SOLUTIONS

Worksheet 1: Math review and 1D motion

1 Sig Figs and Scientific Notation

1.1 How many significant figures does each of the following numbers have?

a. 6.21 3

b. 62.1 3

c. 6210 3

d. 6210.0 5

e. 0.062 2

f. 0.620 3

g. 0.62 2

h. .62 2

i. 1.062 4

j. 6.21×10^3 3

k. 6.21×10^{-3} 3

l. 62.1×10^3 3

1.2 Compute the following numbers with the correct number of sig figs:

a. $33.3 \times 25.4 =$ 846

b. $33.3 - 25.4 =$ 7.9

c. $33.3 \div 45.1 =$ 0.738

d. $2.345 \times 3.321 =$ 7.788

e. $(4.32 \times 1.23) - 5.1 =$ 0.2

f. $33.3^2 =$ 1110

1.3 Express the following numbers and computed results in scientific notation

a. 9,827 9.827×10^3

b. 0.0000000550 5.50×10^{-8}

c. 3,200,000 3.2×10^6

d. $32,041 \times 47 =$ 1.5×10^6

e. $0.059 \div 2,304 =$ 2.6×10^{-5}

f. $320. \times 0.050 =$ 1.6×10^1

2 Algebra Review:

2.1 Simplify or solve each:

a. $\frac{10^2}{(10^3)^2}$ $\boxed{10^{-4}}$

b. $\frac{(10^2)^9}{(10^2)^{10}}$ 10^{-2}

c. $\frac{(10^2)^{10}}{10^{20}}$ 1

d. $\frac{10^9}{(10^4)^2}$ 10

$mv^2 r = \mu mg$

e. Solve for a: $y = v_0 t + \frac{1}{2}at^2$

$a = \frac{2}{t^2}(y - v_0 t)$

f. Solve for g: $T = 2\pi\sqrt{\frac{L}{g}}$

$g = \frac{4\pi^2 L}{T^2}$

g. Solve for μ: $\cancel{\frac{mv^2}{r} = \mu mg}$

$\mu = \frac{v^2 r}{g}$

2.2 Solving systems of equations

$$\text{A)}\ h = h_0 + v_0 t - \frac{1}{2}gt^2, \qquad \text{B)}v^2 = v_0^2 - 2gh, \qquad \text{C)}v = v_0 - gt$$

1) You are given v_0, h_0, and g and the equations above. Do you have enough equations to solve for v? Can you do it with two equations? With one? Solve for v:

Yes you can solve for v. You have to use all three.

$$v^2 = v_0^2 - 2g\left[h_0 + v_0\left(\frac{v_0 - v}{g}\right) - \frac{1}{2}g\left(\frac{v_0 - v}{g}\right)^2\right]$$

2) You are given v, t, and g. Do you have enough equations to solve for h? Can you do it with two equations? With one? Solve for h:

You can solve for h with Equations B and C:

$v_0 = v - gt \longrightarrow v^2 = (v - gt)^2 - 2gh$ Solve for h

arrange (C) plug into (B)

$$\boxed{h = \frac{(v-gt)^2 - v^2}{2g}}$$

3 SI Units and Dimensional analysis:

3.1 Convert the following to SI units. Work across the line and show all steps in the conversion. Use scientific notation and apply the proper use of significant figures.

a. 9.12 μs $\times$ $\frac{1\text{s}}{10^6 \mu s} = \mathbf{9.12 \times 10^{-6}s}$

b. 3.42 km $\times$ $\frac{10^3 m}{1 km} = \boxed{3.42 \times 10^3 m}$

c. 44 cm/ms $\times$ $\frac{10^3 ms}{1 s} \times \frac{1 m}{10^2 cm} = \boxed{440\ m/s}$

d. 80 km/hr $\times$ $\frac{10^3 m}{1 km} \times \frac{1 hr}{3600 s} = \boxed{22\ m/s}$

e. 8 in $\times$ $\frac{2.54 cm}{1 in} \times \frac{1 m}{10^2 cm} = \boxed{0.2\ m}$

f. 13 in^2 $\times$ $\left(\frac{2.54 cm}{1 in}\right)^2 \times \left(\frac{1 m}{10^2 cm}\right)^2 = \boxed{8.3 \times 10^{-3} m^2}$

g. 250 cm^3$\times$ $\left(\frac{1}{10^2 cm}\right)^3 = \boxed{2.5 \times 10^{-4} m}$

3.2 **Determine which of the following statements are *reasonable*:**

a. Joe is 180 cm tall. **1.80 m ≈ 6 ft tall, which is <u>reasonable</u>**

b. I rode my bike to campus at a speed of 50 m/s ≈ 120 mph not reasona

c. A skier reaches the bottom of the hill going 25 m/s ≈ 60 mph reasonabl

d. I can throw a ball a distance of 2 km not reasonable

e. I can throw a ball at a speed of 50 km/hr ≈ 30 mph reasonable

3.3 **Use the following dimensions for variables to determine which equations are valid:**

$[x] = [L]$, $[m] = [M]$, $[v] = [L]/[T]$, $[t] = [T]$, $[a] = [L]/[T]^2$, $[A] = [L]^2$,

$[E] = [M][L]^2/[T]^2$, $[F] = [M][L]/[T]^2$, $[p] = [M][L]/[T]$, $[P] = [M][L]^3/[T]^2$

$x = vt$ $\quad [L] = \frac{[L]}{[T]} \cdot [T] = [L]$, **which is *valid***

$x = \frac{1}{2}at^2$ $\quad [L] = \frac{1}{2}\frac{[L]}{[T]^2}[T]^2$ $\quad \boxed{\text{valid}}$

$v^2 = x + ax$ $\quad \left(\frac{[L]}{[T]}\right)^2 \neq [L] + \frac{[L]}{[T]^2}[L]$ $\quad \boxed{\text{not valid}}$

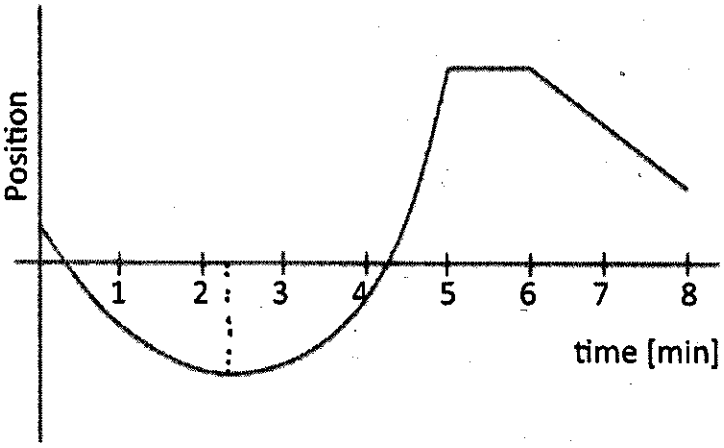
$v = at$ $\quad \frac{[L]}{[T]} = \frac{[L]}{[T]^2}[T]$ $\quad \boxed{\text{Valid}}$

$F = ma$ $\quad \frac{[M][L]}{[T]^2} = [M]\frac{[L]}{[T]^2}$ $\quad \boxed{\text{valid}}$

$E = Fx$ $\quad \frac{[M][L]^2}{[T]^2} = \frac{[M][L]}{[T]^2}[L]$ $\quad \boxed{\text{valid}}$

$E = \frac{1}{2}p^2x$ $\quad \frac{[M][L]^2}{[T]^2} \neq \frac{[M]^2[L]^2}{[T]^2}[L]$ $\quad \boxed{\text{not valid}}$

4 Reading graphs



1. During what time interval is there acceleration? 0-5 min

2. During what time interval is there zero velocity? 5-6 min

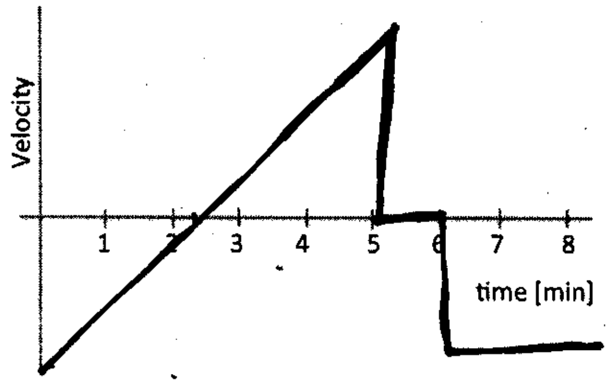
3. At what instant is velocity zero but acceleration nonzero? t = 2.25 min

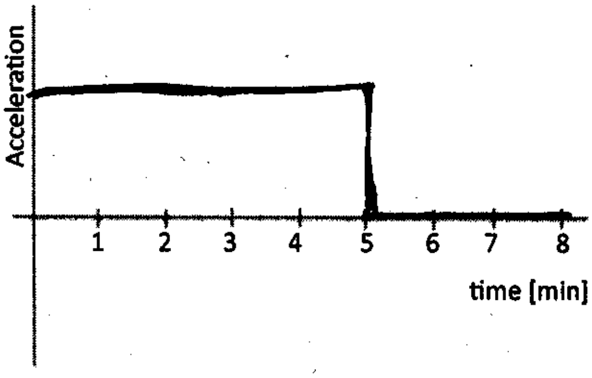
4. During what time interval is there the highest speed? 4-5 min

5. During what time interval is there slow down? 0 min – 2.25 min

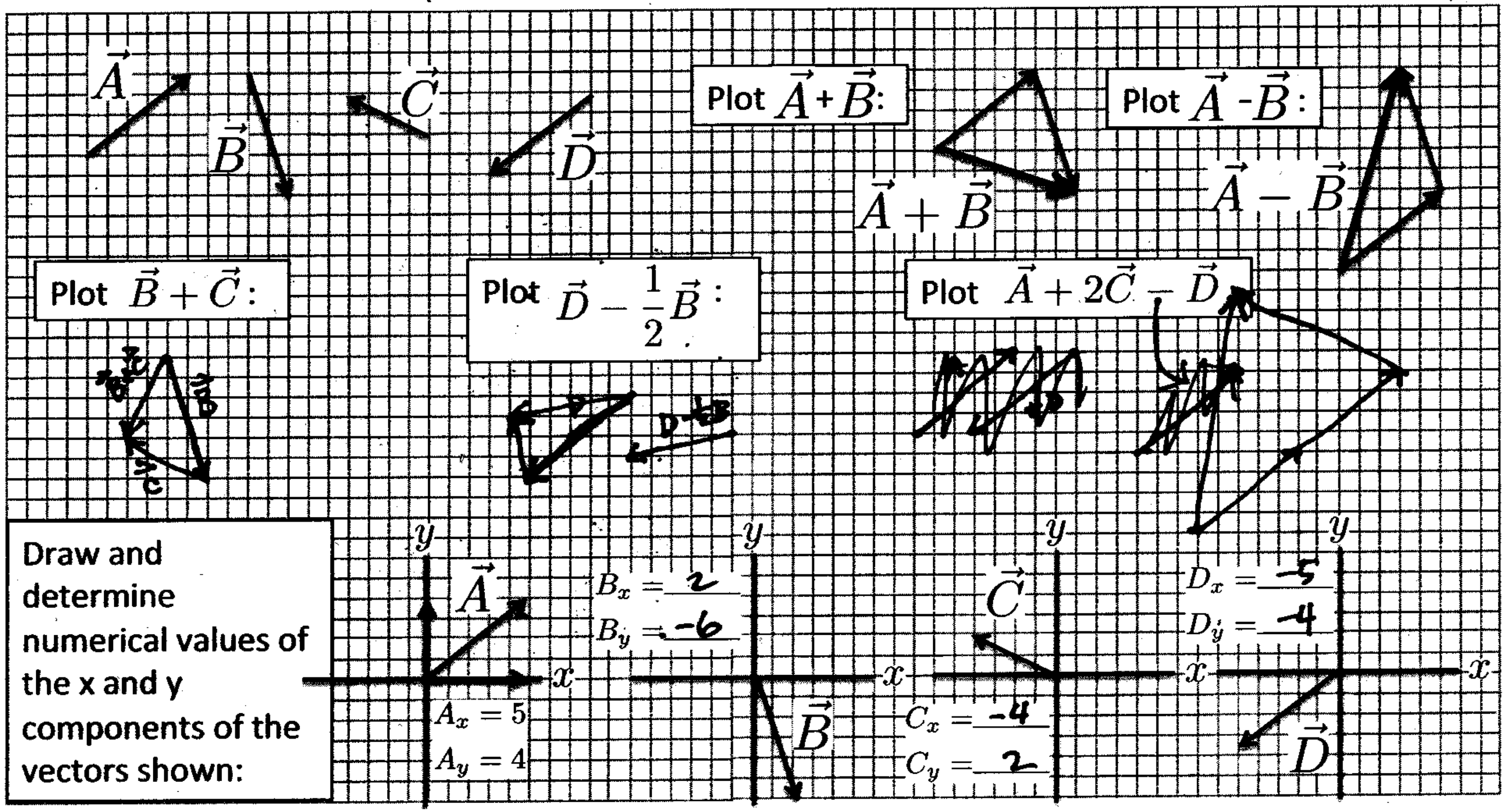
6. During what time interval is there speeding up? 2.25 min – 5 min

7. Do your best to sketch graphs for velocity and acceleration



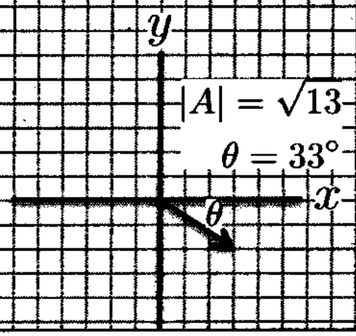


3. Vectors


$\vec{A}$
$\vec{B}$
$\vec{C}$
$\vec{D}$
Plot $\vec{A}+\vec{B}$:
$\vec{A}+\vec{B}$
Plot $\vec{A}-\vec{B}$:
$\vec{A}-\vec{B}$
Plot $\vec{B}+\vec{C}$:
$\vec{B}$
$\vec{C}$
Plot $\vec{D}-\frac{1}{2}\vec{B}$:
Plot $\vec{A}+2\vec{C}-\vec{D}$
Draw and determine numerical values of the x and y components of the vectors shown:
$A_x = 5$
$A_y = 4$
$B_x = 2$
$B_y = -6$
$C_x = -4$
$C_y = 2$
$D_x = -5$
$D_y = -4$
x
y

-Draw the vector on the axes provided.
-Draw and label an angle θ to describe the direction of the vector.
-Find the magnitude and direction of the vector.

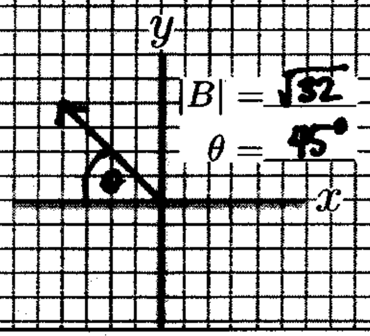
$A_x = 3, A_y = -2$



$|A| = \sqrt{13}$

$\theta = 33°$

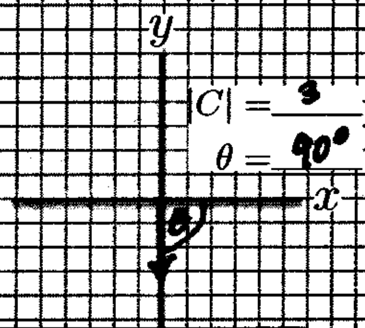
$B_x = -4, B_y = 4$



$|B| = \sqrt{32}$

$\theta = 45°$

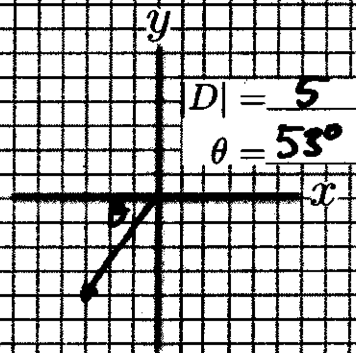
$C_x = 0, C_y = -3$



$|C| = 3$

$\theta = 90°$

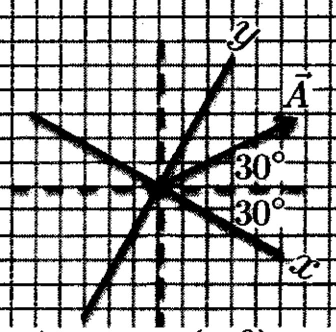
$D_x = -3, D_y = -4$



$|D| = 5$

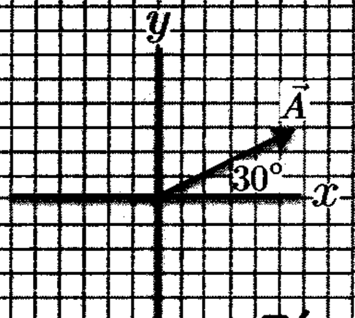
$\theta = 53°$

-Define vector A with magnitude=5, 30° above the horizontal.
-Determine A_x and A_y in each coordinate system.



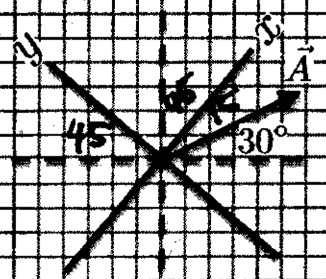
$A_x = 5\cos(60°) = 5/2$

$A_x = 5\sin(60°) = 5\sqrt{3}/2$



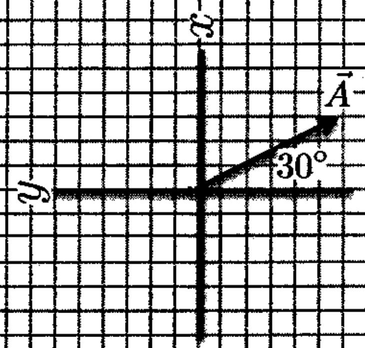
$A_x = 5\cos 30 = 5\sqrt{3}/2$

$A_x = 5\sin 30 = 5/2$



$A_x = 5\cos 15 = 4.8$

$A_x = -5\sin 15 = -1.3$



$A_x = 5\sin 30 = 5/2$

$A_x = -5\cos 30 = -5\sqrt{3}/2$