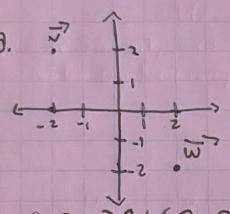
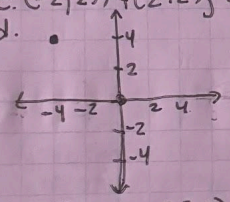
Unit a

1) c
2) b
3) d
4)
5) a
6) c
7)
8) a
9)

a. 

b. $(-2+2)\hat{i} + (2-2)\hat{j} = \vec{0}$

c. $(-2,2)\vec{i} + (2+2)\vec{j} = -4\hat{i} + 4\hat{j}$

d. 

e. $(-2)\cdot 2 + 2(-2) = -4-4 = -8$

Unit 1

1) a. $v = v_0 + at$
$v = 15m/s + (3m/s^2 \cdot 4s)$
$v = 15m/s + 12m/s$
$v = 27m/s$

b. $s = v_0t + \frac{1}{2}at^2$
$s = (15m/s)(4s) + \frac{1}{2}(3m/s^2)(4s)^2$
$s = 60m + \frac{1}{2}(3m/s^2)(16s^2)$
$s = 60m + \frac{1}{2}(48m)$
$s = 60m + 24m$
$s = 84m$

c. instantaneous velocity:
$t=0$: $v = 15m/s$
$t=4$: $v = 27m/s$

average velocity:
$t=0$: $v = \frac{21m/s}{} = 84m/4s$

$t=0$, the average and instantaneous velocity are the same $\Rightarrow$ the cyclist starting to pedal
$t=4$, the average and instantaneous are different due to the person accelerating $\rightarrow$ velocity is increasing continually

3). a. $v^2 = v_0^2 + 2as$

$(6.00\ m/s)^2 = (0\ m/s)^2 + 2(0.8\ m/s^2)s$

$36\ m^2/s^2 = 1.6\ m/s^2 \cdot s$

$s = 36/1.6 =$ 22.5 m before airborne

b. $v = v_0 + at$

$6.00\ m/s = 0 + (0.8\ m/s^2 \cdot t)$

$t = 6.00\ m/s / 0.8\ m/s^2 =$ 7.5 second to become airborne

4) Parameters

initial $v_0 = 13\ m/s$

launch angle $\theta = 45°$ ($\sin(90) = 1$)

acceleration from gravity $= 9.81\ m/s^2$

range $R = \frac{v_0^2 \sin(2\alpha)}{g}$

$R = \frac{(13\ m/s)^2 \cdot 1}{9.81\ m/s^2}$

$R = 161\ m^2/s^2 / 9.81\ m/s^2 =$ 17.24 m

$v_0 = \sqrt{(R \cdot g)/\sin(2\alpha)}$

$v_0 = \sqrt{(60m \cdot 9.81\ m/s^2)/1} = \sqrt{588.6} =$ 24.25 m/s

$t = (2 v_0 \sin(\theta))/g$

$t = (2 \cdot 24.25 \cdot \sin(45°))/9.81\ m$

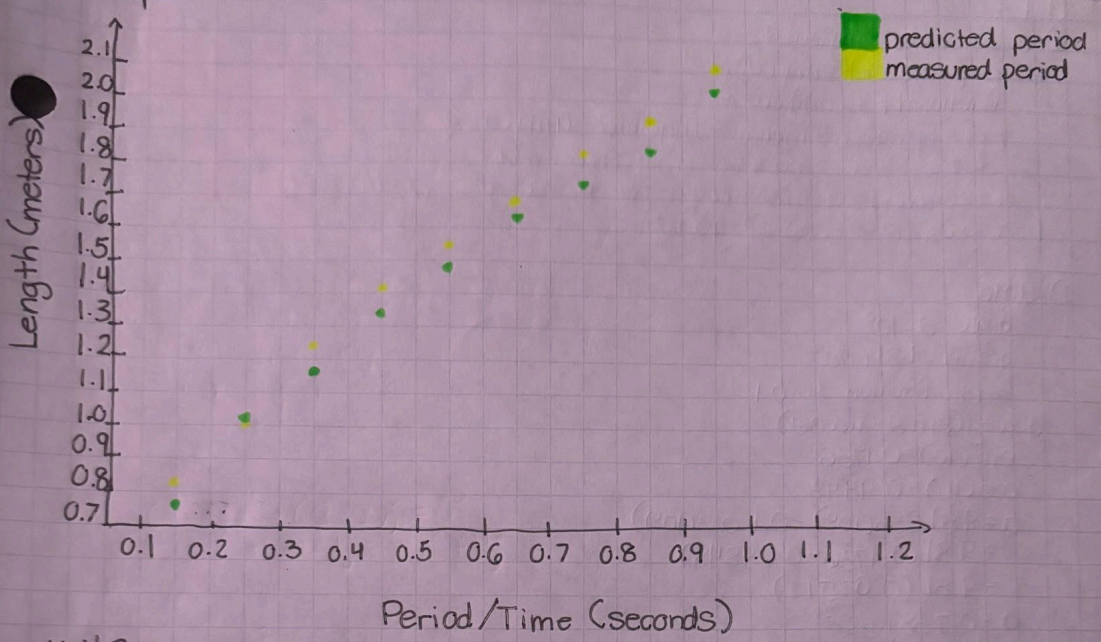
$= (2 \cdot 24.25 \cdot \sqrt{2}/2)/9.81$

$= 34.25/9.81 =$ 3.49 s

5)

Length(m)	Period(s)	
0.15	0.815	$= 2\pi\sqrt{.15m/.815s} = \sqrt{0.0153061} = (0.1237586)\ 2\pi =$ 0.7778
0.25	1.0530	$= 2\pi\sqrt{.25m/1.0530s} = \sqrt{0.0255102} = (0.1597)\ 2\pi =$ 1.004 s
0.35	1.2459	$= 2\pi\sqrt{.35m/1.2459s} = \sqrt{0.0357143} = (0.189)\ 2\pi =$ 1.187 s
0.45	1.4127	$= 2\pi\sqrt{.45m/1.4127s} = \sqrt{0.0459184} = (0.2144)\ 2\pi =$ 1.346 s
0.55	1.5618	$= 2\pi\sqrt{.55m/1.5618s} = \sqrt{0.0561224} = (0.237)\ 2\pi =$ 1.488 s
0.65	1.6979	$= 2\pi\sqrt{.65m/1.6979s} = \sqrt{0.0663265} = (0.2575)\ 2\pi =$ 1.618 s
0.75	1.8238	$= 2\pi\sqrt{.75m/1.8238s} = \sqrt{0.0765306} = (0.2767)\ 2\pi =$ 1.738 s
0.85	1.9416	$= 2\pi\sqrt{.85m/1.9416s} = \sqrt{0.0867347} = (0.2945)\ 2\pi =$ 1.850 s
0.95	2.0526	$= 2\pi\sqrt{.95m/2.0526s} = \sqrt{0.0969388} = (0.3114)\ 2\pi =$ 1.956 s

5) Graph



Unit 2

1) a. $F_y = F_1 \sin(\theta) = 1000\sin(7^\circ) \approx 1000 \cdot 0.12187 = 121.87\,N$

$F_x = F_1\cos(\theta) = 1000\cos(7^\circ) = 1000 \cdot 0.99255 = 992.55\,N$

horizontal $= F_x \Rightarrow T = \boxed{992.55\,N}$

b. $W = 900\,kg \cdot 9.81\,m/s^2 = 8829\,N \rightarrow W = mg$

$F_f = \mu_k N = 0.05 \cdot 8829 = 441.45\,N$

$F_{net} = T - F_f = 992.55 - 441.45 = 551.1\,N$

$a = F_{net}/m = 551.1/900 = \boxed{0.612\,m/s^2}$

2) a. $m = 20{,}000\,kg$

$v_i = 120\,km/hr$

$v_f = 0\,m/s$

$d = 100\,m$

$v_i = 120\,km/hr \cdot (1000\,m/1\,km)(1\,hr/3600\,s) = 120 \cdot 1000/3600 = 33.33\,m/s$

$a = (v_f^2 - v_i^2)/2d = 0 - (33.33)^2/2 \cdot 100 = \boxed{-5.5554\,m/s^2}$

b. $F = ma \rightarrow 20{,}000\,kg \cdot (-5.5554\,m/s^2) = \boxed{-111{,}108\,N}$

3) $F_1 = 10\,N$ @ 45°

$F_2 = 8\,N$ @ 30°

$m = 50\,kg$

$f = 7.5\,N$

$F_{1x} = 10\cos(45^\circ) = 10 \cdot \frac{\sqrt{2}}{2} = 7.07\,N$

$F_{1y} = 10\sin(45^\circ) = 10 \cdot \sqrt{2}/2 = 7.07\,N$

$F_{2x} = 8\cos(30^\circ) = 8 \cdot \sqrt{3}/2 = 6.93\,N$

$F_{2y} = 8\sin(30^\circ) = 8 \cdot 1/2 = 4\,N$

Total $x = 7.07 + 6.93 - 7.5 = 6.5\,N$

Total $y = 7.07 + 4 = 11.07\,N$

$a = 6.5\,N/50\,kg = \boxed{0.13\,m/s^2}$

Unit 3

1) a. parallel $F = mg\sin\theta$

perpendicular $F = mg\cos\theta$

frictional $F = \mu mg\cos\theta$

$F_{net} = F_{parallel} - F_{friction} = mg\sin\theta - \mu mg\cos\theta$

↳ $F_{net} = ma \rightarrow mg\sin\theta - \mu mg\cos\theta = ma$

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

b. $a = g(\sin\theta - 0 \cdot \cos\theta) = g\sin\theta$

2) data:

angle $= \theta = 10°$

gravity $= 9.81\ m/s^2$

kinetic friction $= \mu = 0.1$

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

$\sin(10°) = 0.1736$

$\cos(10°) = 0.9848$

$a = 9.81(\sin(10°) - 0.1\cos(10°))$

$= 9.81(0.1736 - 0.09848)$

$= 9.81(0.07512)$

$a = 0.738\ m/s^2$

b. $d = 1/2\,at^2$

$= 1/2(0.738 \cdot (30)^2)$

$d = 332.1\ m$

$v_f = v_i + at$

$= 0 + 0.738 \cdot 30$

$v_f = 22.14\ m/s$

3) $m = 6000\ kg$

$\theta = 30°$

$L = 80{,}000\ N$

$v = 600\ km/h = 600 \cdot 1000/3600 = 166.67\ m/s$

a. $L_y = 80000\cos(30°) = 80{,}000 \cdot \sqrt{3}/2 = 69{,}282.32\ N$

$W = mg = 6000 \cdot 9.81 = 58{,}860\ N$

$L_x = L\sin(\theta) = 80{,}000\sin(30°) = 80{,}000 \cdot 1/2 = 40{,}000\ N$

b. $F_c = mv^2/r$

$r = mv^2/F_c$

$= 6000(166.67)^2/40{,}000$

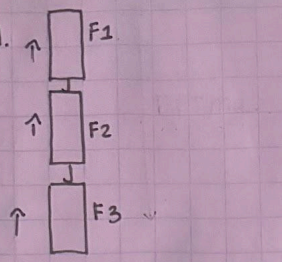
$= 16666666/40{,}000 = 416667\ m$

c. $C = 2\pi r$

$= 2\pi \cdot 4166.67 = 26180.34\ m$

distance $= C/2 = 26180.34\ m/2 = 13090.17\ m$

$t = d/v = 13090.17/166.67 = 78.6\ s$

4) a. 

b. $mg = kx + kx + kx$
$= 3kx$
$x = mg/3k$

c. If $k \to \infty$:
$x \to mg/3\infty = 0$

5) a. $m = 60kg$
$g = 9.81 m/s^2$ $C = 0.5$
$\rho = 1.2 kg/m^3$ $A = 0.25m^2$
$v_t = \sqrt{(2 \cdot 60 \cdot 9.81)/(1.2 \cdot 0.5 \cdot 0.25)}$
$= \sqrt{1177.2/0.15}$
$= \sqrt{7848} = 88.6 m/s$

b. $A' = 100 \cdot .25 = 25m^2$
$v'_t = \sqrt{(2 \cdot 60 \cdot 9.81)/(1.2 \cdot 0.5 \cdot 25)}$
$= \sqrt{1177.2/15} = \sqrt{78.48} = 8.85 m/s$

6) $E = 45 \cdot 10^9 N/m^2$
$F = 10{,}000N$
$L_0 = 10m$
$d = 20cm \to .2m$

a. $A = \pi (.2/2)^2$
$= \pi (0.1)^2$
$= 0.0314m^2$
$\Delta L = (10{,}000 \cdot 10m)/(0.0314m^2 \cdot 45 \cdot 10^9 N/m^2)$
$= 100{,}000 / 1.413 \cdot 10^9$
$= 0.0707mm$

b. $E' = 45 \cdot 10^9/2 = 22.5 \cdot 10^9 N/m^2$
$\Delta L' = (10{,}000N \cdot 10m)/(0.0314m^2 \cdot 22.5 \cdot 10^9 N/m^2)$
$AE' = 0.0314 \cdot 22.5 \cdot 10^9 = 0.7075 \cdot 10^9$
$\Delta L' = 100{,}000/0.7075 \cdot 10^9 = 0.141mm$