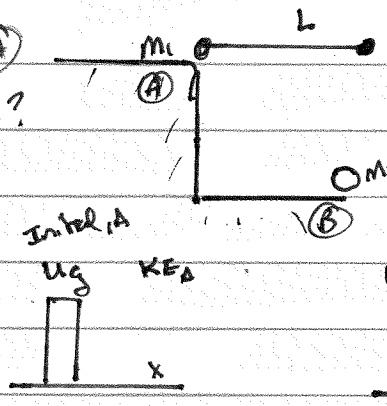
AP Physics - Unit 5

Pre-Exam - FRQ - KEY

① (A)



$U_{g_A} = KE_B$

$mgh = \frac{1}{2}mV_B^2$

$h = L$

$gL = \frac{1}{2}V_B^2$

$\boxed{V_B = \sqrt{2gL}}$

(B) $F_T = ?$

$\Sigma F_{net} = \frac{mV_B^2}{r}$

$r = L$

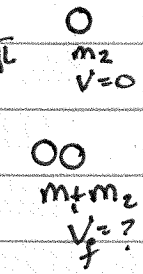
$F_T - mg = \frac{mV_B^2}{L}$ $\quad V_B = \sqrt{2gL}$

$F_T = mg + \frac{m(\sqrt{2gL})^2}{L}$

$F_T = mg + 2mg$ $\quad L$'s cancel

$\boxed{F_T = 3mg}$

(C) $V_f = ?$



$P_i = P_f$ $\quad$ ○ rest

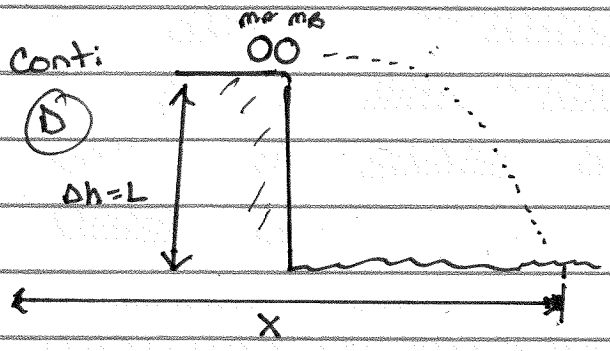
$m_A V_{B_i} + m_B \cancel{V_{B_i}} = V_f(m_A + m_B)$

$V_{A_i} = \sqrt{2gL}$

$V_f = \frac{m_A\sqrt{2gL}}{m_A + m_B}$

Pre-Exam-Unit5-KEY

(1) Conti:



1st How Long to fall L?

$y = y_0 + v_{y_0} t + \frac{1}{2} g t^2$

$y = L$

$L = \frac{1}{2} g t^2$

$$t = \sqrt{\frac{2L}{g}}$$

$d = v \cdot t$

$t = \sqrt{\frac{2L}{g}}$

$v_f = \frac{m_A \sqrt{2gL}}{m_A + m_B}$

$d = \left(\sqrt{\frac{2L}{g}}\right) \frac{m_A \sqrt{2gL}}{m_A + m_B}$

$d = \frac{2L\, m_A}{m_A + m_B}$ Distance from cliff to Landing

$$D_{Total} = L + \frac{2L\, m_A}{m_A + m_B}$$

or

$$L\left(1 + \frac{2 m_A}{m_A + m_B}\right)$$

(2) (A) $a_{avg} = ?$

a = is slope of curve $V_{vs\,T}$

$$\text{slope} = \frac{\Delta \text{Rise}}{\Delta \text{Run}} = \frac{-.18 - -.21}{0.37 - 0.33} \frac{m/s}{s}$$

$$= 9.75 \approx \boxed{10. \; m/s^2}$$

(B) $\Delta p = F\Delta t$

$= $ Area under curve $F_{vs\,T}$

$= (6 \text{ boxes})(10 N)(0.01 s)$

$\boxed{\Delta p = 0.6 \; N \cdot s}$

(C) Mass of cart $= ?$

$$F\Delta t = \Delta p = m\Delta V$$

$$m = \frac{F\Delta t}{V_f - V_i} = \frac{0.6 \; N \cdot s}{(-0.18 - -0.22) \; m/s}$$

$\boxed{m = 1.5 kg}$

(D) Energy Lost ?

$KE_{lost} = \Delta KE$

$= KE_f - KE_i$

$= \frac{1}{2} m V_f^2 - \frac{1}{2} m V_i^2 = \frac{1}{2} m (V_f^2 - V_i^2)$

$= \frac{1}{2}(1.5 kg)[(-0.18)^2 - (0.21)^2]$

$\boxed{KE_{lost} = -0.0088 J}$

Pre-Exam - Unit 5 - KEY

(3)

Cart A
$V_i = 2.0\ m/s$
250 kg

Cart B
$V_i = 0$
200 kg

15 m

(A) T_{Total} ? for 15 m

$V = 5.0\ m/s$

x_1 | x_2

$a = 1.5\ m/s^2$

How Long to accelerate to 5.0 m/s?

$$V_x = V_{x0} + at$$

$$t = \frac{V_x - V_{x0}}{a} = \frac{5.0\ m/s - 2.0\ m/s}{1.5\ m/s^2}$$

$$t = 2\ s$$

How far Travel (x_1) in 2 secs?

$$x_1 = \cancel{x_0}^{0} + V_{x0}t + \frac{1}{2}at^2$$

$$= (2.0\ m/s)(2s) + \frac{1}{2}(1.5\ m/s^2)(2s)^2$$

$$x_1 = 4m + 3m$$

$$x_1 = 7m$$

15m - 7m = 8m

How Long to Travel 8m At 5.0 m/s ? x_2 ?

$$V = \frac{d}{t}$$

$$t = \frac{d}{V} = \frac{8m}{5.0\ m/s}$$

$$t_2 = 1.6\ s$$

Total time = 2s + 1.6s = 3.6s

(B) V_{Af} = ?

$$p_i = p_f$$

$$M_A V_{Ai} + \cancel{M_B V_{Bi}}^{0} = M_A V_{Af} + M_B V_{Bf}$$

$$V_{Af} = \frac{M_A V_{Ai} - M_B V_{Bf}}{M_A}$$

$$= \frac{(250\ kg)(5.0\ m/s) - (200\ kg)(4.8\ m/s)}{250\ kg}$$

$V_{Af} = 1.2\ m/s$ to the Right

(3) Conti

(C) is Collision Elastic?

if Elastic $KE_i = KE_f$ (Rest: $v_B = 0$, $v_f = ?$)

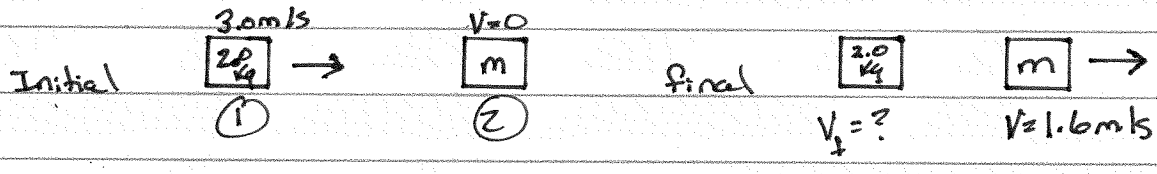
$\frac{1}{2}m_A v_i^2 + \frac{1}{2}m_B v_i \overset{?}{=} \frac{1}{2}m_A v_f^2 + \frac{1}{2}m_B v_f^2$

$\frac{1}{2}(250\,kg)(5.0\,m/s)^2 \overset{?}{=} \frac{1}{2}(250\,kg)(1.2\,m/s)^2 + \frac{1}{2}(200\,kg)(4.8\,m/s)^2$

$3125\,J \neq 2484\,J$

∴ Inelastic Collision

(4)



(A) $V_f = ?$ & direction after Collision

Can't do $p_i = p_f$ Because don't know m, can't 2

But $F\Delta t = m\Delta V$ (P)

$F\Delta t$ = Impulse = Area under Curve Area $= \frac{1}{2}bh$

$A = \frac{1}{2}(1.0\,ms)(10\,kN)\left(\frac{1000\,N}{1\,kN}\right)\left(\frac{1\,s}{1000\,ms}\right)$

$= 5\,N\cdot s$ $\boxed{F\Delta t = -5\,N\cdot s}$ - Because opposite ✗ F

$F\Delta t = mv_f - mv_i$

$v_f = \frac{F\Delta t + mv_i}{m} = \frac{-5\,N\cdot s + (2.0\,kg)(3.0\,m/s)}{2.0\,kg}$

$\boxed{v_f = 0.5\,m/s}$

(B) m can't 2 = ?

$p_i = p_f$ ($v_B = 0$, $v_f = ?$)

$m_A v_{Ai} + m_B v_{Bi} = m_A v_{Af} + m_B v_{Bf}$

$m_B = \frac{m_A v_{Ai} - m_A v_{Af}}{v_{Bf}} = \frac{(2.0\,kg)(3.0\,m/s) - (2.0\,kg)(0.5\,m/s)}{1.6\,m/s}$

$\boxed{m_B = 3.1\,kg}$

(4) cont:

(C) A = ? slope $\frac{\Delta \text{Rise}}{\Delta \text{Run}} = \frac{0.5 - 0.9 \text{ m/s}}{3.5 - 3.0 \text{ s}} = -0.80 \text{ m/s}^2$

(D) D is Area under V vs t graph

○ Bh + ($\frac{1}{2}$Bh + Bh) + Bh

$D = (2s)(1.6 m/s) + [\frac{1}{2}(1.5s)(1.1 m/s) + (1.5s)(0.5 m/s)] + (1.5s)(0.5 m/s)$

$= 3.2 m + 1.6 + 0.75 m$

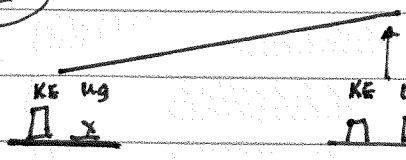
$\boxed{D = 5.6 m}$

or

0-2 constant V	2-3.5 s	3.5-5 s constant V
$D = V \cdot t$	$a = -0.80 m/s^2$	$D = (0.5 m/s)(5 - 3.5)$
$D_1 = (1.6 m/s)(2 sec)$	$V_x^2 = V_{x0}^2 + 2a\Delta x$	$D_3 = 0.75$
$D_1 = 3.2 m$	$\Delta x = \frac{V_x^2 - V_{x0}^2}{2a}$	
	$= \frac{(0.5)^2 - (1.1)^2}{2(0.80)^2}$	
	$\Delta x = 1.4$	

$\boxed{D_T = 5.4 m}$

(E)



Slowing down ∴ up a ramp

$KE_i = KE_f + U_g$?

$\frac{1}{2} m V_i^2 = \frac{1}{2} m V_f^2 + mgh$

$h = \frac{\frac{1}{2}(V_f^2 - V_i^2)}{g} = \frac{\frac{1}{2}(.5^2 - (1.6 m/s)^2)}{9.8 m/s^2}$

$\boxed{h = -0.12 m}$

Pre-Exam-Unit 5 - KEY

8/8

(5) 0.10kg → 1.4m/s; 0.50kg ○ ø

← 0.70m/s; ○ ?

(A) $P_i = P_f$

$m_A v_{Ai} + m_B v_{Bi} = m_A v_{Af} + m_B v_{Bf}$

$v_{Bf} = \dfrac{m_A v_{Ai} - m_A v_{Af}}{m_B}$

$= \dfrac{(0.10kg)(1.4m/s) - (0.10kg)(-0.70m/s)}{(0.50kg)}$

$\boxed{v_{Bf} = 0.42 m/s}$

(B) How long to fall 1.2m? (1st)

$y = y_0 + v_y t + \frac{1}{2} g t^2$

$t = \sqrt{\dfrac{2y}{g}} = \sqrt{\dfrac{2(1.2m)}{9.8 m/s^2}}$

$\boxed{t = 0.49s}$

Horizontal d?

$d = vt = (0.42 m/s)(0.49s)$

$\boxed{d = 0.21 m}$

(C) Same time to fall 1.2m $t = 0.49s$

$v_x = \dfrac{d}{t} = \dfrac{0.150m}{0.49s}$

$\boxed{v_x = 0.31 m/s}$

(D) $P_{y\,direction\,i} = P_{y\,direction\,f}$

$0 = P_{Ay} - P_{cy}$

$P_{Ay} = m_c v_{cy}$

$= (0.10kg)(0.3m/s) \sin 30^\circ$

$\boxed{P_{Ay} = 0.016\ kg\,m/s}$