Physics 01-01 Intro and Units — Name: ________________

What is Physics?

Physics studies ______________ that can be ______________ with our five senses.

Model - ________________________
Theory - _______________________
Law - Uses ______________ language to describe ________________ patterns that have been verified ________ times

Scientific Method - used to solve many types of problems, not just science

Usually begins with ________________ and question about the phenomenon to be studied
Next preliminary research is done and __________________ is developed
Then experiments are performed to ________ the hypothesis
Finally the tests are analyzed and a ______________ is drawn

Prefix	Symbol	Value	Prefix	Symbol	Value
exa	*E*	10^{18}	*deci*	*d*	10^{-1}
peta	*P*	10^{15}	*centi*	*c*	10^{-2}
tera	*T*	10^{12}	*milli*	*m*	10^{-3}
giga	*G*	10^{9}	*micro*	*μ*	10^{-6}
mega	*M*	10^{6}	*nano*	*n*	10^{-9}
kilo	*k*	10^{3}	*pico*	*p*	10^{-12}
hecto	*h*	10^{2}	*femto*	*f*	10^{-15}
decka	*da*	10^{1}	*atto*	*a*	10^{-18}

Units

Science uses ______________________ System (SI System)

Base Units
Length - ___________ (m)
Time - ____________ (s)
Mass - ____________ (kg)

Others are _______________________ units

Unit Conversions

Multiply by ____________________ factors so that unwanted units __________________ out

Convert 20 Gm to m

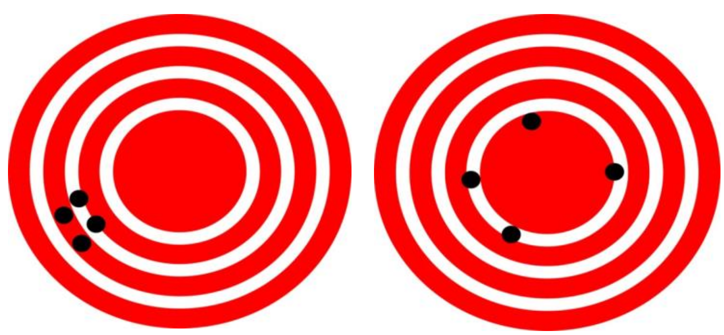
Convert 5 cg to kg

Convert 25 km/h to m/s

Accuracy and Precision

Accuracy is how _____________ a measurement is to the _________________ value for that measurement.
Precision of a measurement system is refers to how ____________ the agreement is between ______________ measurements.

Accuracy and precision mean there is some ____________.
A device can repeatedly get the same ______________ (precise), but always be ___________ (not accurate).



Physics 01-01 Intro and Units Name: _______________

Significant Figures

Used to reflect ______________ in measurements
Each measuring device can only measure so accurately
The ________ digit is always an ______________

To find significant figures
Ignore _________________________ zeros between the decimal point and the first nonzero digit
Count the number of other _____________

0.000000602
1032000
1.023

Rules for combining significant figures

Addition or subtraction

The answer can contain no more _________________ places than the ____________ precise measurement.

1.02 + 2.0223 =

Multiplication or division

The result should have the same number of ________________________ as the quantity having the _____________ significant figures entering into the calculation.

1.002 · 2.0223 =

Homework

1. Classify each as a **model**, **theory**, or **law**.
   a. ________Bohr model of atom
   b. ________Gravity
   c. ________Drawing a picture to represent a physics problem
   d. ________The Earth is round
   e. ________The Big Bang
   f. ________Creation
2. The altitude of the International Space Station is 409 km. What is this in meters? (RW) **409000 m**
3. The elevation of Berrien Springs is 209 m. What is this in cm? (RW) **20900 cm**
4. Convert 1 hour to seconds. (RW) **3600 s**
5. The speed limit on some highways is 100 km/h. How fast is that in m/s? (RW) **27.8 m/s**
6. The Earth orbits the sun at 29.78 km/s. What is this in km/h? (RW) **107200 km/h**
7. The Earth orbits the sun at 29.78 km/s. What is this in mph (assume 1 mile = 1.609 km)? (RW) **66630 mph**
8. The surface area of the Earth is 510,072,000 km^2. What is this in m^2? (RW) $\mathbf{5.10072 \times 10^{14}\ m^2}$
9. Water covers approximately 361,132,000 km^2 of the Earth's surface. What is this in ft^2 (assume 1 m = 3.2808 ft)? (RW) $\mathbf{3.8871 \times 10^{15}\ ft^2}$
10. The average density of Earth is 5.514 g/cm^3. What is this in kg/m^3? (RW) $\mathbf{5514\ kg/m^3}$
11. 148,940,000 km^2 of land are on Earth. How many significant figures are in this number? (RW) **5**
12. During the breeding season, an adult Monarch Butterfly will live 0.0760 yrs. How many significant figures? (RW) **3**
13. The village of Berrien Springs covers 2.64 km^2. How many significant figures? (RW) **3**
14. 0.21 km^2 of Berrien Springs is water. How many significant figures? (RW) **2**
15. Using the information from the previous two questions, how much land is there in Berrien Springs? How many significant figures should be in your answer? (RW) **2.43 km^2, 3**
16. If there are about 740 people per km^2 in Berrien Springs (living on the land), how many people live in Berrien Springs? How many significant figures should be in your answer? (RW) **1800 people, 2**

Physics 01-02 Displacement and Vectors | *Name: ______________*

Kinematics

Studies ______________ without thinking about its ________________

Position (x)

The ____________________ where something is relative to a ____________________ system called a ________________________

The most common coordinate system the _________________________ coordinate system

Displacement (Δx)

The change in position

____

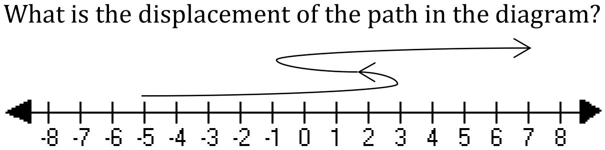
____

Has _______________ and ___________________

Path does ____________ matter

Only ____________ and _______________ position matters

What is the displacement of the path in the diagram?



Distance

The ________________________________ of the path traveled

____

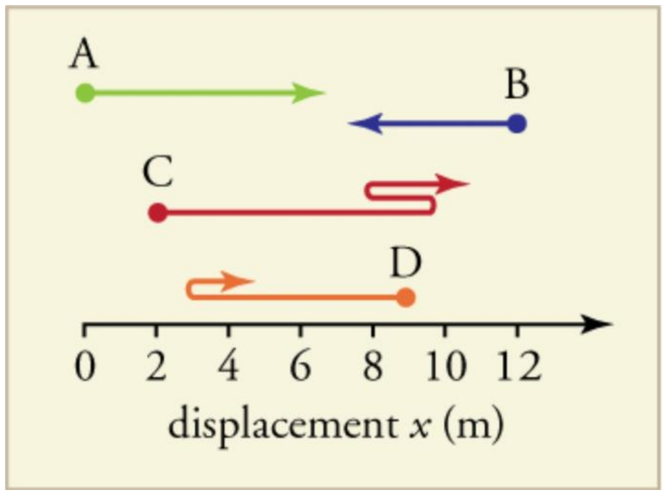
Has only ________________

You drive 20 km east, then turn around and drive 15 km west. What is your displacement?

What was your distance traveled?

Physics 01-02 Displacement and Vectors	***Name: ______________***
Homework	

1. What was difficult about measuring the 3x5 card? Why?
2. How are distance and displacement the same? How are they different?
3. How are scalars and vectors the same? How are they different?
4. Classify each measurement as a scalar or vector.
    a. _____ 20 books on a shelf
    b. _____ A car travels 25 km east
    c. _____ A plane flies 500 km
    d. _____ The car drives 100 km/h west
    e. _____ The plane flies 200 mph north
    f. _____ In an experiment, a toy car moves −15 cm
    g. _____ In an experiment, a mouse moves +20 cm
    h. _____ The temperature is −5 °C
5. The road I live on goes east and west. One day, my family and I decide to go west to the beach. I travel 2 miles west when my wife realizes we passed a flock of wild turkeys. I turn around and drive back 1/2 miles before we find the turkeys. What is my displacement at the flock of turkeys (make west negative)? (RW) **-1.5 miles**
6. What is the distance I traveled to where I stopped by the turkeys? (RW) **2.5 miles**
7. Find the following for path A in the diagram: (a) The distance traveled. (b) The magnitude of the displacement from start to finish. (c) The displacement from start to finish. (OpenStax 2.1) **7 m, 7 m, 7 m**



8. Find the following for path B in the diagram: (a) The distance traveled. (b) The magnitude of the displacement from start to finish. (c) The displacement from start to finish. (OpenStax 2.2) **5 m, 5 m, -5 m**
9. Find the following for path C in the diagram: (a) The distance traveled. (b) The magnitude of the displacement from start to finish. (c) The displacement from start to finish. (OpenStax 2.3) **13 m, 9 m, 9 m**
10. Find the following for path D in the diagram: (a) The distance traveled. (b) The magnitude of the displacement from start to finish. (c) The displacement from start to finish. (OpenStax 2.4) **8 m, 4 m, -4 m**

More about Velocity and Speed

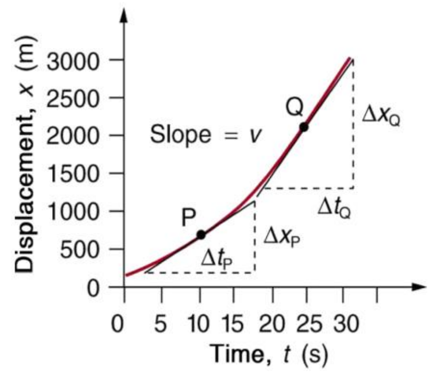
- Velocity is the __________ of a distance vs time graph.

$$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x - x_0}{t - t_0}$$

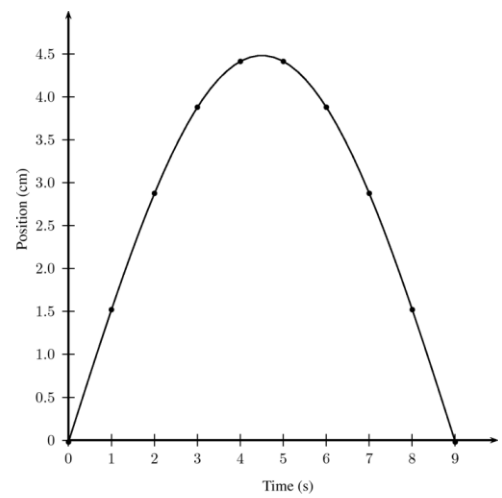
- Often this is rewritten as

$$x = \bar{v}t + x_0$$

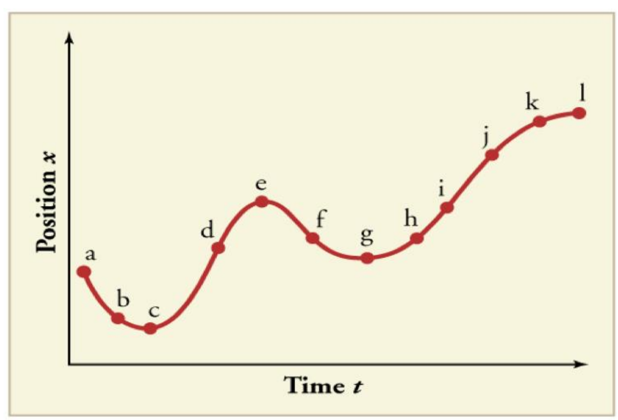
- If the graph is not a ________________ line, then use the slope of a _________________ line drawn to that point.
- Velocity is a vector (has direction) $v = \frac{displacement}{time}$
- Speed is a scalar (no direction) $v = \frac{distance}{time}$
- Units of both are m/s



The graph shows the height of a ball thrown straight up vs time. Find the velocity of the ball at 2 seconds.



(a) Sketch a graph of velocity–time corresponding to the graph of displacement–time given in the graph. (b) Identify the time or times (etc.) at which the instantaneous velocity is greatest. (c) At which times is it zero? (d) At which times is it negative?



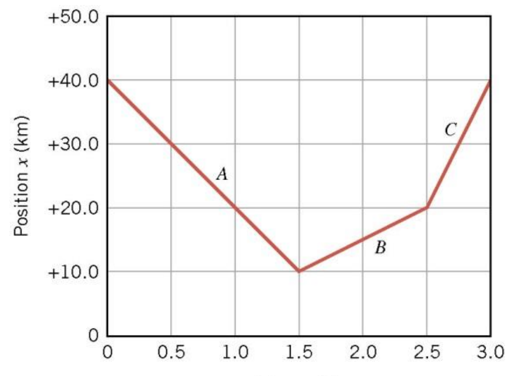
Physics 01-03 Velocity and Graphs **Name: _______________**

The spine-tailed swift is the fastest bird in powered flight. On one flight, a particular bird flies 306 m east, then turns around and flies 406.5 m back west. This flight takes 15 s. What is the bird's average velocity?

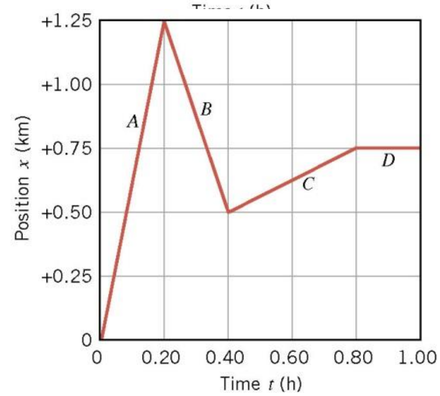
Average speed?

Which of these would we use to say how fast the bird is?

Homework



1. What is the meaning of obtaining a negative velocity?
2. (a)Draw a quick sketch of position–time graph of a ball being thrown up so that it goes up, then comes back down. (b) Describe the graph using mathematical terms.
3. A bus makes a trip according to the position–time graph shown in the drawing. What is the average velocity (magnitude and direction) of the bus during each of the segments labeled A, B, and C? Express your answers in km/h. (Cutnell 2.48)
 -20 km/h, 10 km/h, 40 km/h



4. A person who walks for exercise produces the position–time graph given with this problem. (a) Without doing any calculations, decide which segments of the graph (A, B, C, or D) indicate positive, negative, and zero average velocities. (b) Calculate the average velocity for each segment to verify your answers to part (a). (Cutnell 2.60) **6.3 km/h, -3.8 km/h, 0.63 km/h, 0 km/h**
5. What is the difference between speed and velocity?
6. (a) Does a car's odometer measure distance or displacement? (b) Does its speedometer measure speed or velocity?
7. If you divide the total distance traveled on a car trip (as determined by the odometer) by the time for the trip, (a) are you calculating the average speed or the magnitude of the average velocity? (b) Under what circumstances are these two quantities the same?
8. Land west of the San Andreas fault in southern California is moving at an average velocity of about 6 cm/y northwest relative to land east of the fault. Los Angeles is west of the fault and may thus someday be at the same latitude as San Francisco, which is east of the fault. How far in the future will this occur if the displacement to be made is 590 km northwest, assuming the motion remains constant? (OpenStax 2.8) $\mathbf{1 \times 10^7}$ **yrs**
9. Conversations with astronauts on the lunar surface were characterized by a kind of echo in which the earthbound person's voice was so loud in the astronaut's space helmet that it was picked up by the astronaut's microphone and transmitted back to Earth. It is reasonable to assume that the echo time equals the time necessary for the radio wave to travel from the Earth to the Moon and back (that is, neglecting any time delays in the electronic equipment). Calculate the distance from Earth to the Moon given that the echo time was 2.56 s and that radio waves travel at the speed of light (3.00×10^8 m/s). (OpenStax 2.13) **384,000 km**
10. A football quarterback runs 15.0 m straight forward 2.50 s. He is then hit and pushed 3.00 m straight backward in 1.75 s. He breaks the tackle and runs straight forward another 21.0 m in 5.20 s. Calculate his average velocity (a) for each of the three intervals and (b) for the entire motion. (OpenStax 2.14) **6.00 m/s, -1.71 m/s, 4.04 m/s, 3.49 m/s**
11. As the Earth rotates through one revolution, a person standing on the equator traces out a circular path whose radius is equal to the radius of the earth (6.38×10^6 m). What is the average speed of this person in meters per second? Miles per hour? (Cutnell 2.5) **464 m/s, 1040 mph**

Physics 01-04 Acceleration and Graphs   *Name:* _______________

More about Acceleration

- Acceleration is how quickly __________ is changing.

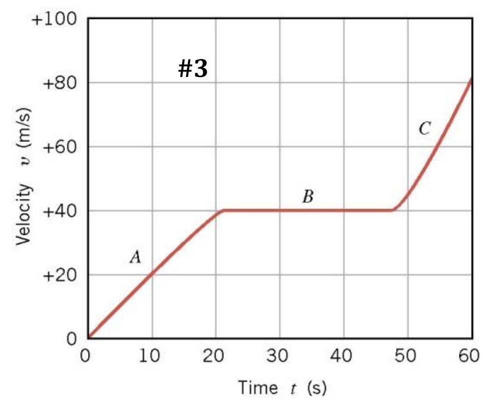
$$a = \frac{\Delta v}{\Delta t} = \frac{v - v_0}{t - t_0}$$
$$v = at + v_0$$

- Acceleration is the __________ of a ___________ vs time graph.
- Acceleration is a ___________ (has direction).
- If the velocity and acceleration are the same direction, then the object ___________________ speed.
- If the velocity and acceleration are in opposite directions, then the object ____________________ speed.
- If there is constant acceleration
  - The graph of position–time is _________________ ($x = \frac{1}{2}at^2 + v_0t + x_0$ is quadratic)
  - The graph of velocity–time is ______________ ($v = at + v_0$ is linear)

A dropped object near the earth will accelerate downward at 9.8 m/s². (Use -9.8 m/s².) If the initial velocity is 1 m/s downward, what will be its velocity at the end of 3 s? Is it speeding up or slowing down?

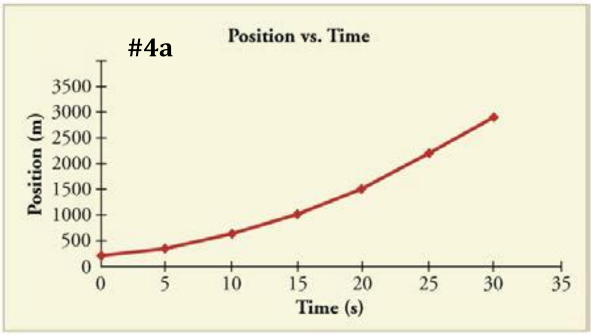
Homework

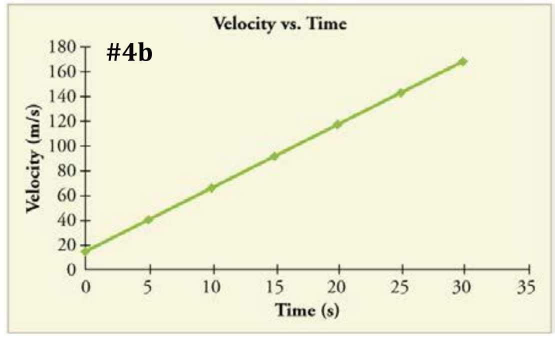
1. (a)Draw a quick sketch of velocity–time graph of a ball being thrown up so that it goes up, then comes back down. (b) Describe the graph using mathematical terms.
2. One way to find the acceleration due to gravity is to graph the position–time of a dropped object. How could you use the position–time graph to find constant acceleration?
3. A snowmobile moves according to the velocity–time graph shown in the drawing. What is the snowmobile's average acceleration during each of the segments A, B, and C? (Cutnell 2.59) **2 m/s², 0 m/s², 3.8 m/s²**



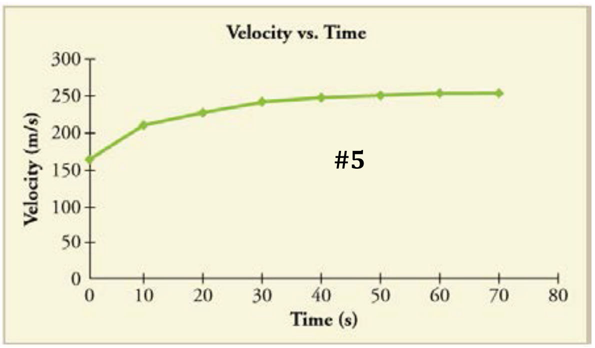
Physics 01-04 Acceleration and Graphs — *Name: _______________*

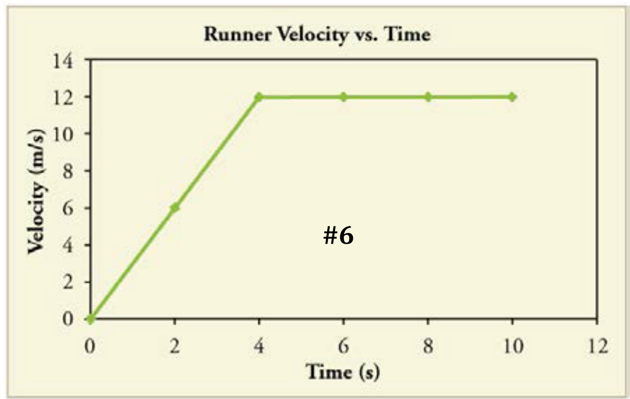
4. (a) By taking the slope of the curve in the position–time graph, verify that the velocity of the jet car is 115 m/s at t=20 s. (b) By taking the slope of the curve at any point in the velocity–time graph, verify that the jet car's acceleration is 5.0 m/s². (OpenStax 2.59)





5. By taking the slope of the curve in graph, verify that the acceleration is 3.2 m/s² at t=10 s. (OpenStax 2.62)





6. A graph of v(t) is shown for a world-class track sprinter in a 100-m race. (a) What is his average velocity for the first 4 s? (b) What is his instantaneous velocity at t=5 s? (c) What is his average acceleration between 0 and 4 s? (d) What is his time for the race? (OpenStax 2.65) **6 m/s, 12 m/s, 3 m/s², 10 s**

7. If a car is accelerating in the positive direction and is currently moving in the negative direction, (a) is it speeding up or slowing down? (b) How about if the acceleration is positive and the velocity is positive?

8. A cheetah can accelerate from rest to a speed of 30.0 m/s in 7.00 s. What is its acceleration? (OpenStax 2.16) **4.29 m/s²**

9. Dr. John Paul Stapp was U.S. Air Force officer who studied the effects of extreme deceleration on the human body. On December 10, 1954, Stapp rode a rocket sled, accelerating from rest to a top speed of 282 m/s (1015 km/h) in 5.00 s, and was brought jarringly back to rest in only 1.40 s! Calculate his (a) acceleration and (b) deceleration. Express each in multiples of g (9.80 m/s²) by taking its ratio to the acceleration of gravity. (OpenStax 2.17) **56.4 m/s², 5.76 g, -201 m/s², 20.6 g**

10. A motorcycle has a constant acceleration of 2.5 m/s². Both the velocity and acceleration of the motorcycle point in the same direction. How much time is required for the motorcycle to change its speed from (a) 21 to 31 m/s, and (b) 51 to 61 m/s? (Cutnell 2.13) **4.0 s, 4.0 s**

11. A runner accelerates to a velocity of 5.36 m/s due west in 3.00 s. His average acceleration is 0.640 m/s², also directed due west. What was his velocity when he began accelerating? (Cutnell 2.15) **3.44 m/s W**

Physics 01-05 Equations for One-Dimensional Motion with Constant Acceleration *Name: ______________*

Equations of 1-D Motion

Assume ______________, so ________________ and acceleration is ____________________

$$x = \bar{v}t + x_0$$
$$\bar{v} = \frac{v_0 + v}{2}$$
$$v = at + v_0$$
$$x = \frac{1}{2}at^2 + v_0 t + x_0$$
$$v^2 = v_0^2 + 2a(x - x_0)$$

Problem Solving Strategy

1. Examine the situation to determine which _________________________________ are involved.
   a. Maybe ________________________
2. Make a ________ of what is _____________ or can be ______________________ from the problem.
3. Identify exactly what needs to be ____________________ in the problem.
4. Find an _____________________ or set of equations that can help you solve the problem.
5. _______________________ the knowns along with their _____________ into the appropriate equation, and Solve
6. Check the answer to see if it is _________________________: Does it make sense?

A plane starting from rest accelerates to 40 m/s in 10 s. How far did the plane travel during this time?

To avoid an accident, a car decelerates at 0.50 m/s^2 for 3.0 s and covers 15 m of road. What was the car's initial velocity?

A cheetah is walking at 1.0 m/s when it sees a zebra 25 m away. What acceleration would be required to reach 20.0 m/s in that distance?

Physics 01-05 Equations for One-Dimensional Motion with Constant Acceleration *Name:* ________________

The left ventricle of the heart accelerates blood from rest to a velocity of +26 cm/s. (a) If the displacement of the blood during the acceleration is +2.0 cm, determine its acceleration (in cm/s^2). (b) How much time does blood take to reach its final velocity?

Homework

1. Is it possible for speed to be constant while acceleration is not zero? Give an example of such a situation.
2. Is it possible for velocity to be constant while acceleration is not zero? Explain.
3. Give an example in which velocity is zero yet acceleration is not.
4. An object moving with a constant acceleration can certainly slow down. But can an object ever come to a permanent halt if its acceleration truly remains constant? Explain.
5. A marble is dropped from 2.5 m and hits the ground in 0.71 s. What is the final velocity before it hits the ground? (RW) **7 m/s**
6. A jet takes off from an aircraft carrier starting from rest and travels 93 m in 1.2 s when being pushed by the catapult. What is its final velocity at takeoff? (RW) **160 m/s**
7. An Olympic-class sprinter starts a race with an acceleration of 4.50 m/s^2. (a) What is her speed 2.40 s later? (b) Write an equation for position as a function of time. (c) Sketch a graph of her position vs. time for this period. (OpenStax 2.20) **10.8 m/s**
8. Freight trains can produce only relatively small accelerations and decelerations. (a) What is the final velocity of a freight train that accelerates at a rate of 0.0500 m/s^2 for 8.00 min, starting with an initial velocity of 4.00 m/s? (b) If the train can slow down at a rate of 0.550 m/s^2, how long will it take to come to a stop from this velocity? (c) How far will it travel in each case? (OpenStax 2.29) **28.0 m/s, 50.9 s, 7680 m, 713 m**
9. A fireworks shell is accelerated from rest to a velocity of 65.0 m/s over a distance of 0.250 m. (a) How long did the acceleration last? (b) Calculate the acceleration. (OpenStax 2.30) $\mathbf{7.69 \times 10^{-3}}$ **s,** $\mathbf{8.45 \times 10^{3}}$ $\mathbf{m/s^2}$
10. A car skids to a stop to try to avoid hitting a deer. The car skids 21 m in 2.3 s. How fast was the car originally going? (RW) **18 m/s**
11. What is the final velocity of a car that starts from rest and accelerates at 3.90 m/s^2 for a distance of 100 m? (RW) **27.9 m/s**
12. A hockey puck slides across the ice with an initial velocity of 7.2 m/s. It has a deceleration of 1.1 m/s^2 and is traveling toward the goal 5.0 m away. How much time does the goalie have to stop the puck? (RW) **0.74 s**
13. If a moose can accelerate at 2.1 m/s^2 from rest, how much time will it take for it to accelerate to a speed of 4 km/h? (RW) **0.53 s**
14. When you try to stop your car in an emergency, there is some time before you can react. Your car is going 25 m/s and your reaction time is 0.20 s, then after you hit your brakes it decelerates at 9.5 m/s^2. How far will your car travel before it stops? (RW) **38 m**

Physics 01-06 Falling Objects **Name: _______________**

Free Fall

Free fall is when an object is moving only under the influence of _________________.

Ignoring air resistance, all objects fall to the earth with the ___________ acceleration due to gravity (g)

$$g = \_\_\_\_\_\_\_\_ \frac{m}{s^2} \_\_\_\_\_\_\_\_\_\_$$

_____ object thrown up, down, or dropped has this ___________.

Use the one-dimensional _______________________.

You drop a coin from the top of a hundred story building (1000 m). If you ignore air resistance, how fast will it be falling right before it hits the ground?

How long does it take to hit the ground?

A baseball is hit straight up into the air. If the initial velocity was 20 m/s, how high will the ball go?

How long will it be until the catcher catches the ball at the same height it was hit?

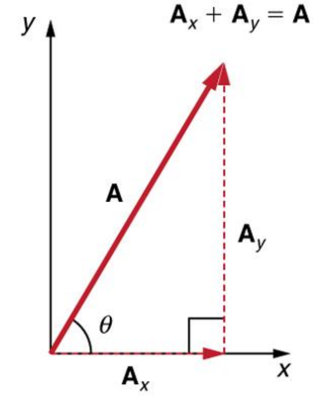
How fast is it going when catcher catches it?

Homework

1. What is the acceleration of a rock thrown straight upward on the way up? At the top of its flight? On the way down?
2. An object that is thrown straight up falls back to Earth. This is one-dimensional motion. (a) When is its velocity zero? (b) Does its velocity change direction? (c) Does the acceleration due to gravity have the same sign on the way up as on the way down?
3. A penny is dropped from rest from the top of the Willis (Sears) Tower in Chicago. Considering that the height of the building is 427 m and ignoring air resistance, find the speed with which the penny strikes the ground. (Cutnell 2.37) **91.5 m/s**
4. At the beginning of a basketball game, a referee tosses the ball straight up with a speed of 4.6 m/s. A player cannot touch the ball until after it reaches its maximum height and begins to fall down. What is the minimum time that a player must wait before touching the ball? (Cutnell 2.42) **0.47 s**
5. A basketball referee tosses the ball straight up for the starting tipoff. At what velocity must a basketball player leave the ground to rise 1.25 m above the floor in an attempt to get the ball? (OpenStax 2.43) **4.95 m/s**
6. A diver springs upward with an initial speed of 1.8 m/s from a 3.0-m board. (a) Find the velocity with which he strikes the water. (b) What is the highest point he reaches above the water? (Cutnell 2.44) **-7.9 m/s, 3.2 m**
7. (a) Calculate and graph the displacement at times of 0.500, 1.00, 1.50, 2.00, and 2.50 s for a rock thrown straight down with an initial velocity of 14.0 m/s from the Verrazano Narrows Bridge in New York City. The roadway of this bridge is 70.0 m above the water. (b) Repeat, but now calculate and graph the velocity. (OpenStax 2.42)
61.8 m, 51.1 m, 38.0 m, 22.4 m, 4.4 m; -18.9 m/s, -23.8 m/s, -28.7 m/s, -33.6 m/s, -38.5 m/s
8. A rescue helicopter is hovering over a person whose boat has sunk. One of the rescuers throws a life preserver straight down to the victim with an initial velocity of 1.40 m/s and observes that it takes 1.8 s to reach the water. (a) List the knowns in this problem. (b) How high above the water was the preserver released? *Note that the downdraft of the helicopter reduces the effects of air resistance on the falling life preserver, so that an acceleration equal to that of gravity is reasonable.* (OpenStax 2.44) **18 m**
9. A dolphin in an aquatic show jumps straight up out of the water at a velocity of 13.0 m/s. (a) List the knowns in this problem. (b) How high does his body rise above the water? To solve this part, first note that the final velocity is now a known and identify its value. Then identify the unknown, and discuss how you chose the appropriate equation to solve for it. After choosing the equation, show your steps in solving for the unknown, checking units, and discuss whether the answer is reasonable. (c) How long is the dolphin in the air? Neglect any effects due to his size or orientation. (OpenStax 2.45) **8.62 m, 2.65 s**
10. A very strong, but inept, shot putter puts the shot straight up vertically with an initial velocity of 11.0 m/s. How long does he have to get out of the way if the shot was released at a height of 2.20 m, and he is 1.80 m tall? (OpenStax 2.48) **2.28 s**
11. You throw a ball straight up with an initial velocity of 15.0 m/s. It passes a tree branch on the way up at a height of 7.00 m. How much additional time will pass before the ball passes the tree branch on the way back down? (OpenStax 2.49) **1.91 s**

Physics 01-07 Two Dimensional Vectors **Name: ______________**

Vectors



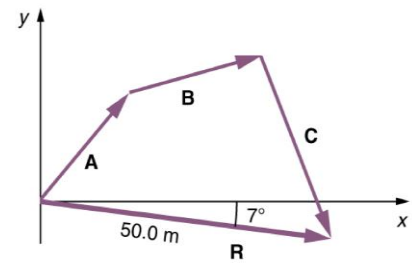
- Vectors are measurements with ________________ and ______________.
  - They are represented by _____________.
  - The length of the arrow is the _________________.
  - The direction of the arrow is the __________________.
- Can be represented in ____________________ form
  - Make a ___________________ using the vector as the ________________
  - Use _____________ and _________________ to find the horizontal (x) component and the vertical (y) component
  - Assign __________________ signs to any component going ___________ or __________
- $\sin(\theta) = \frac{opposite}{hypotenuse}$ $\cos(\theta) = \frac{adjacent}{hypotenuse}$ $\tan(\theta) = \frac{opposite}{adjacent}$

A football player kicks a ball at 15 m/s at 30° above the ground. Find the horizontal and vertical components of this velocity.

Scalar Multiplication

- Multiplying a vector by a _______________ number
- Draw the vector that many times in a ________________
- Or multiply the _______________________ by that number
- A negative vector means multiply by -1, so it goes in the ______________________ direction

Vector Addition - Graphical Method

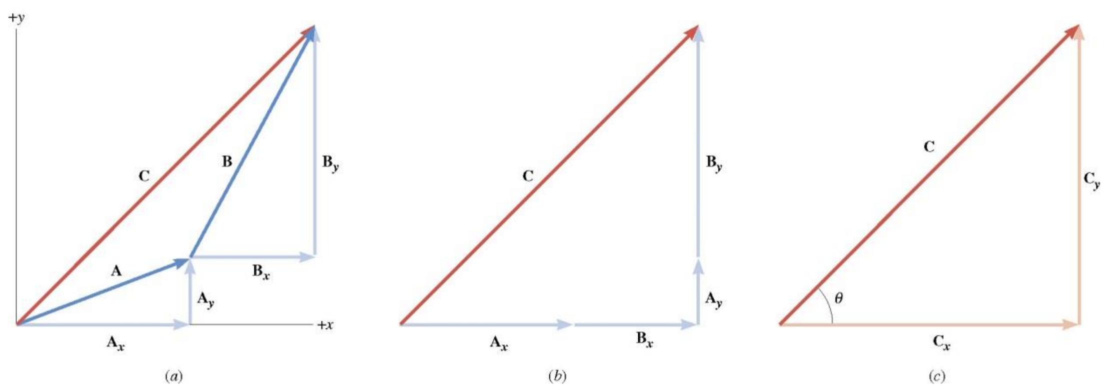


- Draw the ________________ vector.
- Draw the second vector where the ____________________________ (tip-to-tail).
- Draw the resultant vector from where the ____________ vector begins to where the ______________ vector ends.
- ______________________ the resultant's length and direction.

Add the following vectors graphically. $\boldsymbol{A} = 2\sqrt{2}$ at 45° N of E, $\boldsymbol{B} = 2\sqrt{2}$ at 45° W of N.

Vector Addition - Component Method

Vectors can be described by its _________________ to show how far it goes in the x and y directions. To add vectors, you simply add the ______________________ and ____________________ to get total (______________________) x and y components.



1. Find the _______________________ for _________ the vectors to be added
2. ______________ all the _____ components
3. ______________ all the _____ components
4. Use the ______________________ Theorem to find the ___________________ of the resultant
5. Use __________ to find the ___________________ (the direction is always found at the ________________ of the resultant)

   Note: Drawing pictures and triangles helps immensely.

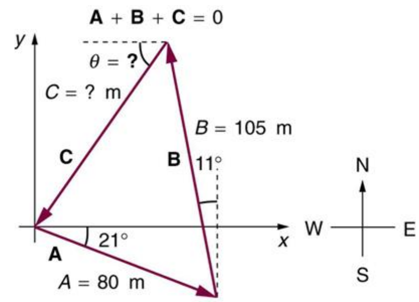
Physics 01-07 Two Dimensional Vectors *Name:* _______________

Add the follow vectors. $\boldsymbol{C} = 15\ m$ at 25° N of E; $\boldsymbol{D} = 20\ m$ at 60° S of E

A jogger runs 145 m in a direction 20.0° east of north and then 105 m in a direction 35.0° south of east. Determine the magnitude and direction of jogger's position from her starting point.

Homework

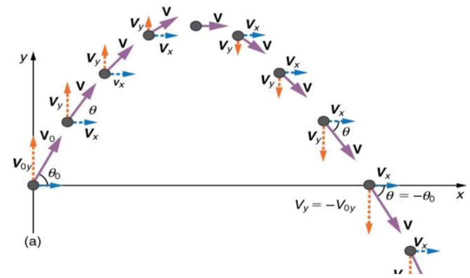
1. (a) Is it possible for one component of a vector to be zero, while the vector itself is not zero? (b) Is it possible for a vector to be zero, while one component is not zero? Explain.
2. Can two nonzero perpendicular vectors be added together so their sum is zero? Explain.
3. Can three or more vectors with unequal magnitudes be added together so their sum is zero? If so, show by means of a tip-to-tail arrangement of the vectors how this could occur.
4. Suppose you first walk 12.0 m in a direction 20° west of north and then 20.0 m in a direction 40.0° south of west. How far are you from your starting point, and what is the compass direction of a line connecting your starting point to your final position? Solve this graphically. (OpenStax 3.5) **19.5 m at 4.65° S of W**
5. An ostrich is running at a speed of 17.0 m/s in a direction of 68.0° north of west. What is the magnitude of ostrich's velocity component that is directed (a) due north and (b) due west? (RW) **15.8 m/s, 6.37 m/s**
6. An ocean liner leaves New York City and travels 18.0° north of east for 155 km. How far east and how far north has it gone? In other words, what are the magnitudes of the components of the ship's displacement vector in the directions (a) due east and (b) due north? (Cutnell 1.33) **147 km, 47.9 km**
7. A new landowner has a triangular piece of flat land she wishes to fence. Starting at the west corner, she measures the first side to be 80.0 m long and the next to be 105 m. These sides are represented as displacement vectors A and B in Figure 3.61. She then correctly calculates the length and orientation of the third side C. What is her result? (Hint: Since A + B + C = 0, then A + B = -C.) (OpenStax 3.20) **92.3 m at 53.7° S of W**



8. A golfer, putting on a green, requires three strokes to "hole the ball." During the first putt, the ball rolls 5.0 m due east. For the second putt, the ball travels 2.1 m at an angle of 20.0° north of east. The third putt is 0.50 m due north. What displacement (magnitude and direction relative to due east) would have been needed to "hole the ball" on the very first putt? (Cutnell 1.41) **7.1 m at 9.9° N of E**
9. You are on a treasure hunt and your map says, "Walk due west for 52 paces, then walk 30.0° north of west for 42 paces, and finally walk due north for 25 paces." What is the magnitude of the component of your displacement (a) due north and (b) due west? (Cutnell 1.42) **46 paces, 88 paces**
10. On a safari, a team of naturalists sets out toward a research station located 4.8 km away in a direction 42° north of east. After traveling in a straight line for 2.4 km, they stop and discover that they have been traveling 22° north of east, because their guide misread his compass. What are (a) the magnitude and (b) the direction (relative to due east) of the displacement vector now required to bring the team to the research station? (Cutnell 1.45) **2.7 km at 60° N of E**
11. While snorkeling in the ocean, you swim directly towards shore at 2 m/s. The current of the water pushes you directly sideways at 3 m/s. What is your resultant velocity (magnitude and direction relative to your intended path of straight towards shore)? (RW) **3.6 m/s at 56.3°**
12. An airplane flies at 200 km/h at 30.0° N of W. The wind blows it at 30 km/h at 45.0° E of N. What is the resultant velocity of the airplane (magnitude and direction)? (RW) **194 km/h at 38.6° N of W**
13. You are trying to row a boat directly across a river that is 50.0 m wide. You can row at 3.1 m/s in a direction directly across the river perpendicular to the shore. The current is 4.8 m/s parallel to shore. (a) What is your velocity relative to the shore? (b) How much time does it take to get to the other side of the river? (c) How far down stream do you land? (RW) **5.71 m/s at 32.9° downstream from shore, 16.1 s, 77.7 m**

Physics 01-08 Projectile Motion *Name: ___________________________*

- Objects in __________ only under influence of ____________
- x and y components are ___________________
- _______ is only quantity that is the ________ in both dimensions
- x-component velocity __________ since nothing pulling it sideways
  - Use ______________
- y-component _____________ because gravity pulling it down
  - Use ______________________
- If the starting and ending height are the ________, the distance the object goes can be found with the _________ equation.



____

A Veggie-meatball with v = 5.0 m/s rolls off a 1.0 m high table. How long does it take to hit the floor if no one sneezes?

What is its velocity when it hits the floor?

A truck (v = 11.2 m/s) turned a corner too sharp and lost part of the load. A falling box will break if it hits the ground with a velocity greater than 15 m/s. The height of the truck bed is 1.5 m. Will the box break?

While driving down a road a bad guy shoots a bullet straight up into the air. If there was no air resistance where would the bullet land in front, behind, or on him?

If a gun were fired horizontally and a bullet were dropped from the same height at the same time, which would hit the ground first?

A batter hits the ball at 35° with a velocity of 32 m/s. How high did the ball go?

How long was the ball in the air?

Physics 01-08 Projectile Motion *Name: ____________________________*

How far did the ball go?

Homework

1. Is the acceleration of a projectile equal to zero when it reaches the top of its trajectory? If not, why not?
2. A tennis ball is hit upward into the air and moves along an arc. Neglecting air resistance, where along the arc is the speed of the ball (a) a minimum and (b) a maximum? Justify your answers.
3. A tennis ball is hit upward into the air and moves along an arc. Neglecting air resistance, where along the arc is the acceleration of the ball (a) a minimum and (b) a maximum? Justify your answers.
4. A wrench is accidentally dropped from the top of the mast on a sailboat. Will the wrench hit at the same place on the deck whether the sailboat is at rest or moving with a constant velocity? Justify your answer.
5. A stone is thrown horizontally from the top of a cliff and eventually hits the ground below. A second stone is dropped from rest from the same cliff, falls through the same height, and also hits the ground below. Ignore air resistance. Discuss whether each of the following quantities is different or the same in the two cases; if there is a difference, describe the difference: (a) displacement, (b) speed just before impact with the ground, and (c) time of flight.
6. A projectile is launched at ground level with an initial speed of 50.0 m/s at an angle of 30.0° above the horizontal. It strikes a target above the ground 3.00 seconds later. What are the x and y distances where the projectile was launched to where it lands? (OpenStax 3.25) $\mathbf{1.30 \times 10^2}$ $\boldsymbol{m}$**, 30.9 m**
7. A ball is thrown horizontally from the top of a 60.0-m building and lands 100.0 m from the base of the building. Ignore air resistance. (a) How long is the ball in the air? (b) What must have been the initial horizontal component of the velocity? (c) What is the vertical component of the velocity just before the ball hits the ground? (d) What is the velocity (including both the horizontal and vertical components) of the ball just before it hits the ground? (OpenStax 3.27) **3.50 s, 28.6 m/s, - 34.3 m/s, 44.7 m/s at 50.2° below x-axis**
8. (a) A daredevil is attempting to jump his motorcycle over a line of buses parked end to end by driving up a 32º ramp at a speed of 40.0 m/s (144 km/h). How many buses can he clear if the top of the takeoff ramp is at the same height as the bus tops and the buses are 20.0 m long? (b) Discuss what your answer implies about the margin of error in this act—that is, consider how much greater the range is than the horizontal distance he must travel to miss the end of the last bus. (Neglect air resistance.) (OpenStax 3.28) **7 buses**
9. An arrow is shot from a height of 1.5 m toward a cliff of height H. It is shot with a velocity of 30 m/s at an angle of 60º above the horizontal. It lands on the top edge of the cliff 4.0 s later. (a) What is the height of the cliff? (b) What is the maximum height reached by the arrow along its trajectory? (c) What is the arrow's impact speed just before hitting the cliff? (OpenStax 3.34) **27.0 m, 36.0 m, 20 m/s**
10. The world long jump record is 8.95 m (Mike Powell, USA, 1991). Treated as a projectile, what is the maximum range obtainable by a person if he has a take-off speed of 9.5 m/s? State your assumptions. (OpenStax 3.36) **9.21 m**
11. An eagle is flying horizontally at a speed of 3.00 m/s when the fish in her talons wiggles loose and falls into the lake 5.00 m below. Calculate the velocity of the fish relative to the water when it hits the water. (OpenStax 3.40) **10.3 m/s, 73.1° below the horizontal**
12. Can a goalkeeper at his goal kick a soccer ball into the opponent's goal without the ball touching the ground? The distance will be about 95 m. A goalkeeper can give the ball a speed of 30 m/s. (OpenStax 3.43) **91.8 m, No**
13. A tennis ball is struck such that it leaves the racket horizontally with a speed of 28.0 m/s. The ball hits the court at a horizontal distance of 19.6 m from the racket. What is the height of the tennis ball when it leaves the racket? (OpenStax 3.14) **2.40 m**
14. A diver runs horizontally with a speed of 1.20 m/s off a platform that is 10.0 m above the water. What is his speed just before striking the water? (RW) **14.1 m/s**
15. The 1994 Winter Olympics included the aerials competition in skiing. In this event skiers speed down a ramp that slopes sharply upward at the end. The sharp upward slope launches them into the air, where they perform acrobatic maneuvers. In the women's competition, the end of a typical launch ramp is directed 63° above the horizontal. With this launch angle, a skier attains a height of 13 m above the end of the ramp. What is the skier's launch speed? (Cutnell 3.24) **18 m/s**

Physics

Unit 1: Introduction and Kinematics Review

1. *Know about scientific method, units, fundamental units, unit prefixes, precision, accuracy, significant figures, vectors, scalars*
2. *Convert 120 Tm to m*
3. *In the process of delivering milk, a milkman, walks 100 m due east from his truck. He then turns around and walks 20 m due west. What is the milkman's displacement relative to his truck (magnitude and direction)? What distance did he travel?*
4. *A pigeon flew 10 km across town with an average speed of 5 m/s. How long, in hours, did it take the pigeon to make this journey?*
5. *A car, starting from rest, accelerates in a straight-line path at a constant rate of 2 m/s^2. How far will the car travel in 10 seconds?*
6. *The minimum takeoff speed for a certain airplane is 50 m/s. What minimum acceleration is required if the plane must leave a runway of length 2000 m? Assume the plane starts from rest at one end of the runway.*
7. *Water drips from rest from a leaf that is 2 m above the ground. Neglecting air resistance, what is the speed of each water drop when it hits the ground?*
8. *What maximum height will be reached by a stone thrown straight up with an initial speed of 5 m/s?*
9. *A cheetah is walking at a speed of 0.5 m/s when it observes a gazelle 15 m directly ahead. If the cheetah accelerates at 3 m/s^2, how long does it take the cheetah to reach the gazelle if the gazelle doesn't move?*
10. *Be able to read graphs and calculate speed, velocity, and acceleration from them.*
11. *A jumper in the long-jump goes into the jump with a speed of 5 m/s at an angle of 20° above the horizontal. What is the jumper's horizontal speed as they jump? What is their vertical speed?*
12. *A sailboat leaves a harbor and sails 21 km in the direction 15° north of east, where the captain stops for lunch. A short time later, the boat sails 2 km in the direction 75° south of east. What is the magnitude of the resultant displacement?*
13. *An eagle is flying due east at 5 m/s carrying a gopher in its talons. The gopher manages to break free at a height of 50 m. What is the magnitude of the gopher's velocity as it reaches the ground?*
14. *A ball is thrown horizontally from the top of a 100 m tall building with an initial speed of 5 m/s. How far from the base of the building did the ball land?*
15. *A swimmer swims with a velocity of 15 m/s south relative to the water. The current of the water is 2 m/s relative to the shore. If the current is moving west, what is the velocity of the swimmer relative to the shore?*

3. *Displacement:* $100\ m - 20\ m = \mathbf{80\ m}$;
Distance: $100\ m + 20\ m = \mathbf{120\ m}$

4. $\overline{v} = 5\frac{m}{s}, \Delta x = 10\ km$
Convert: $\frac{10\ km}{}\left(\frac{10^3\ m}{1\ km}\right) = 10000\ m$
$\overline{v} = \frac{\Delta x}{\Delta t}$
$5\frac{m}{s} = \frac{10000\ m}{t}$
$t = \frac{10000\ m}{5\frac{m}{s}} = \mathbf{2000\ s}$
Convert: $\frac{2000\ s}{}\left(\frac{1\ h}{3600\ s}\right) = 0.56\ h$

5. $a = 2\frac{m}{s^2}, t = 10\ s, v_0 = 0\frac{m}{s}, x = ?$
$x = x_0 + v_0 t + \frac{1}{2}at^2$
$x = 0\ m + \left(0\frac{m}{s}\right)(10\ s) + \frac{1}{2}\left(2\frac{m}{s^2}\right)(10\ s)^2$
$x = \mathbf{100\ m}$

6. $v = 50\frac{m}{s}, x = 2000\ m, v_0 = 0\frac{m}{s}, a = ?$
$v^2 = v_0^2 + 2a(x - x_0)$
$\left(50\frac{m}{s}\right)^2 = \left(0\frac{m}{s}\right)^2 + 2a(2000\ m - 0\ m)$
$2500\frac{m^2}{s^2} = (4000\ m)a$
$a = \mathbf{0.625\ m/s^2}$

7. $y_0 = 2\ m, v_0 = 0\frac{m}{s}, a = -9.8\frac{m}{s^2}, v = ?$
$v^2 = v_0^2 + 2a(y - y_0)$
$v^2 = \left(0\frac{m}{s}\right)^2 + 2\left(-9.8\frac{m}{s^2}\right)(0\ m - 2\ m)$
$v^2 = 39.2\frac{m^2}{s^2}$
$v = \mathbf{6.26\frac{m}{s}}$

8. $v_0 = 5\frac{m}{s}, v = 0\frac{m}{s}, a = -9.8\frac{m}{s^2}, y = ?$
$v^2 = v_0^2 + 2a(y - y_0)$
$\left(0\frac{m}{s}\right)^2 = \left(5\frac{m}{s}\right)^2 + 2\left(-9.8\frac{m}{s^2}\right)(y - 0\ m)$
$-25\frac{m^2}{s^2} = \left(-19.6\frac{m}{s^2}\right)y$
$y = \mathbf{1.28\ m}$

9. $v_0 = 0.5\frac{m}{s}, x = 15\ m, a = 3\frac{m}{s^2}, t = ?$
$x = x_0 + v_0 t + \frac{1}{2}at^2$
$15\ m = 0\ m + \left(0.5\frac{m}{s}\right)t + \frac{1}{2}\left(3\frac{m}{s^2}\right)t^2$
$0 = \left(\frac{3}{2}\frac{m}{s^2}\right)t^2 + \left(0.5\frac{m}{s}\right)t - 15\ m$
$t = \frac{-0.5 \pm \sqrt{(0.5)^2 - 4\left(\frac{3}{2}\right)(-15)}}{2\left(\frac{3}{2}\right)} = \mathbf{3\ s}, \cancel{-3.33\ s}$

11. *Horizontal:* $v_{0x} = 5\frac{m}{s}\cos 20° = \mathbf{4.70\frac{m}{s}}$
Vertical: $v_{0y} = 5\frac{m}{s}\sin 20° = \mathbf{1.71\frac{m}{s}}$

12.

	x	*y*
21 km @ 15° N of E	*20.28*	*5.44*
2 km @ 75° S of E	*0.52*	*-1.93*
	20.80	*3.51*

$r = \sqrt{20.80^2 + 3.51^2} = 21.1\ km$
$\theta = tan^{-1}\frac{3.51}{20.80} = 9.67°\ N\ of\ E$

13. $x: v_{0x} = 5\frac{m}{s}, y: v_{0y} = 0\frac{m}{s}, y_0 = 50\ m, a_y = -9.8\frac{m}{s^2}, y = 0\ m, v_y = ?$
$v_y^2 = v_{0y}^2 + 2a_y(y - y_0)$
$v_y^2 = \left(0\frac{m}{s}\right)^2 + 2\left(-9.8\frac{m}{s^2}\right)(0\ m - 50\ m)$
$v_y^2 = 980\frac{m}{s}$
$v_y = 31.30\frac{m}{s}$
combine: $v = \sqrt{v_x^2 + v_y^2}$
$v = \sqrt{\left(5\frac{m}{s}\right)^2 + \left(31.30\frac{m}{s}\right)^2} = \mathbf{31.7\ m/s}$

14. $x: v_{0x} = 5\frac{m}{s}, x = ?;\ y: y_0 = 100\ m, y = 0\ m, a = -9.8\frac{m}{s^2}, v_{0y} = 0\frac{m}{s}$
find t: $y = y_0 + v_{0y}t + \frac{1}{2}at^2$
$0\ m = 100\ m + \left(0\frac{m}{s}\right)t + \frac{1}{2}\left(-9.8\frac{m}{s^2}\right)t^2$
$-100\ m = \left(-4.9\frac{m}{s^2}\right)t^2$
$20.41\frac{m^2}{s^2} = t^2$
$t = \mathbf{4.52\ s}$
find x: $x = x_0 + v_{0x}t$
$x = 0 + \left(5\frac{m}{s}\right)(4.52\ s) = \mathbf{22.6\ m}$

15. $v_{SW} = 15\frac{m}{s}\ South, v_{WG} = 2\frac{m}{s}\ West$
$v_{SG} = v_{SW} + v_{WG}$

	x	*y*
15 m/s S	*0*	*-15*
2 m/s W	*-2*	*0*
	-2	*-15*

$v_{SG} = \sqrt{(-2)^2 + (-15)^2} = 15.1\ m/s$
$\theta = tan^{-1} - \frac{15}{-2} = 82.4°$
$v_{SG} = \mathbf{15.1\frac{m}{s}\ at\ 82.4°\ S\ of\ W}$