2 Estimations and Unit Analysis

1. Suppose you are standing at the edge of a canyon. You clap, and here the sound of the echo off of the other side of the canyon wall about 1.5 seconds later. You estimate the canyon wall to be about 0.25 km away. 1. What is the speed of sound in meters per second? 2. What is it in kilometers per hour?

   - A: 660 m/s, 2400 km/hr
   - B: 330 m/s, 100 km/hr
   - C: 330 m/s, 1200 km/hr
   - D: 660 m/s, 1200 km/hr

   Speed of Sound = 343 m/s

   $\frac{343}{1000} = 0.343$ km/s $\cdot 60 \cdot 60$

   $= 1234.8$ km/hr

2. What is 0.25 m^3 in cm^3?

   - A: 25 cm^3, 360 m/s
   - B: 250,000 cm^3, 28 m/s
   - C: 2,500 cm^3, 28 m/s
   - D: 25,000 cm^3, 360 m/s

   $m^3 \rightarrow cm^3$

   you times it by 1,000,000 or move decimal 6 times

   0.250000

3. What is 100 km/hour in m/s?

   - A: 360 m/s
   - B: 28 m/s
   - C: 10 m/s
   - D: 1200 m/s

   $100 \cdot 1000 = 100{,}000$ m/hr $/60/60 = 27.77\ldots$

4. A long tube from a construction site has a volume of 0.001 m^3, and a mass of 9 kg. Convert the numbers to a density and determine the substance.

   - A: 19 g cm^{-3}, tungsten
   - B: 9.0 g cm^{-3}, copper
   - C: 2.7 g cm^{-3}, aluminum
   - D: 7.9 g cm^{-3}, iron

   $0.001 m^3 \cdot 1{,}000{,}000 = 1{,}000\ cm^3$

   $9\ kg = 9000\ g$

   $\frac{9000}{1000} = 9$ g/cm^3

3 Vectors

1. $\vec{x}_1$ is a vector with a magnitude of 10 meters and that makes an angle of 30 degrees above the x-axis. What is $\vec{x}_1$ in component form?

   - A: $\vec{x}_1 = 5\sqrt{3}\hat{i} + 5\hat{j}$
   - B: $\vec{x}_1 = \frac{5}{\sqrt{2}}\hat{i} + \frac{5}{\sqrt{2}}\hat{j}$
   - C: $\vec{x}_1 = 5\hat{i} + 5\hat{j}$
   - D: $\vec{x}_1 = 5\sqrt{3}\hat{i} - 5\hat{j}$

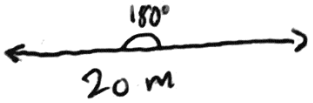
   $\sin(30) \cdot 10 = y$ $\quad y = 5$

   $\cos(30) \cdot 10 = x$ $\quad x = 8.66$ or $5\sqrt{3}$

2. $\vec{x}_2$ is a vector with magnitude 20 meters that makes an angle of 180.0 degrees with respect to the x-axis. What is $\vec{x}_2$ in component form?

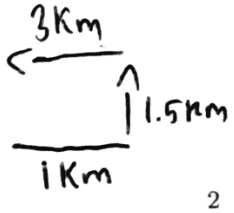
   - A: $\vec{x}_1 = 20\hat{j}$
   - B: $\vec{x}_1 = 20\hat{i}$
   - C: $\vec{x}_1 = 10\hat{i} + 10\hat{j}$
   - D: $\vec{x}_1 = -20\hat{i}$

   not sure if it is left or right of the orgin tho

3. A person goes for a walk. First, they head East for two blocks. Next, they head North for three blocks. Finally, they head West for six blocks. If a block is 500 meters, what is their final location?

   - A: $\vec{x} = -4\hat{i} + 3\hat{j}$ (km)
   - B: $\vec{x} = 2\hat{i} + 2\hat{j}$ (km)
   - C: $\vec{x} = -2\hat{i} + 1.5\hat{j}$ (km)
   - D: $\vec{x} = 8\hat{i} + 1.5\hat{j}$ (km)

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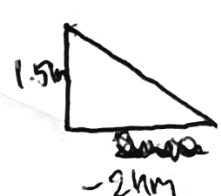
   

4 Motion Along a Straight Line

1. The position of a particle moving along the x-axis is given by $x(t) = 2.0t - 1$ (m). Which of the following is true?

   linear position graph = Constant V

   - A: The particle has a positive acceleration.
   - B: The particle is stationary.
   - C: The particle has a negative acceleration.
   - D: The particle has a positive, constant velocity.

2. (Same $x(t)$ as previous question). What is the velocity, if time is measured in seconds?

   Slope of position graph = Velocity

   - A: 2 m/s
   - B: 3 m/s
   - C: 4 m/s
   - D: -1 m/s

3. A particle moves along the x-axis according to $x(t) = -2t + 7t^2$. What is the average velocity between $t = 0$ and $t = 2$ seconds?

   $x(0) = 0$
   $x(2) = 24$
   $\frac{24-0}{2-0} = \frac{24}{2} = 12$ m/s

   - A: 4 m/s
   - B: 8 m/s
   - C: 12 m/s
   - D: 16 m/s

4. (Same $x(t)$ as previous question). What is the average acceleration of the particle between $t = 0$ and $t = 2$ seconds?

   $x(t) = -2t + 7t^2$
   $v / x'(t) = -2 + 14t$
   $a / x''(t) = 14$

   - A: 10 m/s
   - B: 14 m/s^2
   - C: 12 m/s^2
   - D: 7 m/s^2

5. A sprinter has a constant acceleration of 5.0 m/s^2. Suppose she starts from rest.

   (a) How long does it take her to reach her top speed of 10.0 m/s?

   5 m/s at 1 second 10 m/s at 2 seconds

   - A: 1 second
   - B: 2 seconds
   - C: 3 seconds
   - D: 4 seconds

   (b) What is her displacement at that time?

   - A: 5 meters
   - B: 10 meters
   - C: 15 meters
   - D: 20 meters

   (c) Suppose she is running the 100 meter sprint. If she continues at 10.0 m/s for the remainder of the race, what will be her total time?

   Since she took 2 seconds to reach 10m

   90m left at 10 m/s would take

   9 seconds, so, 2+9 = 11 seconds

   - A: 9 seconds
   - B: 10 seconds
   - C: 11 seconds
   - D: 12 seconds

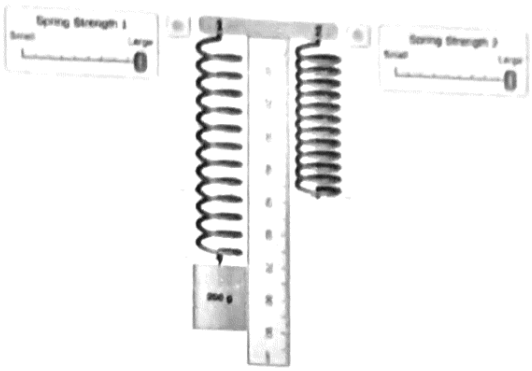
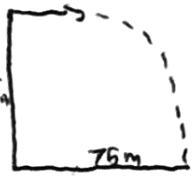


Figure 1: Two identical springs are shown, each having the same spring constant, k. The left-hand spring has 250 grams hung from it. The ruler and dashed lines show the stretched and un-stretched lengths.

5 Motion in Two and Three Dimensions

1. The world record highest basketball shot was made from a height of 162.5 meters above the basketball hoop. The basketball hoop was placed 75 meters horizontally from the shooter. What is the horizontal velocity required to make the shot? That is, assume the shooter shoots the ball with no vertical velocity, only horizontal.

   - A: 5 m/s
   - B: 13 m/s
   - C: 18 m/s
   - D: 25 m/s

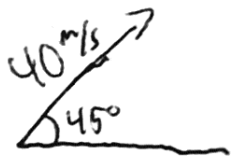


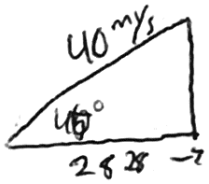
$Y = \frac{1}{2}9.81(t^2) + 0(t) + 162.5$ $\quad t = 5.75$

$-162.5 = \frac{1}{2}9.81(t^2)$ $\quad \frac{2(-162.5)}{9.81} = t$ $\quad \frac{75m}{5.75s} = 13\,m/s$

2. A baseball is hit at a 45 degree angle with respect to the horizontal at 40 m/s. How far away does it land?

   - A: 120 m
   - C: 160 m
   - D: 200 m





$V_{ix} = 28.28\,m/s$

3. How long is it in the air?

   - B: 5.5 seconds
   - C: 2.5 seconds
   - D: 10 seconds

$t = \frac{2(28.28)}{9} = 5.76$

$28.28\,m/s \cdot 5.5\,sec = 155$

$5.76 \cdot V_x = 5.76 \cdot 28.28 = 163.05$

6 Forces

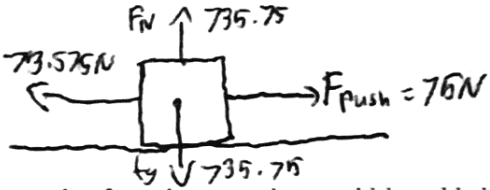
1. Consider Fig. 1. What is the spring constant of these springs?

   - A: 6 N/m
   - B: 8 N/m
   - C: 10 N/m
   - D: 12 N/m

$S = -k\Delta\bar{x}$ $\quad -k = \frac{S}{20}$ $\quad -k = \frac{250}{20}$ $\quad = 12.5\,N/m$

2. A man pushes a palette crate across his shop. He pushes with a force of 75 N. The mass of the crate is 75 kg. The coefficient of friction between the crate and the floor is 0.1. What is the acceleration of the crate?

   - A: 0 m/s^2
   - B: 1 m/s^2
   - C: 2 m/s^2
   - D: 3 m/s^2



$F_{net} = 75N - 73.5N = 1.5N$

$F = ma$ $\quad \frac{1.5}{75} = \frac{75(a)}{75}$ $\quad \frac{1.5}{75} = 0.02\,m/s^2$

3. **Bonus** What is an example of a substance that could be added to the floor that would boost the acceleration?