displacement vs. time for an object that is moving toward its point of origin D

(h) acceleration vs. time for an object that is increasing its speed at a constant rate A

Vectors

1.2.0A – Add vectors graphically.

Use a protractor and a ruler to construct a resultant for the following pair of vectors.



1.2.0B – Determine vector components. Determine the resultant of perpendicular components.

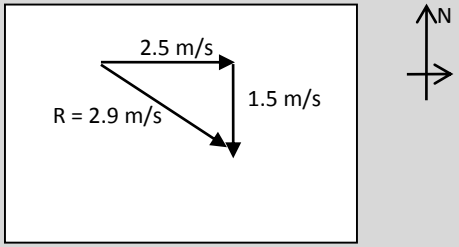
An object moves with a velocity of 15 meters per second in a direction that is 25° north of east. What is the north-ward component of this velocity? What is the east-ward component of this velocity?

6.3 m/s north
13.6 m/s east

Two-Dimensional Motion – Constant Velocity in Both Dimensions

1.2.0C – Determine resultant speed/velocity in a two dimensional system.

A girl rows a boat with a velocity of 2.5 meters per second due east across a river. As she rows across the river, a current of 1.5 meters per second pushes her boat due north. Sketch a set of vectors to represent these two velocities. What is the resultant speed of the girl's boat?



1.2.0D – Determine an unknown variable in a two dimensional system with constant velocity in both directions.

A plane flies north with a speed of 100 meters per second. At the same time, a crosswind pushes the plane east with a speed of 15 meters per second. In the time that the plane flies 300 meters north, how far east will it drift?

45 m

An ant crawls with a speed of 0.1 meter per second directly west across a conveyor belt that is 0.5 meter wide. At the same time, the conveyor belt moves south. What speed was the conveyor belt moving with if the ant moves 10 meters south in the same time that it takes it to get across the belt?

2 m/s

Two-Dimensional Motion – Ground Launched Projectiles

1.2.1A – Determine the components of a ground-launched projectile's initial velocity.

A cannonball is fired at a velocity of 200 meters per second at an angle of 35° above the horizontal.

- What is the vertical component of the ball's initial velocity? 115 m/s
- What is the horizontal component of the ball's initial velocity? 164 m/s

1.2.1B – Explain the assumptions that must be made in order to solve a ground-launched projectile problem.

What assumptions should be made about the horizontal and vertical accelerations of ground-launched projectiles?

$a_x = 0$; $a_y = -9.81\ m/s^2$

What assumption can be made regarding the relationship between the time that it takes for a ground-launched projectile to reach its maximum height and its total time of flight?

Time to top = ½ Total time in the Air

1.2.1C – Sketch a set of vectors at any position in the path of a ground-launched projectile. Compare velocities and accelerations at different points in a projectile path.

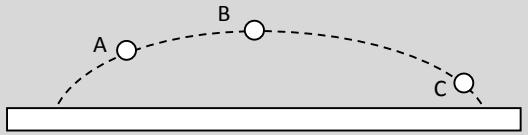
At each position: A, B, and C sketch a vector to represent the vertical and horizontal velocities of the object.

Compare the vertical speed A to the vertical speed at B. A > B

Compare the horizontal speed at B to the horizontal speed at C. same

Compare the vertical acceleration at A to the vertical acceleration at C. same

Compare the horizontal acceleration at A to the horizontal acceleration at B. same



1.2.1D – Use equations to determine: time of flight; maximum height; horizontal distance of travel; or launch angle for a ground-launched projectile.

A ball is thrown with an initial velocity of 15 meters per second at an angle of 20° above the horizontal.

- Determine the vertical component of the ball's initial velocity. 5.13 m/s
- Determine the ball's total time of flight. 1.05 s

A rock that is projected with an initial velocity of 24 meters per second at an angle of 60° above horizontal takes 2.12 seconds to reach its maximum height.

- What is the horizontal component of the ball's initial velocity? 12 m/s
- What total horizontal distance will the rock travel before it lands? 51 m

A projectile is fired with an initial vertical velocity of 12 meters per second and an initial horizontal velocity of 15 meters per second.

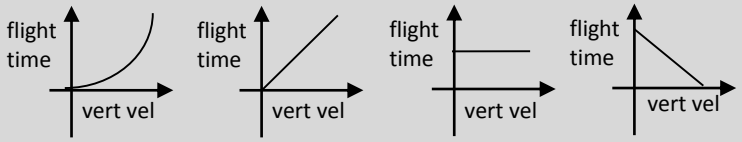
- Determine the maximum vertical height that the projectile will reach. 7.34 m
- Determine the angle with which the projectile was launched. 38.7°

1.2.1E – Explain the relationship between projectile flight time; maximum height; and initial vertical velocity.

A projectile is fired with initial velocity V at an angle θ above the horizontal. Which value of θ will give the projectile its greatest vertical height?

(a) 30° (b) 45° (c) 60° (d) 90° 90°

Which graph best represents the relationship between projectile flight time and initial vertical velocity?



A B C D

1.2.1F – Explain the relationship between a ground-launched projectile's horizontal distance of travel (range) and angle of launch.

At what launch angle will a projectile thrown with initial velocity V attain the greatest horizontal distance of travel? 45°

(a) 30° (b) 45° (c) 60° (d) 90°

Two-Dimensional Motion – Horizontal Projectiles

1.2.1G – Explain the assumptions that must be made in order to solve a horizontal projectile problem.

What assumptions should be made about the horizontal and vertical accelerations of ground-launched projectiles?

$a_x = 0$; $a_y = -9.81$ m/s^2

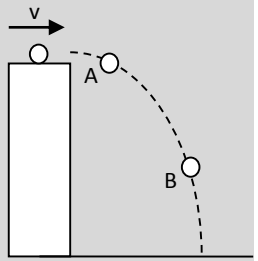
What assumption must be made about the initial vertical velocity of a horizontally launched object?

initial vert. velocity = 0

1.2.1H – Sketch a set of vectors at any position in the path of a horizontally-launched projectile. Compare velocities and accelerations at different points in a projectile path.

At each position: A and B sketch a vector to represent the vertical and horizontal velocities of the object.

- Compare the vertical speed A to the vertical speed at B. B > A
- Compare the horizontal speed at A to the horizontal speed at B. same
- Compare the vertical acceleration at A to the vertical acceleration at B same
- Compare the horizontal acceleration at A to the horizontal acceleration at B. same



1.2.1J – Use equations to determine: time of flight; launch height; horizontal distance of travel; or initial velocity of a horizontally-launched projectile.

An object is thrown horizontally from a height of 10 meters with an initial velocity of 8.0 meters per second. Determine the horizontal distance that the object will travel. 11.4 m

A ball is thrown horizontally with an initial velocity of 5.0 meters per second. The ball travels 15 meters horizontally before it lands. What vertical height was it thrown from? 44.1 m

A projectile is fired horizontally from a height of 15.0 meters above the ground. The projectile travels 40 meters horizontally from the point from which it was fired before it lands. What initial velocity was the projectile fired with?

23 m/s

1.2.1K – Compare horizontally-launched projectiles to objects in freefall.

Two objects A and B begin from the same point above the ground. Object A is thrown horizontally from this height with an intial velocity. Object B is dropped from the same height at the same time. Which of the following statements regarding these two objects is true? (There may be more than one!)

(a) Both objects will experience the same vertical acceleration. true

(b) Both objects will have the same initial vertical velocity. true

(c) Both objects will reach the ground in the same amount of time. true

(d) Both objects will travel the same distance vertically. true

(e) Both objects will travel the same distance horizontally. false

(f) Object A will take less time to hit the ground than object B. false

(g) Object A will have a greater overall speed than object B at all times. true