PHYS 113 | HW#1 | solutions

#1] $\vec{v} = 3\hat{i} + 4\hat{j}$ $\vec{w} = -2\hat{i} + \hat{j}$

a] $3\vec{v} = 9\hat{i} + 12\hat{j}$

b] $2\vec{w} - 3\vec{v} = 6\hat{i} + 8\hat{j} - (-6\hat{i} + 3\hat{j})$

$= 12\hat{i} + 5\hat{j}$

c] $\vec{v} \cdot \vec{w} = 3 \cdot (-2) + 4 \cdot 1 = -2$

d] $|\vec{v}| = \sqrt{3^2 + 4^2} = 5$

e] from $|\vec{v}||\vec{w}| \cos\theta = \vec{v} \cdot \vec{w}$

$$\theta = \cos^{-1}\left(\frac{-2}{5\sqrt{5}}\right) = 1.75 \text{ rad} \approx 100°$$

2] $m = 2\text{kg}$; calc γ first! $p = mv\gamma$

a] $\gamma = \sqrt{1/1 - v^2/c^2} \approx 1$ $p = 20 \text{ kg m/s}$

b] $\gamma \approx 1$ $p = 800 \text{ kg m/s}$

c] $\gamma \cong 1.34$ $p = 5.36 \cdot 10^8 \text{ kg m/s}$

d] $\gamma \cong 3.91$ $p = 22.68 \cdot 10^8 \text{ kg m/s}$

3] $\Delta p = \bar{F}_{net} \Delta t$ Valid since force is constant; assume block starts at rest then $p(t) = \Delta p = F t$ $p = mv$

a] $p = 500 \text{ kg m/s}$

b] $p = 2 \cdot 10^{10} \text{ kg m/s}$

c] $v = 25 \text{ m/s}$

d] $v = 2.57 \cdot 10 \text{ m/s}$ or .857c

given p, t can solve for v

$$v = \frac{p/m}{\sqrt{1 + \frac{p^2}{(mc)^2}}}$$

see 1.11 in textbook

1.95] $m = .4\,kg$ $\vec{v} = 38\hat{i} - 27\hat{k}$ m/s ; low speeds $\gamma \approx 1$ hence $\vec{p} = m\vec{v}$

$$\vec{p} = 15.2\hat{i} - 10.8\hat{k}$$

$$|\vec{p}| = \sqrt{(15.2)^2 + (-10.8)^2} = 18.6\,kg\,m/s$$

1.98] $v = .95c$ $\gamma = (1 - (.95)^2)^{-1/2} = 3.2$

$$p = mv\gamma = (9 \cdot 10^{-31}\,kg)(3 \cdot 10^{8}\,m/s)(3.2)$$

$$= 8.64 \cdot 10^{-22}\,kg\,m/s$$

1.100] $\vec{r}_0 = 15\hat{i} + 8\hat{j} - 3\hat{k}$ $\vec{r}_1 = 20\hat{i} + 6\hat{j} - \hat{k}$ $\Delta t = .1\,s$

$$\Delta\vec{r} = \vec{r}_1 - \vec{r}_0 = 5\hat{i} - 2\hat{j} + 2\hat{k}$$

$$\vec{v}_{avg} = \frac{\Delta\vec{r}}{\Delta t} = 50\hat{i} - 20\hat{j} + 20k\ m/s$$