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algebra-based physics-1: midterm 1

unit 0:

1.) C: 11.0 g cm^{-3}

2.) time = $\frac{\text{distance}}{\text{speed}} = \frac{600\ km}{60\ km/hr} = 10\ hrs$

C: 10.0 hours

3.) $\frac{25\ m}{5} \times \frac{1\ km}{1000\ m} \times \frac{3600\ s}{1\ hr} = 90\ km/hr$

D: 90 km/hr

4.) $a = \frac{v_f - v_i}{t} = \frac{10-0}{60} = \frac{1}{6}\ km/hr$

C: $\frac{1}{6}$ km hr^{-1} s^{-1}

5.) C: 500 m^2

6.) 2 liters = $\frac{2000\ cm^3}{0.5\ cm^3} = 4000$

C: 4×10^3

7.) $v = 10\ km/hr \quad \theta = 225°$

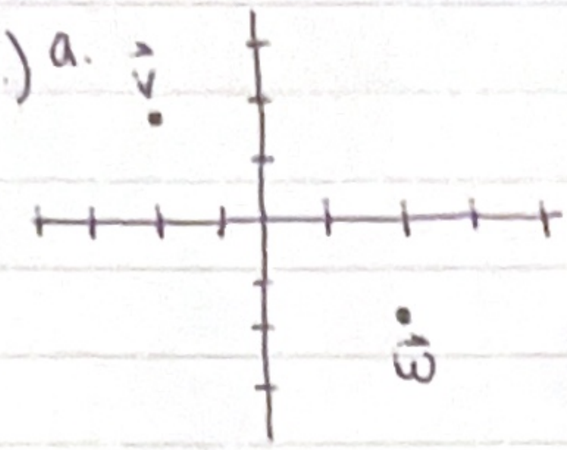
$v_x = v\cos\theta$ $\quad v_y = v\sin\theta$

$= 10\cos(225)$ $\quad = 10\sin(225)$

$= -7.1$ $\quad = -7.1$

D: -7.1 and -7.1 km/hr

8.) A: 225 degrees

9.) a. 

b. $\vec{v} + \vec{w} = 0$

c. $\vec{v} - \vec{w} = -4\hat{i} + 4\hat{j}$

d. $\vec{v} \cdot \vec{w} = -8$

Unit 1:

1.) $v_0 = 15\,m/s \quad a = 3\,m/s^2 \quad t = 4s$

a. $v = v_0 + at$
$v = 15 + 3(4)$
$v = 27\,m/s$

b. $\Delta x = v_0 t + (1/2)at^2$
$\Delta x = 15(4) + (\frac{1}{2})(3)(4)^2$
$\Delta x = 84m$

c. Yes, the average & instantaneous velocities are different at both $t=0$ & $t=4$

2.) a. $v_p = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$

$v_p = \frac{988 - 338\,m}{15 - 5\,s}$ $\quad v_Q = \frac{2900 - 1500}{30 - 20}$

$v_p = 65\,m\,s^{-1}$ $\quad v_Q = 140\,m\,s^{-1}$

b. positive

3.) $v_f = 6.00\,m/s \quad v_0 = 0\,m/s \quad a = 0.8\,m/s^2$

a. $v_f^2 = v_0^2 + 2as \rightarrow s = \frac{v_f^2 - v_0^2}{2a}$

$s = \frac{(6\,m/s)^2 - (0\,m/s)^2}{2(.8\,m/s^2)}$

$s = 22.5\,m$

b. $v_f = v_0 + at \rightarrow t = \frac{v_f - v_i}{a}$

$t = \frac{6 - 0}{.8}$

$t = 7.5s$

4) design problem: throw a basketball with a range of 60 meters

launch angle = 45°

$V_0 = \sqrt{Rg}$

$V_0 = \sqrt{60(9.81)}$

initial velocity $V_0 = 24.26$ m/s

verifing: $R = \frac{V_0^2 \sin(2\theta)}{g} = \frac{24.26^2 \sin(2 \cdot 45)}{9.81} = 59.9999$ meters ~ 60 m
↳ range ✓

$T = \frac{2V_0 \sin\theta}{g}$

$T = \frac{2(24.26)\sin(45)}{9.81}$

flight time $T = 3.50$ s

Unit 2:

1.) $F_\perp = 1000\,N \quad \theta = 7°$

a. $F_\perp = T\sin\theta \rightarrow T = \frac{F_\perp}{\sin\theta}$

$T = \frac{1000}{\sin(7)}$

$\boxed{T = 8205.5\,N}$

b. $w = mg = 900(9.81) = 8829\,N \quad F_f = \mu_K \cdot N = 0.05(8829) = 441.45$

$F_{NET} = T - F_f$

$= 8205.5 - 441.45$

$= 7764.1\,N$

$a = \frac{F_{NET}}{m}$

$a = \frac{7764.1}{900}$

$\boxed{a = 8.63\,m/s^2}$

2.) $\frac{120\,km}{hr} \times \frac{1000\,m}{1km} \times \frac{1hr}{3600\,s} = 33.33\,m/s$

a. $a = \frac{(V_F^2 - V_i^2)}{2\Delta x}$

$a = \frac{(0^2 - 33.33^2)}{2(100)}$

$\boxed{a = -5.56\,m/s^2}$

b. $F = ma$

$F = 20000(-5.56)$

$\boxed{F = 111{,}111\,N}$

3.) $F_{1x} = \cos 45 = \frac{F_{1x}}{10} = 7.1N$ $F_{2x} = \cos 30 = \frac{F_{2x}}{8} = 6.9N$ | $X = 14.0$

$F_{1y} = \sin 45 = \frac{F_{1y}}{10} = 7.1N$ $F_{2y} = \cos 30 = \frac{F_{2y}}{8} = -4.0N$ | $Y = 3.1$

$\vec{R} = \sqrt{x^2 + y^2}$

$\vec{R} = \sqrt{14^2 + 3.1^2}$

$\vec{R} = 14.3N$

$\Sigma F_x = ma_x$

$\frac{14.3 - 7.5 = [redacted]\,50\,a}{[redacted]\,50}$

$a = 0.136\ m/s^2$

Unit 3:

1.) $\cos\theta = \frac{-F_y}{w}$ $\sin\theta = \frac{F_x}{w}$ b. $a = g\sin\theta$

$F_y = -w\cos\theta$ $F_x = w\sin\theta$

$\Sigma F_x = ma_x$

$F_x - f_k = ma_x$

$w\sin\theta - M_k w\cos\theta = ma_x$

$mg\sin\theta - M_k(mg)\cos\theta = ma_x$

$mg(\sin\theta - M_k\cos\theta) = ma_x$

$a = g(\sin\theta - M_k\cos\theta)$

2.) a. $a = 9.81(\sin(10) - 0.1\cos(10))$

$a = 0.737\ m/s^2$

b. $\Delta x = v_i t + \frac{1}{2}at^2$ $v_f = v_i + at$

$\Delta x = 0 + \frac{1}{2}(.737)(30)^2$ $v_f = 0 + 0.737(30)$

$\Delta x = 331.8\ m$ $v_f = [redacted]\,22.12$

3.) a. $W = mg = 6000(9.81) = 58860$

$F_{L_y} = F_L \cos\theta = 80000 \cos 30 = 69282\,N$

$F_{NET,y} = F_{L_y} - W = 69282 - 58860 = 10422\,N$

$F_{f_x} = F_L \sin\theta = 80000 \sin 30 =$

$\boxed{F_{f_x} = 40000\,N}$

$v = \frac{600\,km}{hr} \times \frac{1000\,m}{1\,km} \times \frac{1\,hr}{3600\,s} = 166.67\ m/s$

b. $r = \frac{mv^2}{Fc}$

$r = \frac{6000(166.67)^2}{40000}$

$\boxed{r = 4166.8\,m}$

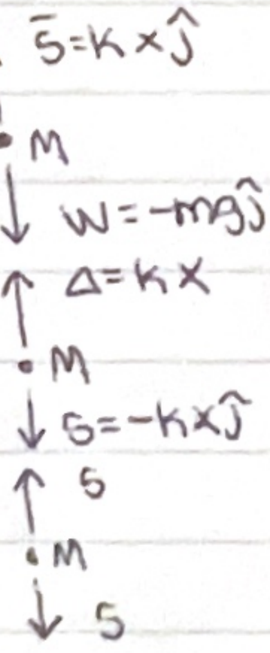
c. $\frac{1}{2}C = \pi r = \pi(4166.8) = 13090.5\,m$

$t = \frac{d}{v}$

$t = \frac{13090.5}{166.67}$

$\boxed{t = 78.5\,s}$

4.) a.



b. $F = mg = kx$

total displacement:

$= 3(l_0 + x)$

$= 3l_0 + 3x$

$= \boxed{3l_0 + 3\frac{mg}{R}}$

c. limits: $m \to 0$ $3l_0$ ✓

$g \to 0$ $3l_0$ ✓

$R \to \infty$ $3l_0$ ✓

$k \to \infty$ $x \to \frac{mg}{\infty} = 0$ ✓

5.) a. $V_t = \sqrt{\frac{2mg}{\rho C A}}$

$$V_t = \sqrt{\frac{2(60)(9.81)}{(1.2)(.5)(.25)}}$$

$$\boxed{V_t = 88.6 \text{ m/s}}$$

b. $A' = 100(.25) = 25 \text{ m}^2$

$$V_t' = \sqrt{\frac{2(60)(9.81)}{(1.2)(.5)(25)}}$$

$$\boxed{V_t' = 8.86 \text{ m/s}}$$

6) $\Delta L = \frac{1}{Y} \frac{F}{A}$

$$\Delta L = \frac{1}{45 \times 10^9} \frac{10000}{0.0314} \cdot 10$$

$$\boxed{\Delta L = 7.07 \times 10^{-5} \text{ m}}$$

b. $\Delta L = \frac{1}{22.5 \times 10^9} \cdot \frac{10000}{.0314} \cdot 10$

$$\boxed{\Delta L = 1.41 \times 10^{-4} \text{ m}}$$