

Problem Set 2
(due Friday, January 19)

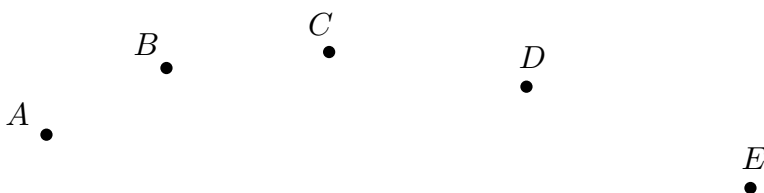
1. The world's land speed record was set by Colonel John P. Stapp when, on March 19, 1954, he rode a rocket-propelled sled that moved along a track at 1020 km/hr. He and the sled were brought to a stop in 1.4 s. What acceleration did he experience? Express your answer both in SI units (m/s^2) and in units of g .
2. A startled armadillo leaps upward, rising 0.544 m in 0.200 s. (a) What was its initial speed? (b) What is its speed at this height? (c) How much higher does it go?
3. A car is driven east for 50 km, then north for 30 km, and then in a direction 30° north of east for 25 km. Draw a vector diagram showing these motions, and determine the total displacement of the car from its starting point.
4. Vector \vec{a} has a magnitude of 5.0 units and is directed east. Vector \vec{b} is directed 35° west of north and has a magnitude of 4.0 units. Use a ruler and a protractor to construct vector diagrams showing $\vec{a} + \vec{b}$ and $\vec{b} - \vec{a}$. Measure the magnitude and direction of the resulting vector in each case.
5. Find the x and y components of the vector \vec{A} shown below, given that $|\vec{A}| = 2.4$ meters and $\phi = 34^\circ$. (The figure is not to scale, so use formulas instead of graphical methods.)



6. If $\vec{a} - \vec{b} = 2\vec{c}$ and $\vec{a} + \vec{b} = 4\vec{c}$ and $\vec{c} = (3, 4)$, then what are \vec{a} and \vec{b} ?
7. Is it always true that $|\vec{a} + \vec{b}| = |\vec{a}| + |\vec{b}|$? If so, explain why. If not, give a counter-example.
8. Just as a sequence of English words may or may not be a grammatically correct sentence, an arrangement of mathematical symbols may or may not be potentially meaningful. Some of the following equations are meaningful (whether or not they are true), while others are meaningless—there is no clear way to interpret what they are trying to say. Determine which ones are meaningless, and for each, explain in a sentence what the problem is. (Any symbol with an arrow represents a vector, while any symbol without an arrow represents a scalar. Symbols with subscripts represent the components of corresponding vectors. Pay no attention to what the symbols might actually stand for, or to whether the intended statements are true!)

$$\vec{a} = \frac{|\vec{v}|^2}{R} \quad \vec{F} = m\vec{a} \quad F_x = ma_y \quad m = \frac{\vec{F}}{\vec{a}} \quad \Delta x = \frac{1}{2}\vec{g}t^2$$

9. While driving around a curve that bends to your left, you suddenly brake to a stop. What is the direction of your acceleration vector as you are braking? (Draw a sketch showing the car and its acceleration vector, as seen from above.)
10. A ball is suspended from a string to make a simple pendulum. Draw a sketch of the arc of the pendulum swinging back and forth. Along the arc, draw arrows indicating the direction of the ball's acceleration vector at various points, including the top of the swing, the bottom of the arc, and at least one intermediate point (as the ball is on its way down).
11. A baseball is thrown with an initial velocity of $v_x = 10$ m/s, $v_y = 15$ m/s (where x is a horizontal direction and y is upward). Air resistance is negligible. When the baseball reaches the top of its trajectory, what are its velocity and acceleration vectors?
12. A "stroboscopic" image of the motion of an object is shown below. The image is shown at actual size, and the time interval between dots is $1/20$ second. Construct arrows representing the velocity of this object at times B and D , using a scale in which 1 cm (on paper) corresponds to a speed of 10 cm/s. Then construct an arrow showing the direction of the object's acceleration at point C , and determine the magnitude of the acceleration of the object at that point.



Study Guide

You should be able to:

- Add, subtract, negate, and scalar-multiply vectors, both graphically and in terms of components.
- Compute vector components from magnitude and angle, and vice-versa.
- Accurately draw velocity and acceleration vectors for any type of motion.