Calculus Based Midterm

Carlos Rodarte

Unit 0:

1. C.

2. C.

3. $\frac{25\,m}{s} \cdot \frac{3600\,s}{1\,hr} \cdot \frac{1\,km}{1000\,m} = 90\ km\ hr^{-1}$ D.

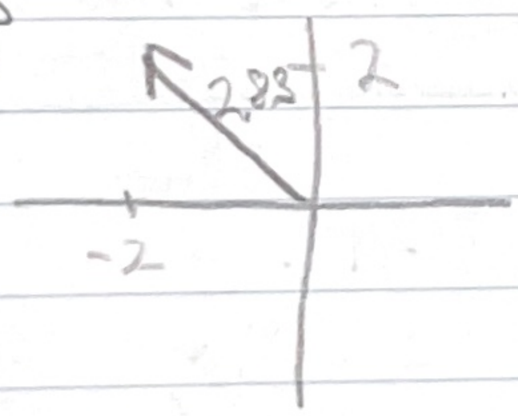
4. $\frac{10\,km\,hr^{-1}}{60\,s} = \frac{1}{6}\ km\ hr^{-1}\ s^{-1}$ C.

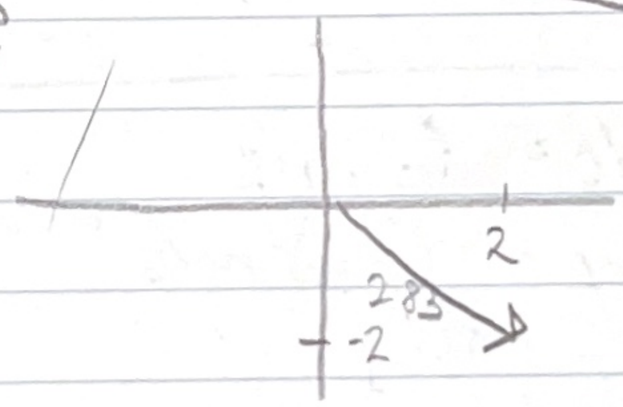
5. $50 \cdot 100 = 5000$ A.

6. $\frac{2000}{0.5} = 4000$ C

7. 10 km/hr — D

8. $\tan^{-1}\frac{2.1}{2.1} = 45°$
$+180°$
$225°$ A

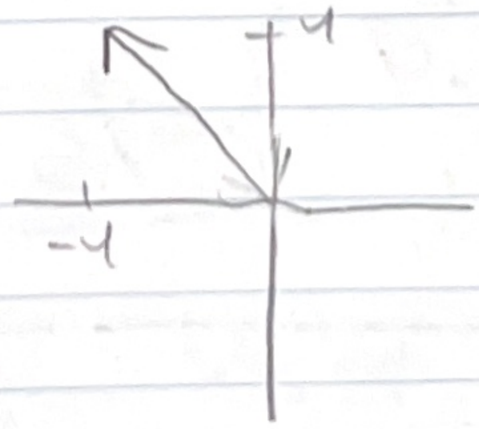
9. $\vec{v}$ 

$\vec{w}$ 

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

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

$\vec{v} \cdot \vec{w}$ 



$\vec{v} \cdot \vec{w}$ $(-2\hat{i} + 2\hat{j})(2\hat{i} - 2\hat{j})$

$-4 - 4 = -8$

Unit 7

1. $V_i = \frac{15m}{s}$ $a = 3\ m/s^2$

$t = 0$

$X_i = 0$

a. $V(4) = 3(4) + 15 = 27\ m/s$

$x(4) = \frac{1}{2}(3)(4)^2 + 15(4) + 0$

$24 + 60$

b. $= 84\ m$

$\frac{84}{4} = 21 = V_{avg}$

Yes the average and instantaneous velocities at $t = 4s$ are different.

---

2. $P = (10, 600)$ $1988/15 = 65.86\ m/s$

$Q = (25, 2138)$ $1500/20 = 75\ m/s$

Positive acceleration $\frac{75 - 65.86}{20 - 15} = \frac{9.14}{5}$

$1.83\ m/s^2$

---

3. $V_f = 6\ m/s$

$a_f = 0.8\ m/s^2$

$\frac{V_f^2}{2a} = \Delta x$

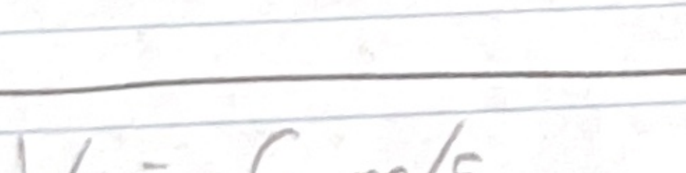
$\frac{6^2}{2(.8)} = \frac{36}{1.6}$

$\Delta x = 22.5\ m$

$22.5 = \frac{\frac{1}{2}(0.8)t^2}{.4}$

$\sqrt{\frac{22.5}{.4}} = t = 7.5\ s$

---

4. 

$60 \cdot 9.81 = V_i^2 \sin(2 \cdot 45)$

$V_i = 24.26\ m/s$

$\theta = 45°$

Phet lab = 24 m/s Range = 58.72 m

T = 3.46 s

Unit 1

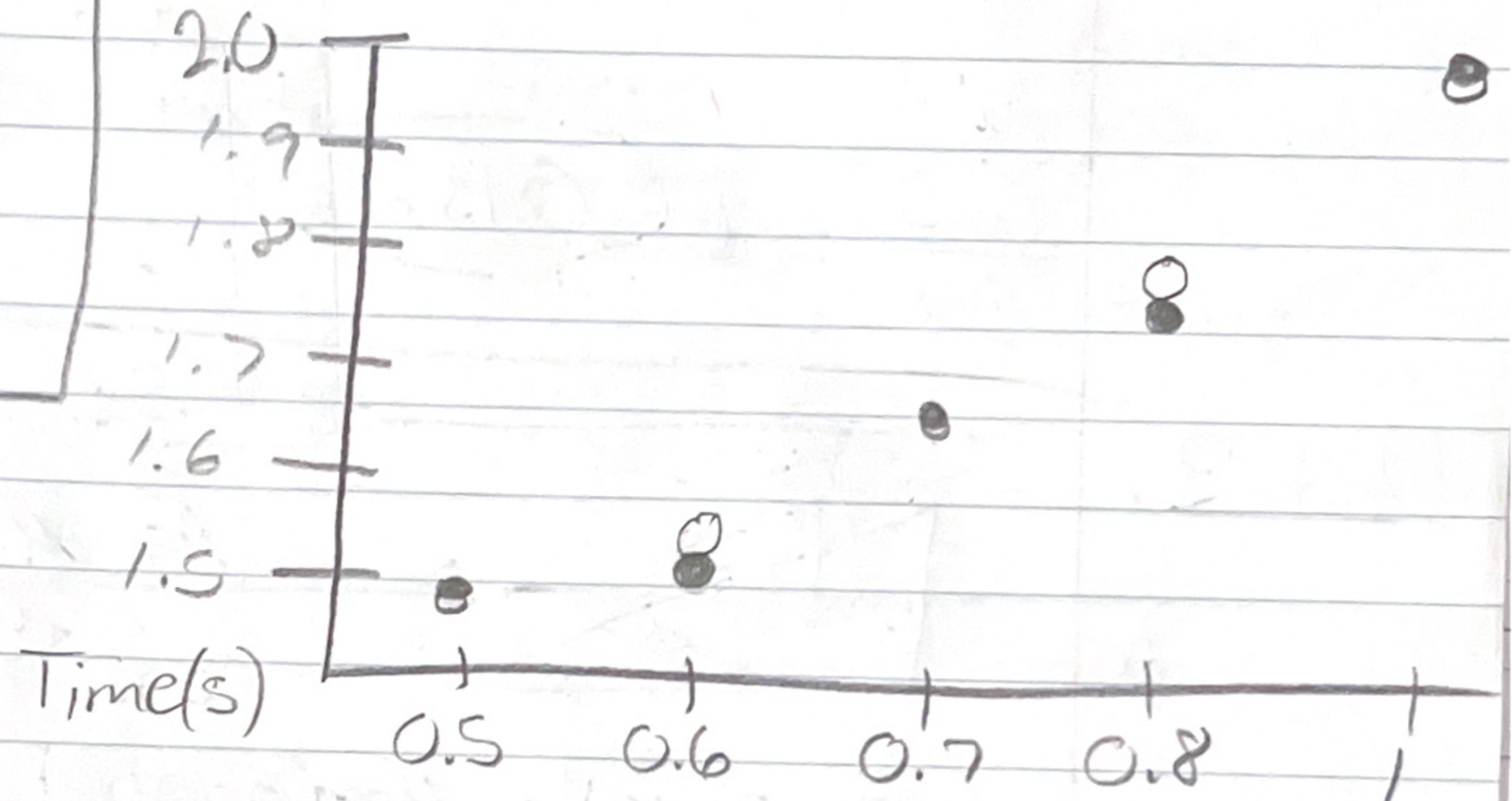
5. $T = 2\pi\sqrt{\frac{L}{g}}$

L(m)	Time in theory (s)
0.5	1.4177
0.6	1.5531
0.7	1.6775
0.8	1.7933
1.0	2.005

O = Theory
● = Lab

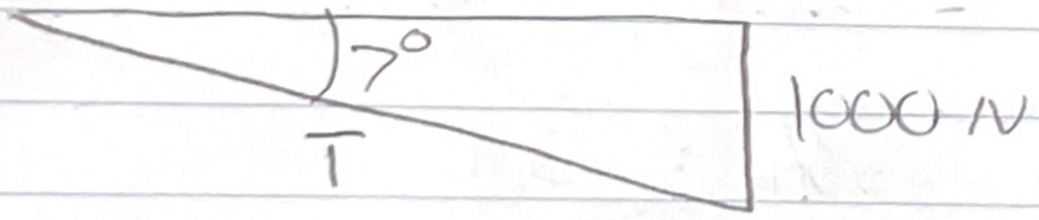
Phet Lab

Length (m)	Time (s)
0.5	1.42
0.6	1.51
0.7	1.67
0.8	1.76
1	2.01



Unit 2

1.



$\sin(7°) = \frac{1000}{T} \cdot T$

$T = \frac{1000}{\sin(7°)}$

a. $T = 8205.5\ N$

b. m $\quad \mu_k = 0.05$ $\quad a = ?$

$F = ma - \mu_k$

$\frac{8205.5 + 0.05}{900} = 9.12\ m/s^2$

2. $0 = 33.33^2 + 2a(100m)$

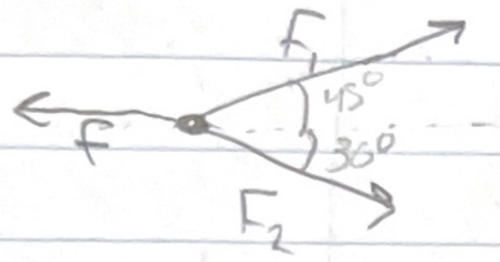
$\frac{-1111.11}{200} = a = -5.6\ m/s^2$

$\frac{120\ km}{hr} \cdot \frac{1000m}{1km} \cdot \frac{1hr}{3600s}$

$F = 20{,}000 \cdot 5.6 = 112{,}000\ N$

Unit 2

3.



$F_1 = 10\,N$
$F_2 = 8\,N$
$F = 7.5\,N$

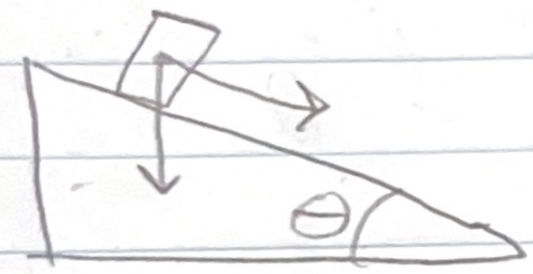
$m = 50\,kg$

$F_{1x} = 10\cos(45°) = 7.07\,N$
$F_{2x} = 8\cos(30°) = 6.93\,N$
$F_{net} = F_{1x} + F_{2x} - f = 6.5\,N$

$\frac{6.5}{50} = a = 0.13\,m/s^2$

Unit 3.

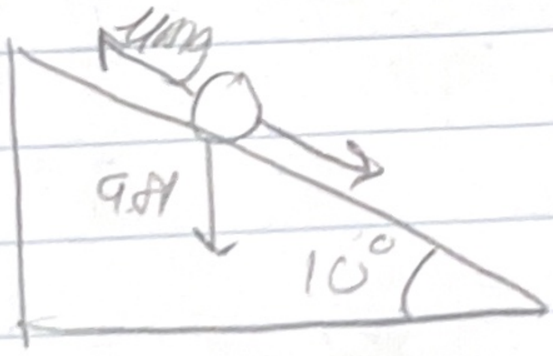
1.



As $\mu \to 0$, $a = g\sin(\theta)$

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

2.



$\mu_k = 0.1$
$g = 9.81$

$a = 9.81(\sin(10) - 0.1\cos(10))$
$a = 0.74\,m/s^2$

$T = 30\,s$

$V(30) = 0.74(30)$
$V_f = 22.2\,m/s$

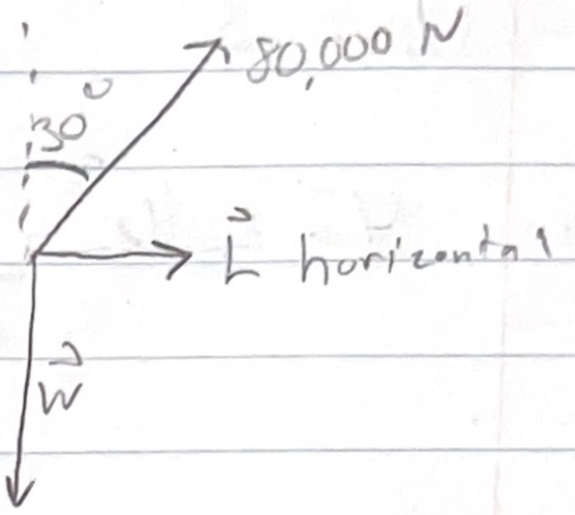
$X(30) = \frac{1}{2}(0.74)(30)^2$
900
$X = 333\,m$

Unit 3.

3. $m = 6000\ kg$

$\theta = 30°$

$L = 80,000\ N$



$F_c = L \sin(\theta)$

$= 80,000 \sin(30°)$

$F_c = 40,000 N$

$r = \frac{600 \frac{km}{hr}}{11.26 \cdot \tan(30°)} =$ Radius $92.3\ km$

$T = \frac{2\pi}{\sqrt{\frac{F_c}{mr}}} = \frac{23.4\ sec}{2} =$ $11.7\ sec$

4.

$\Delta x = \frac{F}{k}$

$k \to \infty, \quad \Delta x = 0$

$\frac{F}{\infty} = 0$ k gets incredibly small

---

5. $m = 60 kg$

$A = 0.25 m^2$

$C = 0.5$

$\frac{1}{2}(0.5)(1.2 \frac{kg}{m^3})(0.25 m^2) v^2 = 1586$

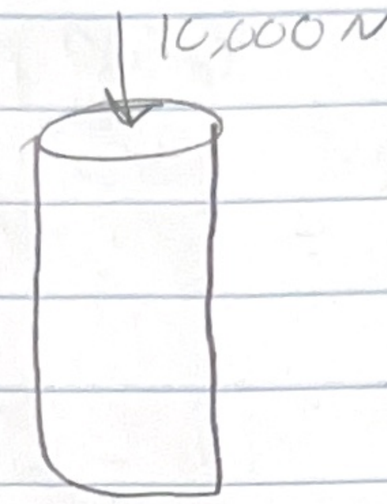
$\sqrt{\frac{1586}{0.075}} =$ $v = 280\ m/s$

C x100

$V = 28\ m/s$ decreases by a factor of 10

Unit 3

6. $45 \times 10^9 \frac{N}{m^2}$



$V = \pi 0.1^2 10$

$V = 0.314 m^3$

$(0.314 m^3)(2.7 \times 10^3 kg) = 847.8 kg$

$(847.8 kg)(9.81 m/s^2) = 8,317 N$

$F_1 = (8317 N) + (10,000 N) = 18,317 N$

$\frac{F_1}{A} \cdot \frac{L_0}{\Delta L}$ $\frac{18317 N}{.0314 m^2} \cdot \frac{10}{\Delta L} = 45 \times 10^9 \frac{N}{m^2}$

$\frac{45,000,000,000}{583344}$ $\frac{10 m}{77,141.4} = \Delta L = 0.00013 m$

Half Young Modulus, the new ΔL doubles at 0.00026 m