7.2

Var	Given value	Units	Description
v		$\frac{m}{s}$	velocity
v_{cmps}	0.50	$\frac{cm}{s}$	velocity
p		$\frac{kg\,m}{s}$	Power
m	3.0×10^{7}	kg	Mass

$$v = v_{cmps} \rightarrow \frac{m}{s}$$

$$= \left(0.50\,\frac{cm}{s}\right)\left(0.01000000000\,\frac{m}{cm}\right)$$

$$= 5.0\times10^{-3}\,\frac{m}{s}$$ ✓

$$p = m\,v$$

$$= \left(3.0\times10^{7}\,kg\right)\left(5.0\times10^{-3}\,\frac{m}{s}\right)$$

$$= 1.5\times10^{5}\,\frac{kg\,m}{s}$$ ✓

7.4

Var	Given value	Units	Description
v_{jet}		$\frac{m}{s}$	velocity of jet
v_{kmph}	960	$\frac{km}{h}$	velocity of jet
p_{jet}		$\frac{kg\,m}{s}$	momentum of jet
m_{jet}	2.3×10^{5}	kg	mass of jet
p_{hs}		$\frac{kg\,m}{s}$	momentum of horseshoe
m_{hs}	1.1	kg	mass of horseshoe
v_{hs}	11.3	$\frac{m}{s}$	velocity of horseshoe
p_{ratio}			ratio of momenta

$$v_{jet} = v_{kmph} \rightarrow \frac{m}{s}$$

$$= \left(960\,\frac{km}{h}\right)\left(1000\,\frac{m}{km}\right)\left(2.777777778\times10^{-4}\,\frac{h}{s}\right)$$

$$= 266.6666667\,\frac{m}{s} \quad \checkmark$$

$$p_{jet} = m_{jet}\,v_{jet}$$

$$= \left(2.3\times10^{5}\,kg\right)\left(266.6666667\,\frac{m}{s}\right)$$

$$= 6.1\times10^{7}\,\frac{kg\,m}{s} \quad \checkmark$$

7.4 (continued)

$$p_{hs} = m_{hs}\, v_{hs}$$

$$= (1.1\,\text{kg})\left(11.3\,\frac{\text{m}}{\text{s}}\right)$$

$$= 12.\,\frac{\text{kg m}}{\text{s}}$$

$$p_{ratio} = \frac{p_{jet}}{p_{hs}}$$

$$= \frac{6.1\times10^{7}\,\frac{\text{kg m}}{\text{s}}}{12.\,\frac{\text{kg m}}{\text{s}}}$$

$$= \boxed{5.1\times10^{6}\ \text{to}\ 1}$$

Var	Given value	Units	Description
KE_{jet}		J	kinetic energy of jet
KE_{hs}		J	kinetic energy of horseshoe
KE_{ratio}			

7.4 (continued)

$$KE_{\text{jet}} = \tfrac{1}{2} m_{\text{jet}} v_{\text{jet}}^{2}$$

$$= \tfrac{1}{2}\left(2.3\times10^{5}\ \text{kg}\right)\left(266.6666667\ \tfrac{\text{m}}{\text{s}}\right)^{2}$$

$$= 8.2\times10^{9}\ \text{J}$$

$$KE_{\text{hs}} = \tfrac{1}{2} m_{\text{hs}} v_{\text{hs}}^{2}$$

$$= \tfrac{1}{2}\left(1.1\ \text{kg}\right)\left(11.3\ \tfrac{\text{m}}{\text{s}}\right)^{2}$$

$$= 70.\ \text{J}$$

$$KE_{\text{ratio}} = \frac{KE_{\text{jet}}}{KE_{\text{hs}}}$$

$$= \frac{8.2\times10^{9}\ \text{J}}{70.\text{J}}$$

$$= \boxed{1.2\times10^{8}\ \text{to}\ 1}$$

7.6

Var	Given value	Units	Description
p	237	$\frac{\text{kg m}}{\text{s}}$	momentum
m	1.73	kg	Mass
v		$\frac{\text{m}}{\text{s}}$	Velocity

$$p = m\, v$$

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

$$= \frac{237\ \frac{\text{kg m}}{\text{s}}}{1.73\,\text{kg}}$$

$$= 137.\ \frac{\text{m}}{\text{s}}$$ ✓

7.8

Var	Given value	Units	Description
p		$\frac{kg\ m}{s}$	momentum
m		kg	Mass
v		$\frac{m}{s}$	Velocity
KE		J	Kinetic energy

$$KE = \frac{1}{2} m v^2$$

$$p = m v$$

$$v^2 = \frac{p^2}{m^2}$$

$$KE = \frac{1}{2} m \frac{p^2}{m^2}$$

$$KE = \frac{p^2}{2 m}$$

7.10

Var	Given value	Units	Description
m		kg	mass
m_g	46.0	g	mass
g	9.80	$\frac{m}{s^2}$	Acceleration due to gravity
h	1.36	m	drop height
v		$\frac{m}{s}$	impact velocity
p		$\frac{kg\ m}{s}$	momentum

$$m = m_g \rightarrow \text{kg}$$

$$= (46.0\,\text{g})\left(1.000000000\times10^{-3}\ \frac{\text{kg}}{\text{g}}\right)$$

$$= 0.0460\,\text{kg}$$

$$PE = KE$$

$$m\,g\,h = \frac{1}{2}\,m\,v^2$$

$$g\,h = \frac{1}{2}\,v^2$$

7.10 (continued)

$$2gh = v^2$$

$$v = \sqrt{2gh}$$

$$= \sqrt{2\left(9.80\,\frac{\text{m}}{\text{s}^2}\right)(1.36\,\text{m})}$$

$$= 5.16\,\frac{\text{m}}{\text{s}} \quad \checkmark$$

$$p = mv$$

$$= (0.0460\,\text{kg})\left(5.16\,\frac{\text{m}}{\text{s}}\right)$$

$$= 0.237\,\frac{\text{kg}\,\text{m}}{\text{s}} \quad \checkmark$$

7.12

Var	Given value	Units	Description
I		$\frac{\text{kg m}}{\text{s}}$	Impulse
F		N	Force
Δt	8.0×10^{-4}	s	Duration
Δp		$\frac{\text{kg m}}{\text{s}}$	change in momentum
m	0.046	kg	Mass
Δv	63	$\frac{\text{m}}{\text{s}}$	change in Velocity

$$I = F\Delta t$$

$$\Delta p = m\Delta v$$

$$F\Delta t = m\Delta v$$

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

$$= \frac{(0.046\,\text{kg})\left(63\,\frac{\text{m}}{\text{s}}\right)}{8.0\times10^{-4}\,\text{s}}$$

$$= 3.6\times10^{3}\,\text{N}$$ ✓

7.14

Var	Given value	Units	Description
I		$\frac{\text{kg m}}{\text{s}}$	Impulse
F		N	Force
Δt	0.0021	s	Duration
Δp		$\frac{\text{kg m}}{\text{s}}$	change in momentum
m	0.14	kg	Mass
v_f	–34	$\frac{\text{m}}{\text{s}}$	final velocity
v_i	28	$\frac{\text{m}}{\text{s}}$	initial velocity

$$I = F\Delta t$$

$$\Delta p = m(v_\text{f} - v_\text{i})$$

$$F\Delta t = m(v_\text{f} - v_\text{i})$$

$$F = \frac{m(v_\text{f} - v_\text{i})}{\Delta t}$$

$$= \frac{(0.14\,\text{kg})\left(\left(-34\,\frac{\text{m}}{\text{s}}\right) - \left(28\,\frac{\text{m}}{\text{s}}\right)\right)}{0.0021\,\text{s}}$$

$$= -4.1\times 10^{3}\,\text{N}$$ ✓

7.16

It seems easier to me to do this problem in terms of conservation of energy.

Var	Given value	Units	Description
$work$		J	work done in stopping
ΔPE		J	change in potential energy
F		N	stopping force
Δx		m	amount knees are bent
m		kg	mass
g	9.80	$\frac{m}{s^2}$	Acceleration due to gravity
Δh	1.60	m	change in height

$$work = \Delta PE$$

$$F \Delta x = m\, g\, \Delta h$$

$$F = 12\, m\, g$$

$$12\, m\, g\, \Delta x = m\, g\, \Delta h$$

$$12\, \Delta x = \Delta h$$

7.16 (continued)

$$\Delta x = \frac{\Delta h}{12}$$

$$= \frac{1.60\,\text{m}}{12}$$

$$= 0.133\,\text{m}$$

7.20

Var	Given value	Units	Description
v_f		$\frac{m}{s}$	final Velocity
v_i	0	$\frac{m}{s}$	Initial velocity
a		$\frac{m}{s^2}$	Acceleration
Δx	42	m	displacement
t	0.038	s	time
F		N	average force on ball
m	0.43	kg	mass of ball

$$\Delta x = \frac{1}{2}(v_i + v_f)\,t$$

$$2\Delta x = (v_i + v_f)\,t$$

$$v_f = \frac{2\Delta x}{t} - v_i$$

$$= \frac{2(42\,m)}{0.038\,s} - \left(0\,\frac{m}{s}\right)$$

$$= 2.2\times10^{3}\,\frac{m}{s}$$

7.20 (continued)

$$Ft = m(v_f - v_i)$$

$$F = \frac{m(v_f - v_i)}{t}$$

$$= \frac{(0.43\,\text{kg})\left(\left(2.2\times10^{3}\,\frac{\text{m}}{\text{s}}\right) - \left(0\,\frac{\text{m}}{\text{s}}\right)\right)}{0.038\,\text{s}}$$

$$= 2.5\times10^{4}\,\text{N}$$ ✓