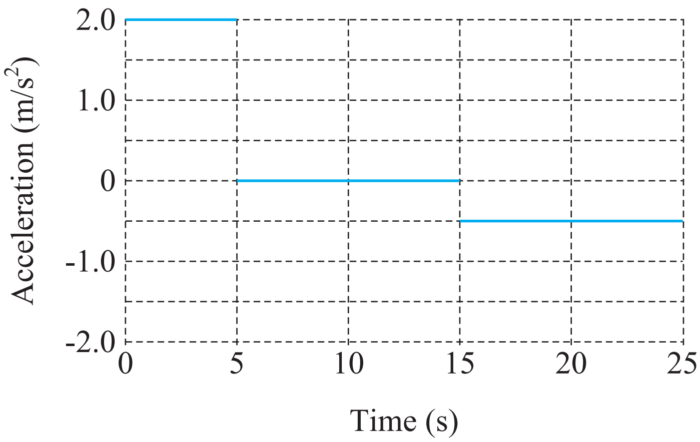
1. (a)



(b) The area under the v vs t graph from 0 to 5.0 s gives the displacement of the object after 5.0 s. Since the object begins at x = 0 m, the displacement (or change in position) of the object is also it's final position after 5.0 s.

Area under the v vs t graph from 0 to 5.0 s: Area $= \frac{1}{2}bh = \frac{1}{2}vt$

Area $= \frac{1}{2}(10\text{ m/s})(5.0\text{ s})$

$\boxed{\text{Area} = 25\text{ m}}$ → Position at t=5.0 s

(c)

____ *A* _X_ *B* ____ *C*

Segment B on the graph has zero acceleration. According to Newton's second law of motion, if there is no acceleration, there is no net force.

(d) Acceleration can be found by taking the slope for the first 3.0 s (or 5.0 s since it is a straight line up until 5.0 s and has a constant slope)

$$\text{slope} = a = \frac{10\text{ m/s} - 0\text{ m/s}}{5.0\text{ s} - 0\text{ s}} = 2.0\text{ m/s}^2$$

$$F_{NET} = ma = (0.40\text{ kg})(2.0\text{ m/s}^2)$$

$\boxed{F_{NET} = 0.80\text{ N}}$

(e) Use the Work-Energy Theorem: $W_{NET} = \Delta KE = \frac{1}{2}mv_2{}^2 - \frac{1}{2}mv_2{}^2$

$$W_{NET} = \frac{1}{2}(0.40\text{ kg})(10\text{ m/s})^2$$

$\boxed{W_{NET} = 20\text{ J}}$

(f)

____ Positive ____ Negative _X_ Zero

There is no change in kinetic energy (velocity is constant) over this time interval, so there is no net work. **OR** There is no net force during this time interval, so, there is no net work by it's definition: $W = Fd\cos\theta$.

1. (a) $y = y_0 + v_{y0} + \frac{1}{2}at^2$
$0 = 0.80\text{ m} + 0 + \frac{1}{2}\left(-9.8\text{ m/s}^2\right)t^2$

$\boxed{t = 0.40\text{ s}}$

x	y
d=1.2 m	v_{yo}=0
v_{xo}=???	y_o=0.80 m
	y=0 m
	g=-9.8 m/s2
	t=?

(b) $d = v_{x0}t$
$1.2\text{ m} = v_{x0}(0.40\text{ s})$

$\boxed{v_{x0} = 3.0\text{ m/s}}$

(c) $\Delta EPE = \Delta KE$
$\frac{1}{2}kx^2 = \frac{1}{2}mv^2$
$\frac{1}{2}(650\text{ N/m})x^2 = \frac{1}{2}(4.0\text{ kg})(3.0\text{ m/s})^2$

$\boxed{x = 0.24\text{ m} = 24\text{ cm}}$

(d) $m_1v_1 + m_2v_2 = (m_1 + m_2)v'$
$(4.0\text{ kg})(3.0\text{ m/s}) + 0 = (4.0\text{ kg} + 4.0\text{ kg})v'$
$v' = 1.5\text{ m/s} = v_{x0}$ of projectile motion. Note: the time the marble is in the air is unaffected by the addition of Block B to the experiment.
$d = v_{x0}t$
$d = (1.5\text{ m/s})(0.40\text{ s})$

$\boxed{d = 0.60\text{ m/s}}$

(e)
_X_ $E_2 < E_1$ ___ $E_2 = E_1$ ___ $E_2 > E_1$
The two blocks collide in an inelastic collision in the second experiment. During any inelastic collision, some of the kinetic energy is converted to other forms of energy such as thermal energy and sound energy which is not part of the total mechanical energy.

1. (a) $\frac{1}{2}kx^2 = mgh$

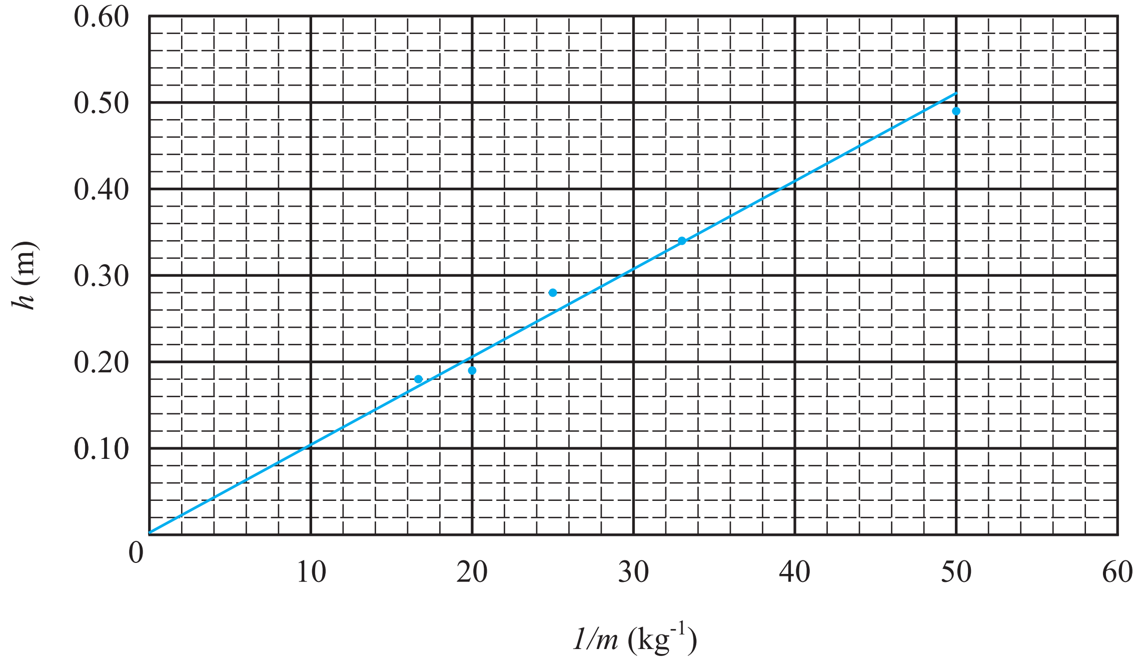
$$\boxed{h = \frac{kx^2}{2mg}}$$

(b) i. A graph of h as a function of $\frac{1}{m}$ would produce a slope equal to $\frac{x^2}{2g}k$. So k would equal the slope multiplied by $\frac{2g}{x^2} = \frac{2\left(9.8 \text{ m/s}^2\right)}{\left(0.020 \text{ m}\right)^2} = 49{,}000 \text{ m}^{-1} \cdot \text{s}^{-2}$

ii.

	m (kg)	h (m)	$1/m$ (kg^{-1})
	0.020	0.49	50
	0.030	0.34	33
	0.040	0.28	25
	0.050	0.19	20
	0.060	0.18	17

(c)



(d) slope $= \frac{(0.51-0) \text{ m}}{(50-0) \text{ kg}^{-1}} = 0.010 \text{ kg} \cdot \text{m}$

$k = slope \cdot 49{,}000 \text{ m}^{-1}\text{s}^{-2} = (0.010 \text{ kg} \cdot \text{m})\left(49{,}000 \text{ m}^{-1}\text{s}^{-2}\right)$

$$\boxed{k = 500 \text{ N/m}}$$

(e) Clamp a horizontal rod to a ringstand. Position the rod above the toy and adjust the height of the rod until the toy just barely touches the rod for a given trial. Measure the height of the rod above the table and subtract $L_0 - x$ from this height to determine h.

1. (a) Accelerated Portion

$v = v_0 + at$

$5.0\ \text{m/s} = 2.0\ \text{m/s} + \left(1.5\ \text{m/s}^2\right)t_a$

$t_a = 2.0\ \text{s}$

$x_a = x_0 + v_0 t + \frac{1}{2}at_a^{\,2}$

$x_a = 0 + (2.0\ \text{m/s})(2.0\ \text{s}) + \frac{1}{2}\left(1.5\ \text{m/s}^2\right)(2.0\ \text{s})^2$

$x_a = 7.0\ \text{m}$

Constant Velocity Portion

$\Delta x_t = \Delta x_a + \Delta x_{cv}$

$15.0\ \text{m} = 7.0\ \text{m} + \Delta x_{cv}$

$\Delta x_{cv} = 8.0\ \text{m}$

$\bar{v}_{cv} = \frac{\Delta x_{cv}}{\Delta t_{cv}}$

$5.0\ \text{m/s} = \frac{8.0\ \text{m}}{t_{cv} - 0}$

$t_{cv} = 1.6\ \text{s}$

Total Trip

$t_t = t_a + t_{cv} = 2.0\ \text{s} + 1.6\ \text{s}$

$\boxed{t_a = 3.6\ \text{s}}$

(b) i. $m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$

$(250\ \text{kg})(5.0\ \text{m/s}) + 0 = (250\ \text{kg})v_1' + (200\ \text{kg})(4.8\ \text{m/s})$

$\boxed{v_1' = 1.16\ \text{m/s}}$

ii. right

(c)

___ Yes _X_ No

The kinetic energy of the system is not conserved. There are 653 J of kinetic energy lost to thermal energy.

$\Delta KE_{system} = \left(\frac{1}{2}m_1 v_1'^{\,2} + \frac{1}{2}m_2 v_2'^{\,2}\right) - \left(\frac{1}{2}m_1 v_1^{\,2} + \frac{1}{2}m_2 v_2^{\,2}\right)$

$\Delta KE_{system} = \left[\frac{1}{2}(250\ \text{kg})(1.16\ \text{m/s})^2 + \frac{1}{2}(200\ \text{kg})(4.8\ \text{m/s})^2\right] - \left[\frac{1}{2}(250\ \text{kg})(5.0\ \text{m/s})^2 + 0\right]$

$\boxed{\Delta KE_{system} = -653\ \text{J}}$

2. (a) $F_S = m_S a$

$4.0 \text{ N} = (10.0 \text{ kg})a$

$a = 0.40 \text{ m/s}^2$

$F_A = m_A a$

$F_A = (2.0 \text{ kg})(0.40 \text{ m/s}^2)$

$\boxed{F_A = 0.80 \text{ N}}$

(b) $F = -kx$

$0.80 \text{ N} = -(80 \text{ N/m})x$

$\boxed{x = 0.010 \text{ m}}$

(c)

___ Greater   ___ Less   _X_ The Same

The magnitude of the force is the same and the mass is the same, so the magnitude of the acceleration will be the same. Only the direction of the acceleration will change.

(d)

_X_ Greater   ___ Less   ___ The Same

$F_A = m_A a$

$F_B = (8.0 \text{ kg})(0.40 \text{ m/s}^2)$

$F_B = 3.2 \text{ N}$

$F = -kx$

$3.2 \text{ N} = -(80 \text{ N/m})x$

$\boxed{x = 0.040 \text{ m}}$ This distance is greater than the 0.10 m that the spring stretched before.

(e) $\Delta KE = \Delta EPE$

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

$\frac{1}{2}(80 \text{ N/m})x^2 = \frac{1}{2}(8.0 \text{ kg})(0.50 \text{ m/s})^2$

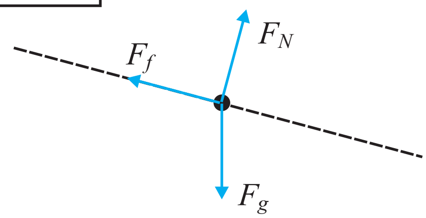
$\boxed{x = 0.16 \text{ m}}$

1. (a) $v = \frac{d}{t}$

$2.4 \text{ m/s} = \frac{21 \text{ m}}{t}$

$\boxed{t = 8.75 \text{ s}}$

(b)



(c) $\sum F_x = F_{gx} - F_f = ma_x$

$mg\sin\theta - F_f = 0$

$F_f = mg\sin\theta$

$F_f = (25 \text{ kg})(9.8 \text{ m/s}^2)\sin(15^o)$

$\boxed{F_f = 63.4 \text{ N}}$

(d) $F_f = \mu F_N$

$F_f = \mu mg\cos\theta$

$63.4 \text{ N} = \mu(25 \text{ kg})(9.8 \text{ m/s}^2)\cos(15^o)$

$\boxed{\mu = 0.27}$

$\sum F_y = F_N - F_{gy} = ma_y$

$F_N - mg\cos\theta = 0$

$F_N = mg\cos\theta$

(e) i. The velocity will decrease as there is now a net negative acceleration, which will be constant, due to the fact that the x-component of gravity down the slope is no longer countering the frictional force. The frictional force will be greater on the flat surface because the normal force will be greater.

$\sum F_x = -F_f = ma_x$

$-\mu F_N = ma$

$-\mu \not{m}g = \not{m}a$

$a = -\mu g = -(0.27)(9.8 \text{ m/s}^2)$

$a = -2.6 \text{ m/s}^2$

$\sum F_y = F_N - F_g = ma_y$

$F_N - mg = 0$

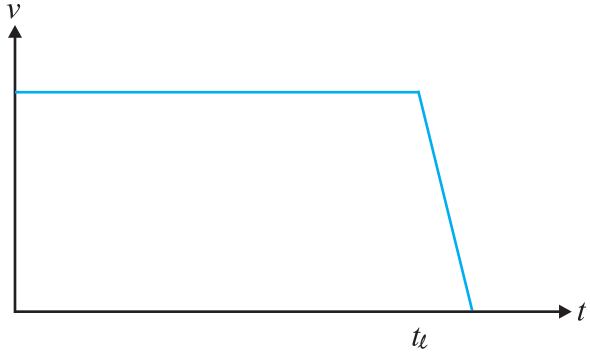
$F_N = mg$

$v = v_0 + at$

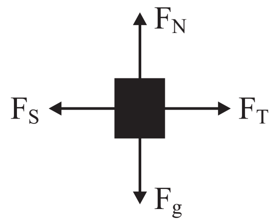
$0 = 2.4 \text{ m/s} + (-2.6 \text{ m/s}^2)t$

$t = 0.92 \text{ s}$

ii.



1. (a)



(b) $\sum F = F_T - F_g = 0$

$F_T = mg = (4.0 \text{ kg})(9.8 \text{ m/s}^2)$

$\boxed{F_T = 39.2 \text{ N}}$

(c) $\sum F = F_T - F_x = 0$

$F_T = kx$

$39.2 \text{ N} = k\,(0.05 \text{ m})$

Note: $x = L - L_0 = 0.25\text{m} - 0.20 \text{ m} = 0.05 \text{ m}$

$\boxed{k = 784 \text{ N/m}}$

(d) $y = y_0 + v_0 t + \frac{1}{2}at^2$

$0 \text{ m} = 0.70 \text{ m} + (0 \text{ m/s})t + \frac{1}{2}(-9.8 \text{ m/s}^2)t^2$

$\boxed{t = 0.378 \text{ s}}$

(e) $f = \dfrac{1}{2\pi}\sqrt{\dfrac{k}{m}} = \dfrac{1}{2\pi}\sqrt{\dfrac{784 \text{ N/m}}{8.0 \text{ kg}}}$

$\boxed{f = 1.58 \text{ Hz}}$

(f) $v_0 = 2\pi f A = 2\pi(1.58 \text{ Hz})(0.05 \text{ m})$

$\boxed{v_0 = 0.495 \text{ m/s}}$

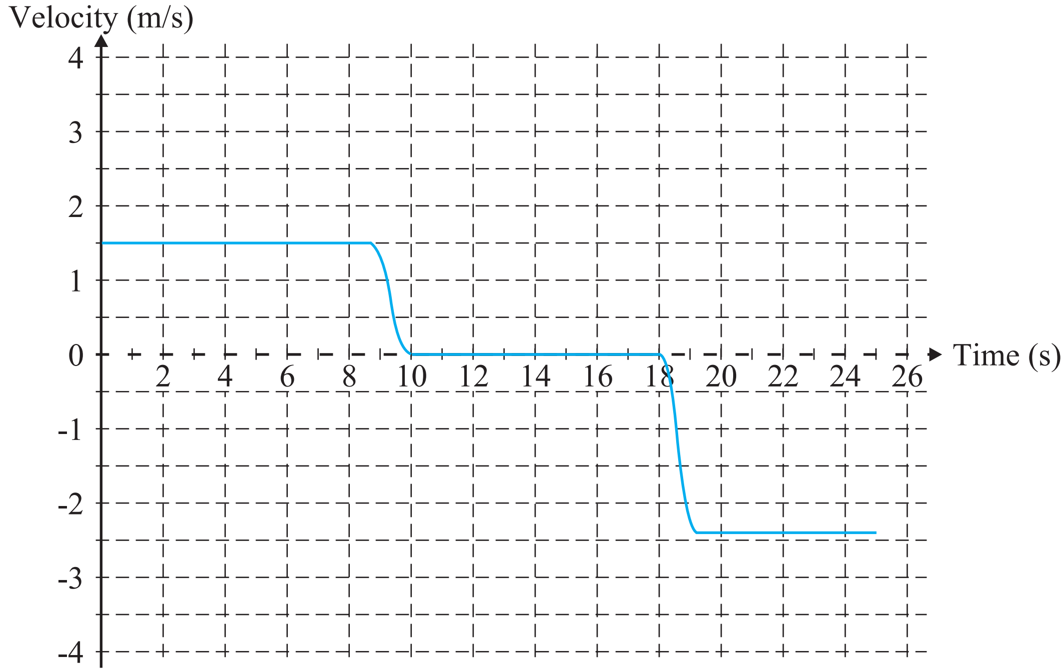
2. (a)

X Stopwatches	**X** Tape measures	____ Rulers	____ Masking Tape
____ Metersticks	**X** Starter's pistol	____ String	**X** Chalk

(b) Using the chalk, mark a starting line on the track. Using a tape metric measure or a meter stick, measure 10 m distances (marked by a chalk-line) up to, and including, 100 m (which is the finish line). Position one student, who has the starter's pistol, at the starting line. The ten other students, who have stopwatches, should be portioned such that one student is at each of the 10 m chalk-lines including the finish line. The student at the starting line will start the world-class runner by firing the starting pistol. Each of the remaining students will time how long it takes the runner to pass his chalk-line using the stopwatch. The 10 m chalk-line can be labeled as x_1 and the time recorded by the student at this chalk-line can be labeled t_1. Similarly, the 20 m chalk-line can be labeled as x_2 and the time recorded by the student at this chalk-line can be labeled t_2. The remaining chalk-lines and times can be labeled in a similar fashion up to position x_{10} at the finish line which will have time t_{10} as the finishing time of the runner.

(c) One of two methods could be used. Method one would calculate the average speed (or magnitude of average velocity) that the runner had up to each chalk-line by dividing the distance a particular chalk-line is from the starting line by the time it took to get to that chalk-line. A general formula to accomplish this would be $\bar{v}_n = \dfrac{x_n}{t_n}$, where $n = 1, 2, 3, \ldots, 10$. When the average speed stops increasing as calculations proceed for positions x_1 through x_{10}, the acceleration period is over at that position (labeled x_u) and the time it took for the runner to get to that position can be called t_u. (Note: this is an approximate position of the conclusion of the acceleration period with a possible error of up to 10 m). To calculate a_u the equation $x_u = x_0 + v_0 t_u + \frac{1}{2} a_u t_u^2$, where x_0 is zero (the starting line), v_0 is zero (the runner starts from rest), and x is the position that corresponds to time t_u. Method two would calculate the magnitude of the average velocity for every 10 m that the runner transverses up to 100 m. A general formula to accomplish this would be $\bar{v}_n = \dfrac{x_n - x_{n-1}}{t_n - t_{n-1}}$, where $n = 1, 2, 3, \ldots, 10$. When the average speed stops increasing as calculations proceed for positions x_1 through x_{10}, the acceleration period is over at that position (labeled x_u) and the time it took for the runner to get to that position can be called t_u. To calculate a_u the equation $x_u = x_0 + v_0 t_u + \frac{1}{2} a_u t_u^2$, where x_0 is zero (the starting line), v_0 is zero (the runner starts from rest), and x is the position that corresponds to time t_u. Or, a_u could be using the definition of acceleration of $a_u = \dfrac{v - v_0}{t_u}$, where v is the final velocity of the acceleration period.

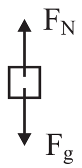
1. (a)



(b) i. $\bar{a} = \dfrac{\Delta v}{\Delta t} = \dfrac{v - v_o}{t - t_o} = \dfrac{0\ m/s - 1.5\ m/s}{10\ s - 8s} = \boxed{-0.75\ m/s^2}$

ii.

(c)

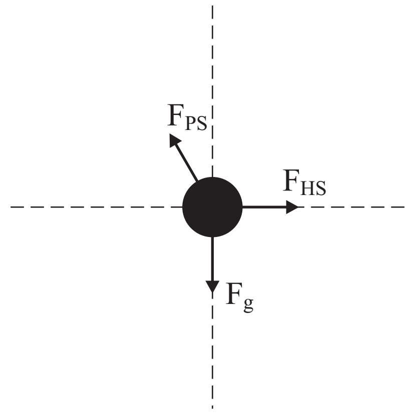


$\Sigma F = F_N - F_g = ma$
$F_N - mg = m(0\ m/s^2)$
$F_N - (70\ kg)(9.8\ m/s^2) = 0$

$\boxed{F_N = 690\ N}$

Note: At $t = 0$ s, $a = 0\ m/s^2$ because the slope of the v vs t graph is acceleration and this graph is a straight horizontal line at $t = 0$ s.

2. (a)



(b) $\Sigma F_y = F_{PSy} - F_g = ma$

$F_{PS} \sin 60 - mg = m(0)$

$F_{PS} \sin 60 - (1.8\text{ kg})(9.8\text{ m/s}^2) = 0$

$F_{PS} = 20.4\text{ N}$

$\Sigma F_x = F_{HS} - F_{PSx} = ma$

$F_{HS} - (20.4\text{ N})\cos 60 = m(0)$

$\boxed{F_{HS} = 10.2\text{ N}}$

(c) $GPE_1 = KE_2$

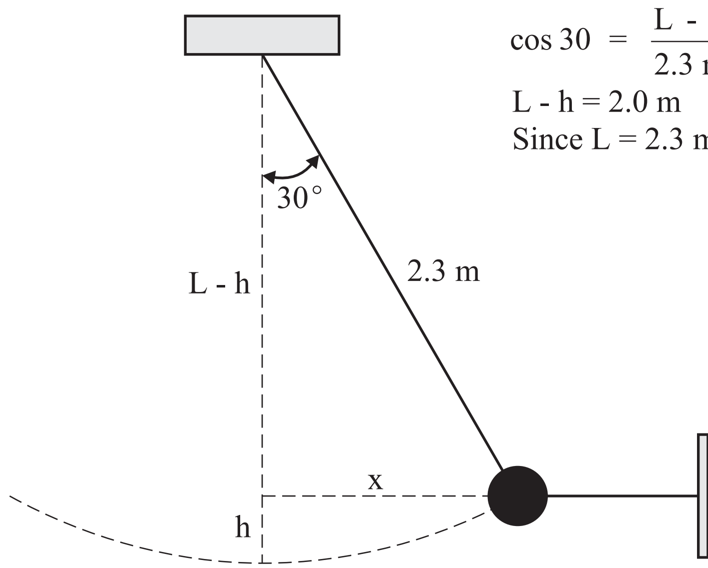
$\not{m}gh = \frac{1}{2}\not{m}v^2$

$gh = \frac{1}{2}v^2$

$v = \sqrt{2gh}$

$v = \sqrt{2\left(9.8\text{ m/s}^2\right)\left(0.3\text{ m}\right)}$

$\boxed{v = 2.4\text{ m/s}}$



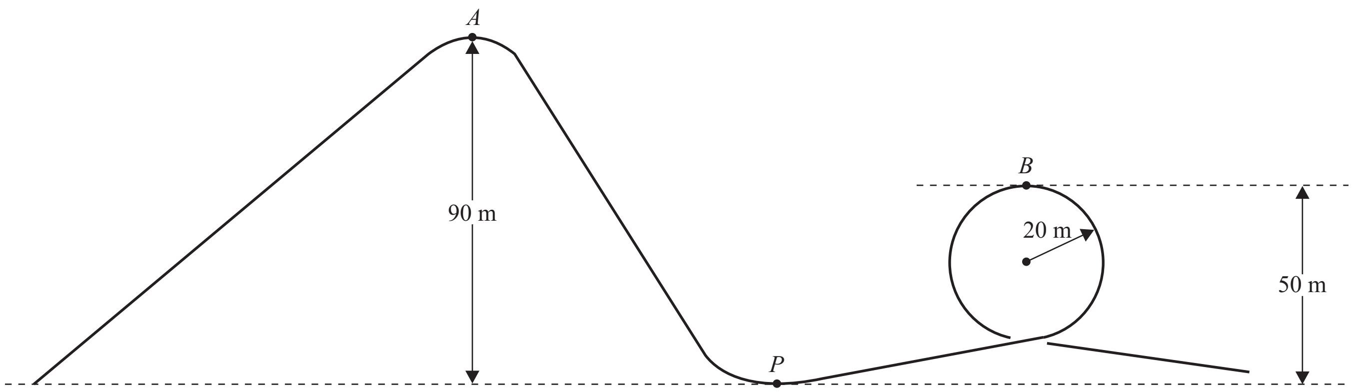
$\cos 30 = \dfrac{L - h}{2.3\text{ m}}$

$L - h = 2.0\text{ m}$

Since $L = 2.3\text{ m}$, $h = 0.3\text{ m}$.

Note: This could have been solved using $v_o = 2\pi f A$. The frequency of a pendulum is $f = \dfrac{1}{2\pi}\sqrt{\dfrac{g}{L}}$. The amplitude could be determined by converting 30° to 0.52 radians and using $l = r\theta$ where l is the maximum arc length of the pendulum swing, or l is the amplitude, A, and r is the radius of the circle, or the length of the string.

1. (a) i.



ii. $GPE_1 = KE_2$

$$\not{m}gy_1 = \tfrac{1}{2}\not{m}v_{max}^2$$

$$v_{max} = \sqrt{2gy_1} = \sqrt{2(9.8\ m/s^2)(90\ m)}$$

$$\boxed{v_{max} = 42\ m/s}$$

(b.) $GPE_1 = KE_2 + GPE_2$

$$\not{m}gy_1 = \tfrac{1}{2}\not{m}v_{max}^2 + \not{m}gy_2$$

$$v_{max} = \sqrt{2g(y_1 - y_2)} = \sqrt{2(9.8\ m/s^2)(90\ m - 50\ m)}$$

$$\boxed{v_{max} = 28\ m/s}$$

OR

$KE_1 = GPE_2$

$$\tfrac{1}{2}\not{m}v_{max}^2 = \not{m}gy_2$$

$$v_{max} = \sqrt{2gy_1} = \sqrt{2(9.8\ m/s^2)(40\ m)}$$

$$v_{max} = 28\ m/s$$

(c) i.

ii. $F_g = mg = (700\ kg)(9.8\ m/s^2)$

$F_g = 6860\ N$

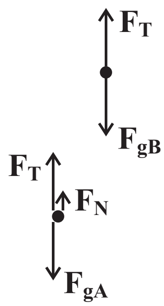
$$\Sigma F = F_N + F_g = F_C = m\frac{v^2}{r}$$

$$F_N + 6860\ N = (700\ kg)\frac{(28\ m/s)^2}{(20\ m)}$$

$$\boxed{F_N = 20580\ N}$$

(d) Put the bottom of the loop at ground level so the ΔGPE from the top of the hill to the top of the loop is greater. Therefore, some loss of energy due to friction would leave the same amount of KE.

1. (a)



(b) $\Sigma F_A = F_N + F_T - F_{gA} = ma$

$F_N + F_T - m_A g = 0$

$F_N + 588\text{ N} - (70\text{ kg})(9.8\text{ m/s}^2) = 0$

$F_N = 98\text{ N}$

$\Sigma F_B = F_T - F_{gB} = ma$

$F_T - m_B g = 0$

$F_T - (60\text{ kg})(9.8\text{ m/s}^2) = 0$

$F_T = 588\text{ N}$

(c) $\Sigma F_B = F_T - F_{gB} = ma$

$F_T - m_B g = ma$

$F_T - (60\text{ kg})(9.8\text{ m/s}^2) = (60\text{ kg})(0.25\text{ m/s}^2)$

$F_T = 603\text{ N}$

(d) No, because the upward tension force (603 N) on Student A is less than the downward force of gravity [(70 kg)(9.8 m/s^2) = 686 N].

(e) The tension force must equal the weight (686 N) of Student A to just begin to lift him off the ground. Since the tension force is the same throughout the rope, this is the tension force that will be exerted on Student B.

$\Sigma F_B = F_T - F_{gB} = ma$

$F_T - m_B g = ma$

$686\text{ N} - (60\text{ kg})(9.8\text{ m/s}^2) = (60\text{ kg})a$

$a = 1.6\text{ m/s}^2$

3. (a) $x = x_o + v_o t + \frac{1}{2}at^2$

$F = ma$

$x = 0 + 0 + \frac{1}{2}\frac{F}{M}t^2$

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

$$\boxed{x = \frac{1}{2}\frac{F}{M}t^2}$$

(b) $v^2 = v_o^2 + 2a(x - x_o)$

$v^2 = 0 + 2\frac{F}{M}(L - 0)$

$$\boxed{v = \sqrt{\frac{2FL}{M}}}$$

(c) $\Delta KE = \frac{1}{2}mv^2 - \frac{1}{2}mv_o^2$

$\Delta KE = \frac{1}{2}M\left(\sqrt{\frac{2FL}{M}}\right)^2 - 0 = \frac{1}{2}M\left(\frac{2FL}{M}\right)$

$$\boxed{\Delta KE = FL}$$

OR $W = \Delta KE$

$FL = KE_f - KE_i = KE_f - 0$

$\Delta KE = FL$

(d) The direction of the magnetic field must be out of the page toward the reader. To determine this direction use the right-hand rule that governs the direction of the force on a current-carrying wire in the presence of a magnetic field. This rule stipulates that the fingers are placed in the direction of the current, the wrist is rotated so that the fingers can curl in the direction of the magnetic field resulting in the thumb pointing in the direction of the force on the wire. (More formally, $\mathbf{F} = I\ell \times \mathbf{B}$ so the fingers are put in the direction of $I\ell$ and curled in the direction of $\mathbf{B}$ with the thumb again demonstrating the direction of the force on the wire). Here, the directions of the current and the force are known. So, the fingers are place in the direction of the current (toward the top of the page) and the wrist is rotated so that the thumb can point to the right in the direction of the force, resulting in the fingers being able to curl out of the page showing the direction of the magnetic field.

(e) From part (c) above, $W = \Delta KE$

$FL = \frac{1}{2}mv^2 - \frac{1}{2}mv_o^2$

$(100\ N)(10\ m) = \frac{1}{2}(0.5\ kg)v^2 - \frac{1}{2}(0.5\ kg)(0 m/s)$

$F = I\ell B \sin\theta$ (or $\mathbf{F} = I\ell \times \mathbf{B}$)

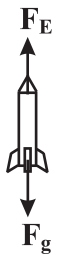
$F = (200\ A)(0.10\ M)(5\ T)\sin 90 = 100\ N$

$$\boxed{v = 63.2\ m/s}$$

2002 B

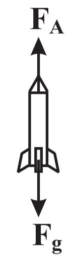
1. (a)

i.



ii.

iii.



Notes: F_E is the average force from engine (reaction force from gases on rocket that are expelled by rocket)

F_A is force from air ressistance

(b) $\Sigma F = F_E - F_g = ma$

$F_E - mg = ma$

$10\text{ N} - (0.250\text{ kg})(9.8\text{ m/s}^2) = (0.250\text{ kg})a$

$J_E = F_E\Delta t$

$20\text{ N}\bullet\text{s} = F_E(2.0\text{ s})$

$F_E = 10\text{ N}$

$a = 30.2\text{ m/s}^2$

(c) $y_1 = y_o + v_o t + \frac{1}{2}at^2$

$y_1 = 0 + 0 + \frac{1}{2}(30.2\text{ m/s}^2)(2.0\text{s})^2$

$y_1 = 60.4$ m = height achieved while engines were firing

$W_{net} = \Delta KE_1$ [Note: the net work includes the work done against gravity so ΔGPE does not appear on the right side of the equation.]

$F_{net}y_1 = \frac{1}{2}mv_1^2 - \frac{1}{2}mv_o^2$

$may_1 = \frac{1}{2}mv_1^2 - 0$

$(0.25\text{ kg})(30.2\text{ m/s}^2)(60.4\text{ m}) = \frac{1}{2}(0.25\text{ kg})v_1^2$

$v_1 = 60.4\text{ m/s}$

$\Delta KE_2 = \Delta GPE_2$

$\frac{1}{2}mv_2^2 - \frac{1}{2}mv_o^2 = mgy_2$

$\frac{1}{2}(0.25\text{ kg})(60.4\text{ m/s})^2 - 0 = (0.25\text{ kg})(9.8\text{ m/s}^2)y_2$

$y_2 = 186$ m = additional height achieved after the engines are cut

$y_{total} = y_1 + y_1 = 60.4\text{ m} + 186\text{ m}$

$y_{total} = 246\text{ m}$

(d) $v = v_o + at_2$

$0 = (60.4\text{ m/s}) + (-9.8\text{ m/s}^2)t_2$

$t_2 = 6.2$ seconds

2. (a) 0.05 J (estimate from graph)

(b) 10 cm - From the graph, the potential energy is 0.4 J (the enrgy of the object) at 10 cm. This is when all of the energy of the simple harmonic oscillator is potential (none kinetic), thus, 10 cm is the ampltidude of the motion.

(c) From the graph, the object's potential energy is approximately 0.2 J when the object's displacement is -0.7 m. Since the total energy of the object of 0.4 J is the sum of the kinetic energy and poential enrgy at any point in the path:

$E = U + KE$

$0.4\ J = 0.2\ J + KE$

$\boxed{KE = 0.2\ J}$

(d) $KE = ½mv^2$

$0.4\ J = ½(3.0\ kg)v^2$ Note: At x = 0 cm, there is zero potential energy (from the graph), so all of of the energy (0.4 J) is kinetic.

$\boxed{v = 0.52\ m/s}$

(e)

x	y
$v_{xo} = 0.52\ m/s$	$v_{yo} = 0\ m/s$
$d = ?$	$y_o = 0.5\ m$
	$y = 0\ m$
	$g = -9.8\ m/s^2$
	$t = ?$

$y = y_o + v_{yo}t + ½gt^2$

$0\ m = 0.5\ m + (0\ m/s)t + ½(9.8\ m/s^2)t^2$

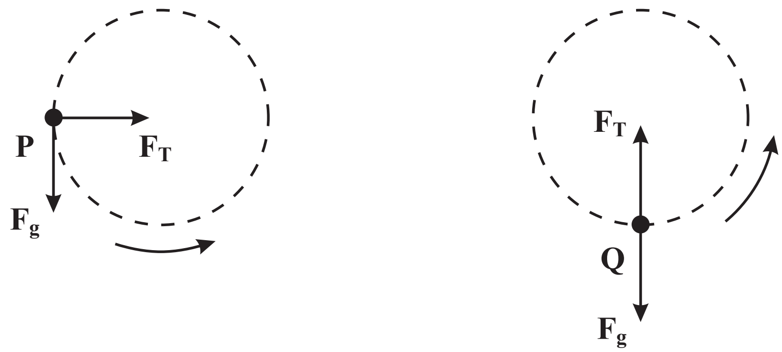
$t = 0.32\ s$

$d = v_{xo}t = (0.52\ m/s)(0.32\ s)$

$\boxed{d = 0.16\ m}$

2001 B

1. (a)



(b) $\Sigma F = F_T + F_g = F_C$

$0 + mg = m\frac{v^2}{r}$

$v^2 = rg$

$$v = \sqrt{rg}$$

(c)Analyze at point Q where tension is a maximum.

$\Sigma F = F_T - F_g = F_C$

$T_{max} - mg = m\frac{v_{max}^2}{r}$

$v_{max}^2 = \frac{(T_{max} - mg)r}{m}$

$$v_{max} = \sqrt{\frac{(T_{max} - mg)r}{m}}$$

(d) It will move straight up (tangent to the circle).

2001 B

2. (a) $m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

$(0.10\text{ kg})(1.4\text{ m/s}) + (0.50\text{ kg})(0\text{ m/s}) = (0.10\text{ kg})(-0.70\text{ m/s}) + (0.50\text{ kg})\, v_2'$

$v_2' = 0.42\text{ m/s}$

(b) Given:

x	y
$x = ?$	$y_o = 1.2\text{ m}$
$v_{x0} = 0.42\text{ m/s}$	$y = 0\text{ m}$
	$v_{y0} = 0\text{ m/s}$
	$g = -9.8\text{ m/s}^2$
	$t = ?$

$y = y_o + v_{y0}t + \frac{1}{2}gt^2$

$0 = 1.2\text{ m} + (0\text{ m/s})t + \frac{1}{2}(-9.8\text{ m/s}^2)t^2$

$-1.2\text{ m} = (-4.9\text{ m/s}^2)t^2$

$t^2 = 0.24\text{ s}^2$

$t = 0.49\text{ s}$

$x = v_{x0}t = (0.42\text{ m/s})(0.49\text{ s})$

$x = 0.21\text{ m}$

(c) Given:

x	y
$x = 0.15\text{ m}$	$y_o = 1.2\text{ m}$
$v_{x0} = ?$	$y = 0\text{ m}$
	$v_{y0} = 0\text{ m/s}$
	$g = -9.8\text{ m/s}^2$
	$t = ?$

$y = y_o + v_{y0}t + \frac{1}{2}gt^2$

$0 = 1.2\text{ m} + (0\text{ m/s})t + \frac{1}{2}(-9.8\text{ m/s}^2)t^2$

$-1.2\text{ m} = (-4.9\text{ m/s}^2)t^2$

$t^2 = 0.24\text{ s}^2$

$t = 0.49\text{ s}$

$x = v_{x0}t$

$0.15\text{ m} = v_{x0}(0.49\text{ s})$

$v_{x0} = 0.30\text{ m/s} = v_0$

(d) $p_A' = m_A v_{yA} \sin 30 = (0.10\text{ kg})(0.30\text{ m/s})\sin 30$

$p_A' = 0.015\text{ m/s}$

1. (a) 4 s, 18 s

   (b) 4 s - 9 s, 18 s - 20 s

   (c) Δx = Area under the graph up to 4.0 s + Area under the graph from 4.0 s to 9.0 s (these areas can be found using the formula for the area of a triangle)

   $\Delta x = ½\, \Delta v_{x4} \bullet t + ½\, \Delta v_{x9} \bullet t$

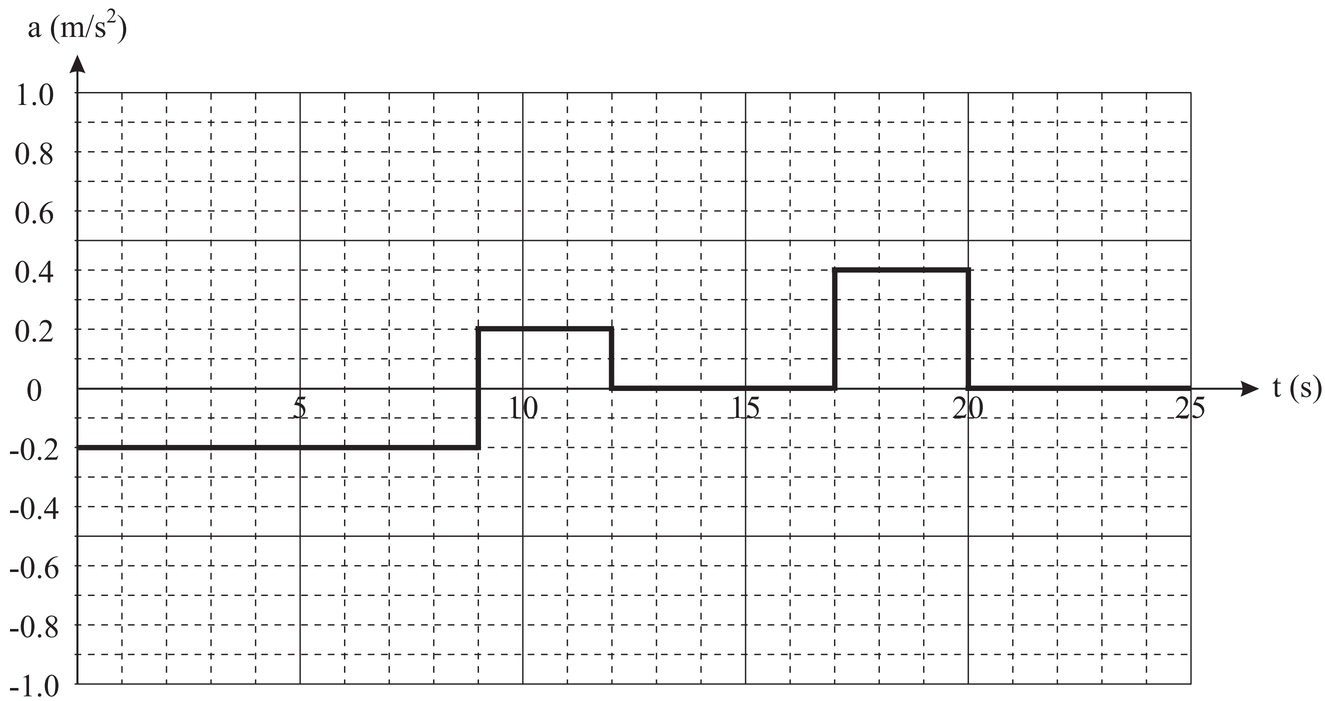
   $\Delta x = ½\,(0.8\text{ m/s})(4.0\text{ s}) + ½\,(-1.0\text{ m/s})(5.0\text{ s})$

   $\Delta x = -0.9\text{ m}$

   $x = x_0 + \Delta x = 2.0\text{ m} + (-0.9\text{ m})$

   $x = 1.1\text{ m}$

   (d)



   (e) i. $y = y_0\, v_{y0}t + ½gt^2$

   $0\text{ m} = 0.40\text{ m} + (0\text{ m/s})t + ½(-9.8\text{ m/s}^2)t^2$

   $t = 0.286\text{ s}$

x	y
$v_{x0} = 0.80$ m/s	$v_{y0} = 0.80$ m/s $y_0 = 0.40$ m $y = 0$ m $g = -9.8$ m/s^2

   ii. $x = v_{xo}t = (0.80\text{ m/s})(0.286\text{ s})$

   $x = 0.229\text{ m}$

   iii. $KE_1 + GPE_1 = KE_2$

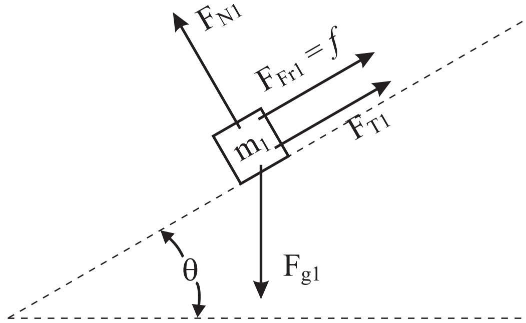
   $½mv_1^2 + mgh = KE_2$

   $KE_2 = ½(0.5\text{ kg})(0.8\text{ m/s})^2 + (0.5\text{ kg})(9.8\text{ m/s}^2)(0.40\text{ m})$

   $KE_2 = 2.12\text{ J}$

2000 B

2. (a)



(b) $F_{Fr1} = \mu F_N$

$f = \mu mg\cos\theta$

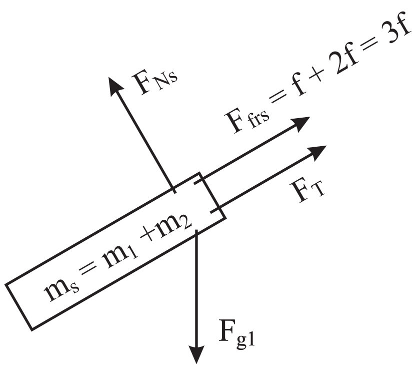
$$\mu = \frac{f}{m_1 g\cos\theta}$$

$\Sigma F_y = F_N - F_{gy} = ma$

$F_N - mg\cos\theta = 0$

$F_N = mg\cos\theta$

(c)



$\Sigma F_x = F_T + F_{fr} - F_{gsx} = ma$

$Mg + 3f - (m_1 + m_2)g\sin\theta = 0$

$Mg = (m_1 + m_2)g\sin\theta - 3f$

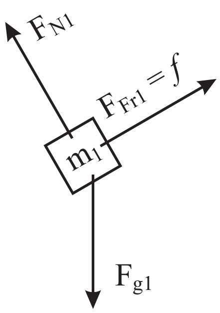
$$M = (m_1 + m_2)\sin\theta - \frac{3f}{g}$$

$\Sigma F_y = F_T - F_g = ma$

$F_T - Mg = 0$

$F_T = Mg$

(d)



$\Sigma F_x = F_{g1} - F_{Fr} = ma$

$m_1 g\sin\theta - f = m_1 a$

$$a = g\sin\theta - \frac{f}{m_1}$$