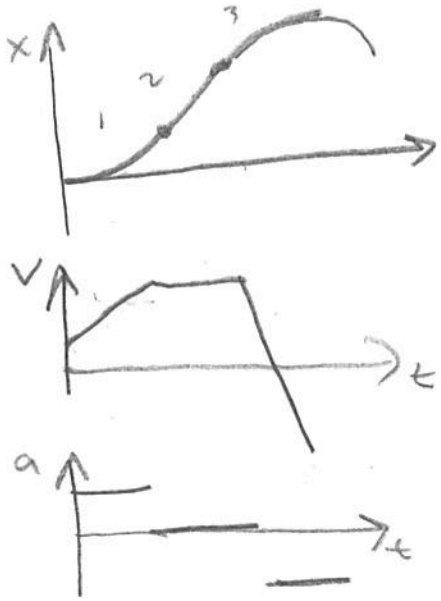
Motion

1.



① Moving forward speeding up
② Maintain forward speed
③ Slow down, turn around, speed up backwards

2. $x = 2t^3 - t$

a) $v = \frac{dx}{dt} = 6t^2 - 1 \quad v(3) = 6(3)^2 - 1 = \boxed{53\ m/s}$

b) $v_{AVE} = \frac{\Delta x}{\Delta t} = \frac{(2(3)^3 - 3) - (2(1)^3 - 1)}{(3-1)} = \frac{(54-3)-(1)}{2} = \boxed{25\ m/s}$

c) $\boxed{v = 6t^2 - 1}$

d) $\boxed{a = 12t}$

3. $x_i = 0$ m
$x_f =$
$V_{xi} = 25\cos 30 = 21.7$ m/s
$V_{xf} =$
$a_x = 0$ m/s²
$t =$

$y_i = 0$ m
$y_f =$
$V_{yi} = 25\sin 30 = 12.5$ m/s
$V_{yf} =$
$a_y = -9.8$ m/s²
$t =$

$x_f = x_i + V_{xi}t + \frac{1}{2}a_x t^2$
$x_f = 21.7t$

$V_{xf} = V_{xi} + a_x t$
$V_{xf} = 21.7$ m/s

$y_f = y_i + V_{yi}t + \frac{1}{2}a_y t^2$
$y_f = 12.5t - 4.9t^2$

$V_{yf} = V_{yi} + a_y t$
$V_{yf} = 12.5 - 9.8t$

t = 1 s
$x_f = 21.7$ m
$V_{xf} = 21.7$ m/s
$a_x = 0$
$y_f = 7.6$ m
$V_{yf} = 2.7$ m/s
$a_y = -9.8$ m/s²

t = 2 s
$x_f = 43.4$ m
$V_{xf} = 21.7$ m/s
$a_x = 0$
$y_f = 5.4$ m
$V_{yf} = -7.1$ m/s
$a_y = -9.8$ m/s²

top when $V_{yf} = 0$ t = 1.28 s
$x_f = 27.7$ m
$V_{xf} = 21.7$ m/s
$a_x = 0$
$y_f = 8.0$ m
$V_{yf} = 0$ m/s
$a_y = -9.8$ m/s²

4.

Ball
$x_i = 0$
$x_f =$
$V_{xi} = 27.1$ m/s
$V_{xf} = 27.1$ m/s
$a_x = 0$ m/s²
$t =$

$y_i = 0$ m
$y_f = 0$ m
$V_{yi} = 12.7$ m/s
$V_{yf} = -12.7$ m/s
$a_y = -9.8$ m/s²
$t =$

Person
$x_i =$
$x_f =$
$V_i = 7$ m/s
$V_f = 7$ m/s
$a = 0$ m/s²
$t =$

a) $V_{BP} = V_{BG} + V_{GP} = 27.1 + (-7) = \boxed{20.1\ m/s}$

b) $V_{yf} = V_{yi} + a_y t$
$-12.7 = 12.7 - 9.8t$
$2.59\ s = t$

$x_f = x_i + V_{xi}t + \frac{1}{2}at^2$
$x_f = 0 + 27.1(2.59) + 0$
$\boxed{x_f = 70.1\ m}$

c) $x_f = x_i + V_i t + \frac{1}{2}at^2$
$70.1 = x_i + 7(2.59) + 0$
$\boxed{x_i = 52\ m}$

Forces

1. 

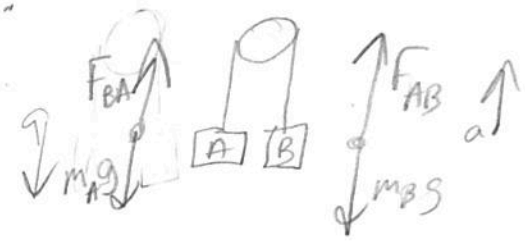
$\Sigma F = ma$

$F_{EP} - mg = ma$

$600 - 70(9.8) = 70a$

$-1.23 \frac{m}{s^2} = a$

Acceleration is down @ $1.23 \frac{m}{s^2}$. Either speeding up downward or slowing as it's moving up.

2. 

A

$\Sigma F = ma$

$m_A g - F_{BA} = m_A a$

$(5)(9.8) - F_{BA} = 5a$

$(5)(98) - (3(9.8) + 3a) = 5a$

$19.6 = 8a$

$a = 2.45 \frac{m}{s^2}$

B

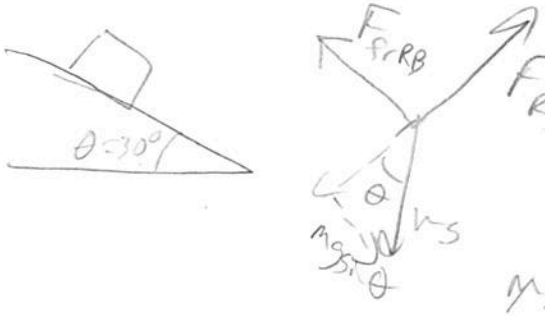
$\Sigma F = ma$

$F_{AB} - m_B g = m_B a$

$F_{AB} - (3)(9.8) = (3)a$

$F_{AB} = 3(9.8) + 3a$

$F_{AB} = 36.75 N$

3. 

Along R_B

$\Sigma F = ma$

$mg\sin\theta - F_{fr\,RB} = ma$

$mg\sin\theta - \mu mg\cos\theta = ma$

$g\sin(30) - 0.1(9.8)\cos 30 = a$

$4.05 \frac{m}{s^2} = a$

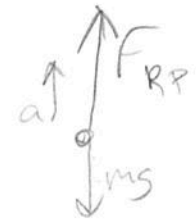
$\perp R_B$

$\Sigma F = ma$

$F_{RB} - mg\cos\theta = 0$

$F_{RB} = mg\cos\theta$

4. 



$\Sigma F = ma$

$F_{RP} - mg = m\frac{v^2}{r}$

$F_{RP} - 60(9.8) = 60\left(\frac{4^2}{3}\right)$

$F_{RP} = 908 N$

5. 

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

$F_{RP} = m\frac{v^2}{r} - mg$

$F_{RP} = 50\left(\frac{15^2}{5}\right) - 50(9.8)$

$F_{RP} = 1760 N$

Energy

1, a) $W = \vec{F} \cdot \vec{d}$

$W = 150(2)$

$\boxed{W = 300\,J}$

b) $W = \Delta K + \Delta U$

$300 = \frac{1}{2} m v_f^2 - 0 + mgh_f - 0$

$300 = \frac{1}{2}(10) v_f^2 + (10)(9.8)(2)$

$\boxed{v_f = 4.56 \frac{m}{s}}$

2. a) $K_i + U_i = K_f + U_f$

$\frac{1}{2}(200)(2)^2 + (200)(9.8)h = \frac{1}{2}(200)(35)^2$

$\boxed{h = 62.3m}$

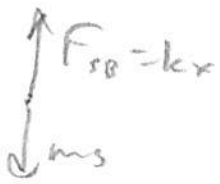
b) $W = \Delta K + \Delta U$

$W = 0 - \frac{1}{2}(200)(2)^2 + 200(9.8)(31.15) - 200(9.8)(62.3)$

$\boxed{W = -61454\,J}$

3. 

a) Max speed when $a = 0$



$\Sigma \vec{F} = m\vec{a}$

$F_{SB} - mg = 0$

$kx - mg = 0$

$300x - 5(9.8) = 0$

$x = 0.163m \Rightarrow \boxed{16.3cm}$

b) $K_i^{\,0} + U_i = K_f^{\,0} + U_f$

$mg(2+x) = \frac{1}{2}kx^2$

$(5)(9.8)(2) + (5)(9.8)x = 150x^2 \Rightarrow 0 = 150x^2 - 49x - 98$

$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{49 \pm \sqrt{49^2 + 4(150)(98)}}{2(150)}$

$x = \boxed{0.99m}$ or $-0.66m$

4. $U = 3r^2 - \frac{4}{r}$

$F = -\frac{dU}{dr} = \boxed{-\left(6r + \frac{4}{r^2}\right)}$

5. $W = \Delta K + \Delta U^{\,0} \Rightarrow -(10.4)(8)(9.8)d = 0 - \frac{1}{2}(8)(4)^2$

$\boxed{d = 2.04m}$

Momentum

1. 

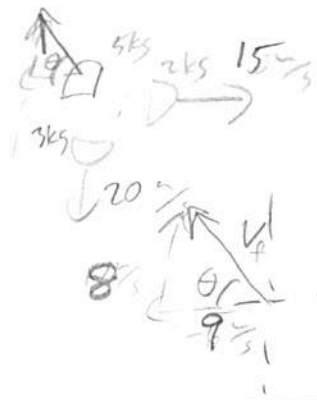
a) $x_{cm} = \frac{1}{M_T}\sum m_i x_i = \frac{1}{9}(4(2)+5(0)) = \boxed{0.89\ m}$

b) $P_i = P_f$

$5(3) + 4(-6) = 9v_f$

$15 - 24 = 9v_f \Rightarrow \boxed{v_f = -1\ \frac{m}{s}}$

c) $J = \Delta p = 5(-1-3) = \boxed{-20\ kg\frac{m}{s}}$

2. 

x	y
$\vec{P}_i = \vec{P}_f$	$P_i = P_f$
$0 = 3(15)+2(0)+5v_x$	$0 = 3(0)+2(-20)+5v_y$
$-9\ \frac{m}{s} = v_x$	$8\ \frac{m}{s} = v_y$

$v_f = \sqrt{(-9)^2 + 8^2} = 12.0\ \frac{m}{s}$

$\theta = \tan^{-1}\left(\frac{8}{9}\right) = 41.6°$

$\boxed{v_f = 12.0\ \frac{m}{s}\ @\ 41.6°\ +y\ of\ -x}$

3. 

a) $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$

$3(2) + 0 = 3(1) + 1v_{2f}$

$\boxed{3\ \frac{m}{s} = v_{2f}}$

b) $K_i = \frac{1}{2}(3)(2)^2 + 0 = 6\ J$

$K_f = \frac{1}{2}(3)(1)^2 + \frac{1}{2}(1)(3)^2 = 1.5 + 4.5 = 6\ J$

$\boxed{\text{Elastic collision since } K_i = K_f}$