Problem Set #7 Solutions

1. mass of sled = 40,000 kg

$\mu_{k\,snow} = 0.02$

$\mu_{k\,grass} = 0.35$

$F_f = \mu_k \cdot F_N$

$F_N = mg = 40{,}000 \cdot 9.8 = 392{,}000\ N$

$F_{f\,grass} = 0.35 \cdot 392{,}000\ N = 137{,}200\ N$

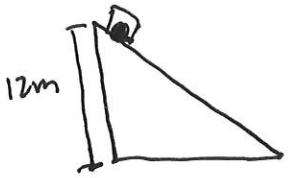
$F_{f\,snow} = 0.02 \cdot 392{,}000\ N = 7{,}840\ N$

$F_{f\,grass} - F_{f\,snow} = 137{,}200 - 7{,}840 = 129{,}360\ N$ more on grass

2. Fill each grid space with a concise and corresponding description

	Position vs. Time Graphs	Velocity vs. Time Graphs	Acceleration vs. Time Graphs
"Y intercept"	**Initial Displacement**	Initial velocity	Initial Acceleration
Slope of the line (or slope of the tangent line)	velocity	acceleration	Jerk
Positive Slope	+ velocity	+ acceleration	+ Jerk
Negative Slope	− velocity	− acceleration	− Jerk
Zero Slope	Not Moving	Constant Velocity	Constant Acceleration
Straight	Constant Velocity	Constant Acceleration	Constant Jerk
Curved	Accelerating	Increasing Jerk	X
Area under the Curve	X	Displacement	Velocity
Stopped when...	Graph has 0 slope	is 0	is 0
Uniform Velocity	Straight line	0 slope	0
Uniform Acceleration	Curve	straight line	0 slope

3.



m = 15 kg
h = 12

GPE at top of Hill = mgh = Kinetic Engy at bottom

a. mgh = 15 • 9.8 • 12 = 1,764 J = Kinetic Engy

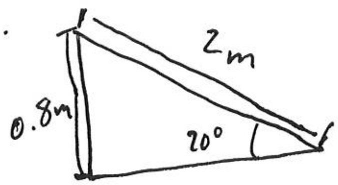
b. KE = $\frac{1}{2}mv^2$ = 1,764

$$\frac{\frac{1}{2} \cdot 15 \cdot v^2}{\frac{1}{2} \cdot 15} = \frac{1,764}{\frac{1}{2} \cdot 15}$$

$$\sqrt{v^2} = \sqrt{235.2}$$

$$v = 15.3 \text{ m/s}$$

4.



M = 0.5 Kg

a. to get velocity we will use Kinetic Engy.
to find Kinetic Energy we will us Potential Engy.

GPE at top of Ramp = mgh = Kinetic Engy at the bottom of the ramp

$$0.5 \cdot 9.8 \cdot 0.8 = \frac{1}{2} \cdot 0.5 \cdot v^2$$

$$3.92 = \frac{1}{2} \cdot 0.5 v^2$$

$$\frac{3.92}{0.25} = \frac{0.25 v^2}{0.25}$$

$$\sqrt{15.68} = \sqrt{v^2}$$

$$3.96 \text{ m/s} = v$$

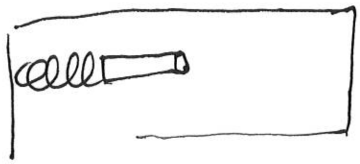
b. GPE = mgh = 0.5 • 9.8 • 0.8
= 3.92 J

c. Actual KE = $\frac{1}{2} \cdot 0.5 \cdot 2.1^2$
= 1.1 J

3.92 − 1.1 = 2.82 J lost to friction

Problem set #7

5.



$m = 10g = 0.01\,kg$
$F = 185N$
$x = 10cm = 0.1m$

a. $F_{spring} = 185 = kx = k\,0.1 \rightarrow \frac{185}{0.1} = \frac{0.1k}{0.1} \rightarrow k = 1{,}850\,N/m$

b. $EPE = \frac{1}{2}kx^2 = \frac{1}{2} \cdot 1{,}850 \cdot (0.1)^2 = 9.25J$

c. $EPE = KE = \frac{1}{2}mv^2$

$9.25 = \frac{1}{2} \cdot 0.01 \cdot v^2 \rightarrow \frac{9.25}{0.005} = \frac{0.005v^2}{0.005}$

$\sqrt{1850} = \sqrt{v^2}$

$43\,m/s = v$

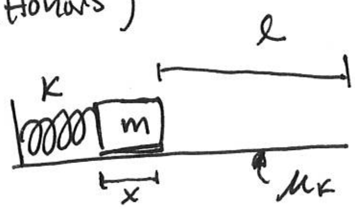
d. $mgh = \frac{1}{2}mv^2 = EPE \rightarrow mgh = 9.25$

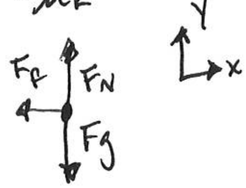
$0.01 \cdot 9.8 \cdot h = 9.25$

$\frac{0.098h}{0.098} = \frac{9.25}{0.098}$

$h = 94.39m$

6. (Honors)





$\rightarrow EPE = \frac{1}{2}kx^2 = KE = \frac{1}{2}mv^2$

$\frac{\cancel{\frac{1}{2}}kx^2}{m} = \frac{\cancel{\frac{1}{2}}mv^2}{m}$

$\sqrt{\frac{kx^2}{m}} = \sqrt{v^2} \rightarrow \sqrt{\frac{kx^2}{m}} = v$

$F_f = -\mu_k F_N = -\mu_k \cdot mg = ma$

$-\mu_k \cancel{m}g = \cancel{m}a$

$-\mu_k g = a$

x
$a = -\mu_k g$
$V_0 = \sqrt{\frac{kx^2}{m}}$
$V_f = 0$
$S_0 = 0$
$S_f = l$
$t_f = ?$
$t_0 = 0s$

$V_f^2 = V_0^2 + 2a\Delta S$

$0^2 = \left(\sqrt{\frac{kx^2}{m}}\right)^2 + 2(-\mu_k g)(l - 0)$

$0 = \frac{kx^2}{m} + (-2 \cdot \mu_k g l)$

$2\mu_k g l = \frac{kx^2}{m} \rightarrow \boxed{l = \frac{kx^2}{2\mu_k mg}}$