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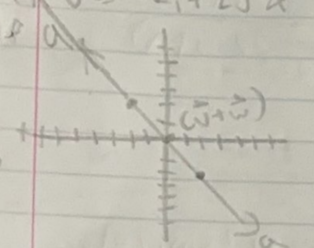
Midterm 1 Physics

1. C : 11.0 g cm^{-3}
2. C : 10.10 hours
3. D : 90 km hr^{-1}
4. C : 1/6 km $hr^{-1} s^{-1}$
5. A : 5000 m^2
6. C : 4×10^3
7. D : −7.1 and −7.1 km / hr
8. C : 135 degrees

9. $\vec{v} = -2\hat{i} + 2\hat{j}$ & $\vec{w} = 2\hat{i} - 2\hat{j}$

d.



b. $-2\hat{i} + 2\hat{i} = 0$

$2\hat{j} - 2\hat{j} = 0$

$\vec{v} + \vec{w} = 0\hat{i} + 0\hat{j}$

c. $\vec{v} - \vec{w} = (-2-2)\hat{i} + (2-\!-2)\hat{j}$

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

$\vec{v} \cdot \vec{w} = (-2)(2) + (2)(-2)$

$= -4 - 4$

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

Unit 1: Kinematics II & III

1. a. $v(t) = at + v_i$

$= (3)(4) + (15)$

$= 12 + 15$

$v_f = 27\ ms^{-1}$

b. $x(t) = \frac{1}{2}at^2 + v_i t + x_i$

$\Delta x = x_f - x_i$

$\Delta x = \frac{1}{2}(3\ ms^{-2})(4s)^2 + 15\ ms^{-1}(4s)$

$= \frac{3}{2}(16)\ m + 60\ m = \boxed{84m}$

c. Yes

Unit 1: Kinematics II & III

2) $V = \frac{\Delta x \ (x_f - x_i)}{\Delta t \ (t_f - t_i)}$

a. $v_P = \frac{988 - 338\text{ m}}{15 - 5\text{ s}} = \frac{660\text{ m}}{10\text{ s}} = \boxed{65\text{ ms}^{-1}}$

$v_Q = \frac{2900 - 1500\text{ m}}{30 - 20\text{ s}} = \frac{1400\text{ m}}{10\text{ s}} = \boxed{140\text{ ms}^{-1}}$

b. Positive Acceleration
$65\text{ ms}^{-1} \rightarrow 140\text{ ms}^{-1}$

3) $V_0 = 0\text{ m/s}$
$V_f = 6\text{ m/s}$
$a = 0.8\text{ m/s}^2$

a. $v_f^2 = v_0^2 + 2a\Delta x$
$\frac{v_f^2 - v_0^2}{2a} = \Delta x \Rightarrow \Delta x = \frac{6^2 - 0^2}{2(0.8)}$
$\boxed{\Delta x = 22.5\text{ M}}$

b. $V_f = V_0 + at$
$t = \frac{V_f - V_0}{a} = \frac{6 - 0}{0.8} = \boxed{7.5\text{ s}}$

Baseball

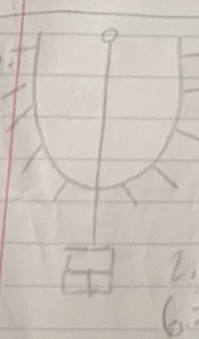
4) range = 60m
launch angle = 30°
initial velocity = ?
time of flight = ?

$T = 2V_0 \sin\theta / g$
$T = 2(26)\sin 30° / 9.81$
$T = 26/9.81 = \boxed{2.65\text{ s}}$

*Verified in PhET Simulator

$R = V_0^2 \sin(2\theta)/g$
$60\text{ m} = V_0^2 \sin(2 \cdot 30)/9.81$
$60\text{ m} = V_0^2(\frac{\sqrt{3}}{2})/9.81$
$V_0^2 = 60 \times 9.81 / \frac{\sqrt{3}}{2} = \frac{588.6}{0.866} = 678.5$
$\sqrt{V_0^2} = \sqrt{678.5}$
$\boxed{V_0 = 26\text{ ms}^{-1}}$

5.



$T = 2.6\text{ S}$
$M = 1.00\text{ kg}$
$L = 0.75\text{ M}$

$T = 2\pi\sqrt{\frac{L}{g}}^2$
$2.6^2 = 2\pi\sqrt{0.75g}^2$
$6.76 = 2\pi 0.75g^2$
$\frac{6.76}{4.73} = \frac{4.73g^2}{4.73} \Rightarrow \sqrt{g^2} = \sqrt{1.636} \Rightarrow g = 1.279$

Unit 2: Forces I & II

1.) a. $T = \frac{F1}{\sin\theta} = \frac{1000}{\sin(7)} = \frac{1000}{.12187} \approx \boxed{8205\ N}$

b. $F_{net} = m \cdot a \quad a = \frac{F_{net}}{m} \quad a = \frac{7763.65}{900} \Rightarrow \boxed{a \approx 8.63\ m/s^2}$

2) a. $v_f^2 = v_0^2 + 2ad \quad a = \frac{v_f^2 - v_0^2}{2d}$

$a = \frac{0-(33.33)^2}{2 \cdot 100} = \frac{-1111.11}{200} = \boxed{-5.56\ m/s^2}$

b. $F = ma$

$F = 20{,}000(-5.56) = -111{,}200\ N \Rightarrow \boxed{111{,}200\ N}$

3.) $F_{net} = -7.5\ N + F_2 \cos 30 + F_1 \cos 45$

$= -7.5 + 8\cos 30 + 10\cos 45$

$= -7.5 + 6.9282 + 7.07$

$= \underline{+6.49927\ N} = ma$

$m = \frac{+6.49927\ N}{50\ kg}$

$\boxed{a = +0.13\ m/s^2}$

x-direction

$F_{ynet} = 10\sin 45 - 8\sin 30$

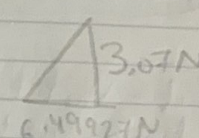
$= \underline{3.07\ N}$

$a = \frac{F}{m}$

$a = \frac{3.07}{50}$

$\boxed{a = 0.06\ m/s^2}$

y-direction



$F = \sqrt{6.49927^2 + 3.07^2}$

$F = 7.18\ N = ma$

$a = \frac{7.18\ N}{50\ kg}$

$\boxed{a = 0.14\ m/s^2}$

Unit 3: Forces III & IV

1) a. $g(\sin\theta - \mu\cos\theta) = \frac{k\Delta x}{m}$

b. $\mu = 0$

$a = g\sin\theta$

2) a.

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

$a = 9.81(\sin 10^\circ - 0.05\cos 10^\circ)$

$a = 9.81(0.1736 - 0.04924) = 9.81 \times .12436$

$\boxed{a \approx 1.22 \ m/s^2}$

b. $d = v_0 t + \frac{1}{2}at^2$

$d = 0 \cdot 30 + \frac{1}{2} \cdot 1.22 \cdot 30^2$

$d = 0 + 0.61 \cdot 900 = 549 \ m$

$v = v_0 + at = 1.22(30) = \boxed{36.6 \ m/s}$ (speed after 30 sec)

$600\frac{km}{hr}\left(\frac{1000m}{1km}\right)\cdot\left(\frac{1hr}{60min}\right)\cdot\left(\frac{1min}{60s}\right)$

$\boxed{=166.667\ m/s}$

3) a) $F_{centripetal} = L_{horizontal} = L\sin\theta = L\sin(30)$

$F_{centripetal} = 80{,}000\sin(30) = \boxed{40{,}000\ N}$

$F_{cent} = \frac{mv^2}{r} \Rightarrow r = \frac{mv^2}{F_{cent}} = \frac{(6000kg)(166.667\ m/s)^2}{40{,}000\ N}$

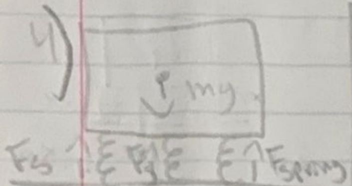
$\boxed{= 4166.68\ M = 4.17\ km}$

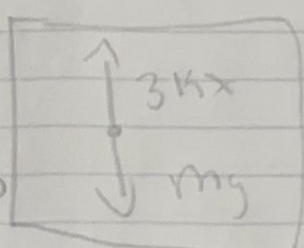
$C = 2\pi r \quad d_{plane\ path} = \pi r$

$v = \frac{d}{t} \Rightarrow t = \frac{d}{v} = \frac{\pi r}{166.667\ m/s} = \frac{(4166.68m)\pi}{166.667\ m/s}$

$\boxed{t = 78.54s}$

4)





$F_{y\,net} = 3kx - mg = 0$
$\Rightarrow mg = 3kx$

$\boxed{x = \frac{mg}{3k}}$

x & k are inversely proportional so as $k \to \infty$, the bottom gets infinitely greater making x small.

5) a) $v_t = \sqrt{\frac{2\cdot 60\cdot 9.81}{1.2\cdot 0.25\cdot 0.5}} = \sqrt{\frac{1177.2}{0.15}} = \sqrt{7848} \approx \boxed{88.57\ m/s}$

b) $A_{new} = 100 \times 0.25 = 25m^2 \quad V_t = \sqrt{\frac{2\cdot 60\cdot 9.81}{1.2\cdot 25\cdot 0.5}} \Rightarrow V_t = \sqrt{\frac{1177.2}{15}}$

$= \sqrt{78.48}$

$\boxed{\approx 8.86\ m/s}$

a) a. $A = \pi \cdot \left(\frac{0.2}{2}\right)^2 = \pi (0.1)^2 = \pi (0.01) m^2 \approx 0.314 m^2$

$\Delta L = \frac{10{,}000 \cdot 10}{0.0314 \cdot 45 \cdot 10^9} = \frac{100{,}000}{1.413 \times 10^9}$ $\boxed{\Delta L = 7.08 \times 10^{-5} m}$

b. $\Delta L_{new} = \frac{F \cdot L_0}{A \cdot Y_{new}} = \frac{10{,}000 \cdot 10}{0.0314 \cdot 22.5 \times 10^9} = \frac{100{,}000}{0.7065 \times 10^9} \approx \boxed{1.415 \times 10^{-4} m}$