PHYS 1311 Spring 2016

Chapter 2 Problems

P9, P15, P17, P21, P29, P35, P37, P41 1-30-2016

Problem P9

$\vec{p}_i = \langle 65{,}000, 0, 0\rangle$ kg m/s $t_i = 0$

$\vec{p}_f = \langle 26{,}000, 0, 0\rangle$ kg m/s $t_f = 4.1$ s

→ assume force is constant and apply momentum principle

$$\Delta\vec{p} = \vec{F}_{net}\,\Delta t$$

$$\vec{F}_{net} = \frac{\vec{p}_f - \vec{p}_i}{\Delta t} = \frac{\langle 26{,}000, 0, 0\rangle - \langle 65{,}000, 0, 0\rangle}{4.1}$$

$$\boxed{\vec{F}_{net} = \langle -9510, 0, 0\rangle\ N}$$

Problem P15 $m = 5$ kg, $\vec{F}_{net} = \langle 29, -15, 40\rangle$ N

$\Delta t = 4$ s, $\vec{V}_f = \langle 114, 94, 112\rangle$ m/s

for constant force again use momentum principle

$$\vec{p}_f = \vec{p}_i + \vec{F}_{net}\,\Delta t$$

since $|\vec{V}_f| << |c|$, $\vec{p} \approx m\vec{V}$, divide by m

$$\vec{V}_f = \vec{V}_i + \frac{\vec{F}_{net}}{m}\Delta t$$

or $$\vec{V}_i = \vec{V}_f - \frac{\vec{F}_{net}}{m}\Delta t = \langle 114, 94, 112\rangle - \frac{(4s)\langle 29, -15, 40\rangle}{5\ kg}$$

$$\boxed{\vec{V}_1 = \langle 90.8, 106, 80\rangle\ m/s}$$

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Problem P17 $m = 2500\,kg$, $\vec{V}_i = \langle 24, 0, 0 \rangle\, m/s$

$\vec{V}_f = \langle 0, 0, 0 \rangle$

a) $\vec{V}_{avg}$ during collision $= \frac{1}{2}(\vec{V}_i + \vec{V}_f) = \frac{1}{2}[\langle 24, 0, 0\rangle + \langle 0, 0, 0\rangle]$

$= \langle 12, 0, 0 \rangle \frac{m}{s}$ or $\boxed{|\vec{V}_{avg}| = 12\, m/s}$

b) End of truck displacement is $0.72\,m = \Delta x = |\vec{V}_{avg}|\, \Delta t$

or $\Delta t = \frac{\Delta x}{|\vec{V}_{avg}|} = \frac{0.72\,m}{12\, m/s} = \boxed{0.063\,s}$

c) $\Delta \vec{p} = \vec{F}_{net}\, \Delta t \Rightarrow \vec{F}_{net} = \frac{\Delta \vec{p}}{\Delta t} = \frac{m \Delta \vec{V}}{\Delta t}$

$\vec{F}_{net} = \frac{m |\Delta \vec{v}|}{\Delta t} = \frac{(2500\,kg)\,|24\, m/s|}{0.06\,s} = \boxed{1 \times 10^6\, N}$

d) ratio $= \frac{\vec{F}_{net}}{mg}$ $\frac{1 \times 10^6}{(2500)(9.8)} = \boxed{40.8}$

e) Approximations → 1) Force due to wall is constant during collision, 2) neglect friction

3) $\frac{1}{2}(V_i + V_f)$ is valid which means acceleration is constant

Problem P21 $m = 0.25\,kg$, $t_0 = 0$, $\vec{r}_0 = \langle 0, 2, 0 \rangle\, m$

$\vec{V}_0 = \langle 3, 4, 0 \rangle\, m/s$, using iterative method with $\Delta t = 0.05\,s$, find $\vec{r}_1, \vec{r}_2, \vec{r}_3, \vec{V}_1, \vec{V}_2, \vec{V}_3$ for $t_1 = \Delta t$, $t_2 = 2\Delta t$, $t_3 = 3\Delta t$.

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Problem P21 (Cont'd)

Net force acting on ball is gravity $\vec{F}_{net} = -m\langle 0, g, 0\rangle$

Momentum principle

$$\vec{p}_f = \vec{p}_i + \vec{F}_{net}\Delta t$$

since $|\vec{v}| << c$

$\vec{p} = m\vec{v}$

$$\Rightarrow \vec{v}_f = \vec{v}_i - \frac{\vec{F}_{net}}{m}\Delta t$$

at t_1 $$\vec{v}_1 = \vec{v}_0 - \frac{\vec{F}_{net}}{m}\Delta t$$

$$= \langle 3, 4, 0\rangle - \frac{m}{m}\langle 0, g, 0\rangle 0.05$$

$$\boxed{\vec{v}_1 = \langle 3, 3.51, 0\rangle \, m/s}$$

take $\vec{v}_{avg} = \vec{v}_1 \Rightarrow \vec{r}_1 = \vec{r}_0 + \vec{v}_{avg}\Delta t$

$$\vec{r}_1 = \langle 0, 2, 0\rangle + \langle 3, 3.51, 0\rangle(0.05) = \boxed{\langle 0.15, 2.18, 0\rangle \, m}$$

t_2: $$\vec{v}_2 = \vec{v}_1 - \frac{\vec{F}_{net}}{m}\Delta t$$

$$= \langle 3, 3.51, 0\rangle - \langle 0, 9.8, 0\rangle 0.05$$

$$= \boxed{\langle 3, 3.02, 0\rangle \, m/s}$$

$$\vec{r}_2 = \vec{r}_1 + \vec{v}_{avg}\Delta t = \langle 0.15, 2.18, 0\rangle + \langle 3, 3.02, 0\rangle 0.05$$

$$= \boxed{\langle 0.30, 2.33, 0\rangle \, m}$$

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Problem P21 (cont'd)

t_3: $\vec{V}_3 = \vec{V}_2 + \frac{\vec{F}_{net}}{m}\Delta t$

$$= \langle 3, 3.02, 0\rangle - \langle 0, 9.8, 0\rangle(0.05)$$

$$= \boxed{\langle 3, 2.53, 0\rangle \text{ m/s}} = \vec{V}_{avg}$$

$$\vec{r}_3 = \vec{r}_2 + \vec{V}_{avg}\Delta t = \langle 0.30, 2.33, 0\rangle + \langle 3, 2.53, 0\rangle(0.05)$$

$$\boxed{\vec{r}_3 = \langle 0.45, 2.46, 0\rangle \text{ m}}$$

Problem P29

1) 

(h)

2) 

(d)

3) 

(c)

4) 

(i)

5) 

(g)

6) 

(b)

(a) none (f) none

(e) none

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Problem P 35 Ball kicked from

$\vec{r}_i = \langle 9, 0, -6 \rangle$ m

$\vec{v}_i = \langle -11, 16, -6 \rangle$ m/s

a) Only force acting is gravity $\vec{F}_{net} = -m\langle 0, g, 0 \rangle$ N

Find $\vec{v}_f$ for $t_f = 0.5$ s, $t_i = 0$

$|\vec{v}_i| << c$, $\vec{p} \approx m\vec{v}$, use momentum principle

$\vec{p}_f = \vec{p}_i + \vec{F}_{net} \Delta t \qquad \div m$

$\vec{v}_f = \vec{v}_i + \frac{\vec{F}_{net}}{m} \Delta t = \langle -11, 16, -6 \rangle - \frac{m}{m}\langle 0, 9.8, 0 \rangle (0.5)$

$\boxed{\vec{v}_f = \langle -11, 11.1, -6 \rangle \frac{m}{s}}$

b) $\vec{v}_f$ will give the most accurate $\vec{v}$ at t_f

c) Since $\vec{F}_{net}$ = constant

$\vec{v}_{avg} = \frac{1}{2}(\vec{v}_i + \vec{v}_f) = \frac{1}{2}\left[\langle -11, 16, -6 \rangle + \langle -11, 11.1, -6 \rangle\right]$

$\boxed{\vec{v}_{avg} = \langle -11, 13.6, -6 \rangle \frac{m}{s}}$

d) $\vec{r}_f = \vec{r}_i + \vec{v}_{avg} \Delta t = \langle 9, 0, -6 \rangle + \langle -11, 13.6, -6 \rangle (0.5)$

$\boxed{\vec{r}_f = \langle 3.5, 6.8, -9 \rangle \text{ m}}$

e) want t_{max} for y_{max}, there $\boxed{v_y = 0}$ new final

f) $m v_{yf} = m v_{yi} + F_{net,y} \Delta t \rightarrow \boxed{0 = 16 - 9.8(\Delta t)}$

$0 = \cancel{m} v_{yi} + -\cancel{m} g \Delta t$

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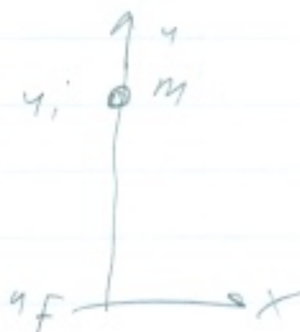
Problem P35 (cont'd)

g) $\Delta t = \frac{V_{yi}}{g} = \frac{16 m/s}{9.8 m/s^2} = \boxed{1.63 s}$

h) $V_{y,avg} = \frac{1}{2}(V_{yi} + V_{yf}) = \frac{1}{2}(16+0) = 8 m/s$

$y_f = y_i + V_{y,avg} \Delta t = 0 + (8\frac{m}{s})(1.63 s) = \boxed{13.1 m}$

Problem P37 ball m



$\boxed{y_i = h, \ V_{iy} = 0}$

$\boxed{y_f = 0}$

$\cancel{y_f}^{0} = y_i + \cancel{V_{yi}}^{0} t_f - \frac{1}{2} g t_f^2$

$0 = h - \frac{1}{2} g t_f^2 \Rightarrow \boxed{t_f = \sqrt{\frac{2h}{g}}}$

$V_{yf} = \cancel{V_{yi}}^{0} - g t_f \Rightarrow V_{yf} = -g\sqrt{\frac{2h}{g}} = \boxed{-\sqrt{2gh} = V_{yf}}$

- changing the mass has no effect since we neglect air resistance

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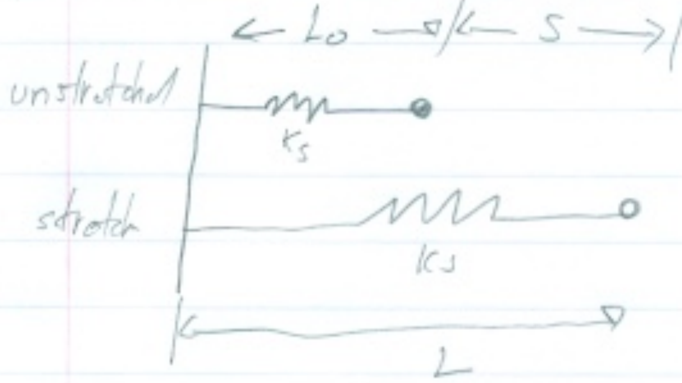
Problem PA1 $k_s = 40\,N/m$, $F = 2N$, $S = 18cm$

$L = L_0 + S$



Apply Hookes Law for magnitude

$$|\vec{F}_{spring}| = k_s |\vec{s}|$$

$$|\vec{s}| = \frac{|\vec{F}_{spring}|}{k_s} = \frac{2N}{40N/m} = 0.05\ m$$

$$L_0 = L - S = 0.18 - 0.05 = \boxed{0.13m}$$