PHYS 1311 EOC HW #1 ①
Spring 2016 Chabay & Sherwood, 4th ed

Chapter 1 Problem Solutions 1-24-2016

Problems P15, P23, P31, P37, P41, P51, P59, P63

Problem P15

a) $\vec{a} = \langle -4, -3, 0 \rangle$
b) $\vec{b} = \langle -4, -3, 0 \rangle$
c) $\vec{a} = \vec{b}$ True
d) $\vec{c} = \langle 4, 3, 0 \rangle$

e) $\vec{c} = -\vec{a}$
$\langle 4, 3, 0 \rangle = -\langle -4, -3, 0 \rangle = \langle 4, 3, 0 \rangle$ True
f) $\vec{d} = \langle -3, 4, 0 \rangle$
g) $-\vec{c} = \langle -4, -3, 0 \rangle \neq \vec{d}$ False

Problem P23 $\langle 3\times10^{-10}, -3\times10^{-10}, 8\times10^{-10} \rangle$ m

a) $\vec{r} = \vec{r}_p - \vec{r}_o = \langle 3, -3, 8 \rangle \text{Å} - \langle 0, 0, 0 \rangle$
$= \langle 3, -3, 8 \rangle \text{Å}$

b)
$$|\vec{r}| = \sqrt{x^2 + y^2 + z^2} = \sqrt{3^2 + (-3)^2 + 8^2}\ \text{Å} = 9.055\ \text{Å}$$

c) $\vec{r} = |\vec{r}|\,\hat{r} \Rightarrow \hat{r} = \dfrac{\vec{r}}{|\vec{r}|} = \dfrac{\langle 3, -3, 8 \rangle}{9.055}$
$= \langle 0.331, -0.331, 0.883 \rangle$

Problem P31

$\vec{r}_i = \langle 0.2, -0.05, 0.17 \rangle$ m
$\vec{r}_f = \langle -0.202, 0.054, 0.0987 \rangle$ m

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Problem P31 (cont'd) $\Delta t = 2 \times 10^{-6}\ s$

$\Delta \vec{r} = \vec{r}_f - \vec{r}_i = \langle -0.402, 0.104, -0.002 \rangle\ m$

$\vec{v}_{avg} = \frac{\Delta \vec{r}}{\Delta t} = \langle -2.01, 0.52, -0.01 \rangle \times 10^5\ m/s$

$|\vec{v}|_{avg} = \sqrt{2.01^2 + 0.52^2 + 0.01^2} \times 10^5\ m/s$

$= 2.08 \times 10^5\ m/s$

Problem P37 $\vec{r}_1 = \langle -3.5, 9.4, 0 \rangle m$, $t_1 = 6.3\ s$

$\vec{r}_2 = \langle -1.3, 6.2, 0 \rangle m$, $t_2 = 6.8\ s$

$\vec{r}_3 = \langle 0.5, 1.7, 0 \rangle m$, $t_3 = 7.3\ s$

a) $6.3 \rightarrow 6.8\ s$, $\Delta t_{12} = 0.5\ s$

$\vec{v}_{12\,avg} = \frac{\Delta \vec{r}_{12}}{\Delta t_{12}} = \frac{\langle 2.2, -3.2, 0 \rangle m}{0.5\ s} = \langle 4.4, -6.4, 0 \rangle \frac{m}{s}$

b) $6.3 \rightarrow 7.3\ s$, $\Delta t_{13} = 1.0\ s$

$\vec{v}_{13\,avg} = \frac{\Delta \vec{r}_{13}}{\Delta t_{13}} = \frac{\langle 4, -7.7, 0 \rangle}{1.0\ s} = \langle 4, -7.7, 0 \rangle \frac{m}{s}$

c) answer to part a) is best estimate of $\vec{v}_1$

d) For $t_4 = 6.33\ s$, use $\vec{v}_{12,avg}$ to find $\Delta \vec{r}_{14}$

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Problem P37 (cont'd)

$$\Delta \vec{r}_{14} = \vec{V}_{ave}\,\Delta t_{14} = \langle 4.4, -6.4, 0\rangle \frac{m}{s} \times 0.03\,s$$

$$= \langle 0.132, -0.192, 0\rangle\ m$$

Problem P41 $\quad \vec{r}_i = \langle 7, 21, -17\rangle m, \; t_i = 0$

$t_f = 3\,s, \quad \vec{V}_{avg} = \langle -11, 42, 117\rangle \frac{m}{s}$

$y_f = ?$

$$y_f = y_i + \frac{1}{2}(V_{iy} + V_{fy})\,t_f = y_i + V_{y\,avg}\,t_f$$

$$= 21 + 42(3) = \boxed{147\,m}$$

Problem P51 $\quad m, \; \vec{V}_i = \langle V_x, 0, 0\rangle, \; \vec{V}_f = \langle -V_x, 0, 0\rangle$

a) $\Delta \vec{P} = \vec{P}_f - \vec{P}_i = m[\langle -V_x, 0, 0\rangle - \langle V_x, 0, 0\rangle]$

$$= \langle -2mV_x, 0, 0\rangle$$

b) change in magnitude of momentum

$$|\vec{P}_f| - |\vec{P}_i| = |mV_x| - |mV_x| = \boxed{0}$$

Not the magnitude of the change in momentum

Problem P59 $m = 0.170\ kg$

$\vec{p}_f = \langle 0, 0, -6.37 \rangle\ kg\ m/s$

$\vec{r}_f = \langle 0, 0, -267 \rangle\ m$

$t_f = 0.45\ s$

$\vec{r}_i = ?$ $t_i = 0$, since $\vec{p} \sim m\vec{v}$ and $\vec{p}_i = \vec{p}_f$

$$\vec{r}_f = \vec{r}_i + \frac{1}{2}(\vec{v}_f + \vec{v}_i)\Delta t = \vec{r}_i + \vec{v}\,\Delta t$$

$$\vec{r}_f = \vec{r}_i + \frac{\vec{p}}{m}\Delta t \Rightarrow \vec{r}_i = \vec{r}_f - \frac{\vec{p}}{m}\Delta t$$

$$\vec{r}_i = \langle 0, 0, -267 \rangle\ m - \frac{\langle 0, 0, -6.37 \rangle\ kg\ m/s\ (0.45)}{0.170\ kg}$$

$$= \boxed{\langle 0, 0, -11.2 \rangle\ m}$$

Problem P63 $\left|\frac{\vec{v}}{c}\right| = 0.9999$, $m_p = 1.672 \times 10^{-27}\ kg$

$c = 3.000 \times 10^8\ m/s$

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

$$|\vec{p}| = \frac{1}{\sqrt{1 - \left(\frac{|\vec{v}|}{c}\right)^2}}\, m\, 0.9999c = \frac{0.9999\, mc}{\sqrt{1 - 0.9999^2}}$$

$$= (70.712)(0.9999)(1.672 \times 10^{-27}\ kg)(3.000 \times 10^8\ m/s)$$

$$= \boxed{3.54 \times 10^{-17}\ kg\ m/s}$$