/69

Practice problems

1) Impulse may be calculated using either $\vec{F}\Delta t$ ***or*** $m\Delta\vec{v}$. Why? The equation $\vec{F}\Delta t = m\Delta\vec{v}$ states that impulse and change in momentum are equivalent. Since we are given *m*, $\vec{v}_i$ and $\vec{v}_f$ we calculate impulse using $m\Delta\vec{v}$.

A.

$$impulse = m\Delta\vec{v}$$
$$impulse = m(\vec{v}_f - \vec{v}_i)$$
$$impulse = 2.50kg(0 - 5.00\,{}^{m}\!/\!_{s})$$
$$\boxed{impulse = -12.5\,{}^{kg\cdot m}\!/\!_{s}}$$

B.

$$\vec{F}\Delta t = m\Delta\vec{v}$$
$$\vec{F} = \frac{m(\vec{v}_f - \vec{v}_i)}{\Delta t}$$
$$\vec{F} = \frac{2.50kg(0 - 5.00\,{}^{m}\!/\!_{s})}{0.75s}$$
$$\boxed{\vec{F} = -16.7N}$$

2) First calculate the person's speed as she hits the bed. I chose to use conservation of energy.

$$E_{k\ final} = E_{p\ initial}$$
$$\tfrac{1}{2}\cancel{m}v^2 = \cancel{m}gh$$
$$v = \sqrt{2gh}$$
$$v = \sqrt{2(9.81\,{}^{m}\!/\!_{s^2})(2.0m)}$$
$$v = 6.26\,{}^{m}\!/\!_{s}$$

When landing on the bed:

$$\vec{v}_i = -6.26\,{}^{m}\!/\!_{s}$$
$$\vec{v}_f = 0$$
$$\Delta t = 0.75s$$

$$\Delta\vec{p} = m\Delta\vec{v}$$
$$\Delta\vec{p} = m(\vec{v}_f - \vec{v}_i)$$
$$\Delta\vec{p} = 75kg(0 - (-6.26\,{}^{m}\!/\!_{s}))$$
$$\boxed{\Delta\vec{p} = +469.8\,{}^{kg\cdot m}\!/\!_{s}}$$

since impulse = change in momentum

$$\boxed{impulse = +469.8\,{}^{kg\cdot m}\!/\!_{s}}$$

$$\vec{F}\Delta t = m\Delta\vec{v}$$
$$\vec{F} = \frac{\Delta\vec{p}}{\Delta t}$$
$$\vec{F} = \frac{+469.8\,{}^{kg\cdot m}\!/\!_{s}}{0.75s}$$
$$\boxed{\vec{F} = +626.4N}$$

Assignment

1) Impulse can be calculated using either force times time or mass times change in velocity

/4

The units for impulse are either N·s or kg·m/s

2) The concept of impulse is that in order to maximize the change in momentum, the force and the time of contact must be maximized. Therefore, a karate expert must make contact with a tremendous amount of force in as long a time as possible.

/2

3) Impulse = area of graph

$$\text{Impulse} = \tfrac{1}{2}ab$$

/6

$$\text{Impulse} = \tfrac{1}{2}(5000N)(1.0\times10^{-3}s)$$

$$\boxed{\text{Impulse} = 2.5N\bullet s[\text{S}]}$$

$$\text{Impulse} = 2.5N\bullet s[\text{S}]$$

$$m\Delta\vec{v} = 2.5N\bullet s[\text{S}]$$

$$\Delta\vec{v} = \frac{2.5N\bullet s[\text{S}]}{m}$$

$$\vec{v}_2 - \vec{v}_1 = \frac{2.5N\bullet s[\text{S}]}{m}$$

$$\vec{v}_2 = \frac{2.5N\bullet s[\text{S}]}{m} - \vec{v}_1$$

$$\vec{v}_2 = \frac{2.5N\bullet s[\text{S}]}{0.048kg} - 0$$

$$\boxed{\vec{v}_2 = 52\,{}^{m}\!/\!{}_{s}[\text{S}]}$$

4)

$$\vec{F}\Delta t = m\Delta\vec{v}$$

/3

$$\vec{F} = \frac{m\Delta\vec{v}}{\Delta t} = \frac{5.40\,kg(14.0\,{}^{m}\!/\!{}_{s}[\text{W}] - 0)}{0.135s}$$

$$\boxed{\vec{F} = 5.60\times10^{2}\,N[\text{W}]}$$

5) Seat belts are designed to slow a person down with the vehicle. Without a seatbelt when the vehicle comes to a sudden stop, for example, the person continues to move and then collides with a steering wheel, dashboard or windshield resulting in a sudden stop with a large force.

/2

A headrest is designed to make sure that the head slows down or speeds up at the same rate as the rest of the body. As the previous question shows, if the head lags the body by even a small amount, the forces on the neck are quite large.

6) $\Delta\vec{p} = \vec{F}\Delta t$

$\Delta\vec{p} = (+840N)(5.0s)$

/3 $\boxed{\Delta\vec{p} = +4.2\times10^{3}\,N\cdot s}$

7) a. $\Delta\vec{p} = m\Delta\vec{v}$

$\Delta\vec{p} = 0.045kg(28\,{}^{m}\!/\!_{s} - 0)$

$\boxed{\Delta\vec{p} = +1.3\,{}^{kg\cdot m}\!/\!_{s}}$

/12 b. Impulse $= \boxed{\Delta\vec{p} = +1.3N\cdot s}$

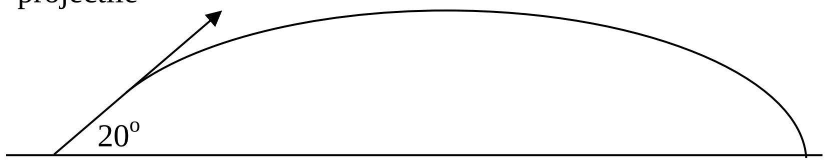
c. $\vec{F}\Delta t = \Delta\vec{p}$

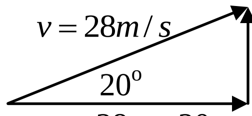
$$\vec{F} = \frac{\Delta\vec{p}}{\Delta t}$$

$$\vec{F} = \frac{+1.3\,{}^{kg\cdot m}\!/\!_{s}}{0.0060s}$$

$\boxed{\vec{F} = +210N}$

d. projectile





$v = 28m/s$

$\vec{v}_{vi} = +28\,{}^{m}\!/\!_{s}\sin 20$

$\vec{v}_{vi} = +9.58\,{}^{m}\!/\!_{s}$

$v_h = 28\cos 20$

$v_h = 26.31m/s$

$$\Delta t = \frac{\vec{v}_{vf} - \vec{v}_{vi}}{\vec{a}}$$

$$\Delta t = \frac{-9.58\,{}^{m}\!/\!_{s} - (+9.58\,{}^{m}\!/\!_{s})}{-9.81\,{}^{m}\!/\!_{s^2}}$$

$\Delta t = 1.95s$

$d_h = v_h \cdot \Delta t$

$d_h = (26.31\,{}^{m}\!/\!_{s})(1.95s)$

$\boxed{d_h = 51m}$

8) Impulse $= \vec{F}\Delta t = (+150N)(0.12s)$

/7 $\boxed{\text{Impulse} = +18N\cdot s}$

$\Delta\vec{p} = \text{Impulse}$

$\boxed{\Delta\vec{p} = +18\,{}^{kg\cdot m}\!/\!_{s}}$

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

$\Delta\vec{p} = m(\vec{v}_f - \vec{v}_i)$

$$\vec{v}_f = \frac{\Delta\vec{p}}{m} + \vec{v}_i$$

$$\vec{v}_f = \frac{+18\,{}^{kg\cdot m}\!/\!_{s}}{0.750kg} + (-12.8\,{}^{m}\!/\!_{s})$$

$\boxed{\vec{v}_f = +11.2\,{}^{m}\!/\!_{s}}$

9) $\vec{F}\Delta t = m\Delta\vec{v}$

$$\vec{F} = \frac{m\Delta\vec{v}}{\Delta t}$$

/3

$$\vec{F} = \frac{0.300kg(-100\,{}^{m}\!/\!_{s} - 50\,{}^{m}\!/\!_{s})}{0.020s}$$

$\boxed{\vec{F} = -2.3\times10^{3}\,N}$

10) 

$\Delta t = 4.0 \times 10^{-4}\,s$

/6

$$\vec{F}\Delta t = m\Delta\vec{v}$$
$$\vec{F} = \frac{m\Delta\vec{v}}{\Delta t}$$
$$\vec{F} = \frac{0.0080kg(+100\,{}^{m}\!/\!_{s} - (+400\,{}^{m}\!/\!_{s}))}{4.0 \times 10^{-4}\,s}$$
$$\boxed{\vec{F} = -6.0 \times 10^{3}\,N}$$

$$\Delta d = \left(\frac{v_2 + v_1}{2}\right)\Delta t$$
$$\Delta d = \left(\frac{400\,{}^{m}\!/\!_{s} + 100\,{}^{m}\!/\!_{s}}{2}\right)4.0 \times 10^{-4}\,s$$
$$\boxed{\Delta d = 0.10m}$$

11)

/4

$$\vec{v}_1 = +18.0\,{}^{m}\!/\!_{s}$$
$$\vec{v}_2 = -18.0\,{}^{m}\!/\!_{s}$$
$$\frac{m}{\Delta t} = \frac{25.0kg}{s}$$

$$\vec{F}\Delta t = m\Delta\vec{v}$$
$$\vec{F} = \frac{m}{\Delta t}\Delta\vec{v}$$
$$\vec{F} = \frac{25.0kg}{s}(-18.0\,{}^{m}\!/\!_{s} - +18.0\,{}^{m}\!/\!_{s})$$
$$\boxed{\vec{F} = -900N \rightarrow \text{ on water}}$$
$$\boxed{\vec{F} = +900N \rightarrow \text{ on blade}}$$