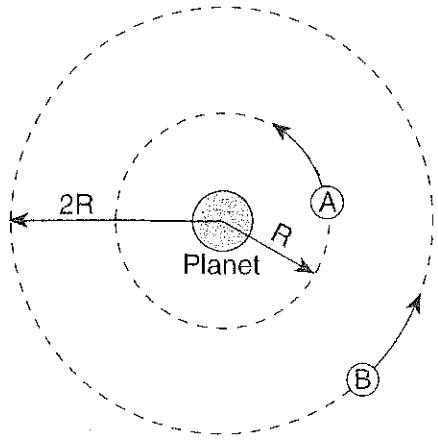
224. The diagram below represents two satellites of equal mass, *A* and *B*, in circular orbits around a planet.



Compared to the magnitude of the gravitational force of attraction between satellite *A* and the planet, the magnitude of the gravitational force of attraction between satellite *B* and the planet is

A) half as great
B) twice as great
C) one-fourth as great
D) four times as great

$r \times 2 = \frac{F_g}{4}$

225. An object weighs 200. Newtons at a distance of 100. kilometers above the center of a small uniform planet. How much will the object weigh 200. kilometers above the planet's center?

A) 400. N
B) 100. N
C) 50.0 N
D) 25.0 N

$r \times 2 = \frac{F_g}{4} \quad \frac{200N}{4} = 50N$

226. What is the magnitude of the gravitational force between an electron and a proton separated by a distance of 1.0×10^{-10} meter?

A) 1.0×10^{-47} N
B) 1.5×10^{-46} N
C) 1.0×10^{-37} N
D) 1.5×10^{-36} N

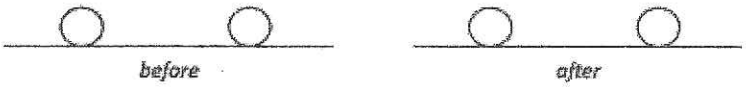
$F_g = \frac{(6.67 \times 10^{-11} \frac{Nm^2}{kg^2})(9.11 \times 10^{-31} kg)(1.67 \times 10^{-27} kg)}{(1 \times 10^{-10} m)^2}$

227. If the distance between a spaceship and the center of the Earth is increased from one Earth radius to 4 Earth radii, the gravitational force acting on the spaceship becomes approximately

A) 1/16 as great
B) 1/4 as great
C) 16 times greater
D) 4 times greater

$r \times 4 = \frac{F_g}{16}$

228. A 2kg ball moving at 3 m/s collides with a 3 kg ball at rest. Assuming that the 2.0 kg ball stops after the collision, what is the velocity of the 3 kg ball after the collision



	before 1	before 2	after 1	after 2
m	2kg	3kg	2kg	3kg
v	3m/s	0	0	2m/s
p	6kgm/s	0	0	6kgm/s
Total	6kgm/s		6kgm/s	

$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

$(2kg)(3m/s) + (3kg)(0) = (2kg)(0) + (3kg)(v_2')$

$6kgm/s + 0 = 0 + 3kg\,v_2'$

$v_2' = \frac{6kgm/s}{3kg} = 2m/s$

229. A 50 kg football player moving at 2 m/s east collides with a 70kg player moving at 4 m/s west. At what speed will the two players be moving if they are locked together after they collide?

	before 1	before 2	after 1	after 2
m	50kg	70kg	120kg	
v	2m/s	−4m/s	−1.5m/s	
p	100kgm/s	−280kgm/s	−180kgm/s	
Total	−180 kgm/s		= −180 kgm/s	

or

$m_1v_1 + m_2v_2 = (m_1+m_2)v'$

$(50kg)(2m/s) + (70kg)(-4m/s) = (120kg)v'$

$100kgm/s - 280kgm/s = 120kg\,v'$

$-180kgm/s = 120kg\,v'$

$v' = -1.5m/s$

230. A 1000 kg car moving at 3.0 m/s east collides with a 1500 kg car moving west. If the two cars stop after the collision, what velocity did the 1500 kg car have before the collision?

	before 1	before 2	after 1	after 2
m	1000kg	1500kg	1000kg	1500kg
v	3m/s	−2m/s	0	
p	3000kgm/s	−3000kgm/s	0	
Total	0		0	

$m_1v_1 + m_2v_2 = 0$

$(1000kg)(3m/s) + (1500kg)(v_2) = 0$

$v_2 = -2m/s$

231. A 100 kg cannon has a 5.0 kg cannon ball ready for launch. If the cannonball is fired with an initial velocity of 20 m/s, what is the recoil velocity of the cannon?

	before 1	before 2	after 1	after 2
m	100kg	5kg	100kg	5kg
v	0		−1m/s	20m/s
p	0		−100kgm/s	100kgm/s
	0		0	

$0 = m_1v_1 + m_2v_2$

$0 = (100kg)(v_1) + (5kg)(20m/s)$

$0 = (100kg)(v_1) + 100kgm/s$

$v_1 = -1m/s$

Skill 27-Conservation of Momentum

232. The magnitude of the momentum of an object is 64.0 kilogram•meter per second. If the velocity of the object is doubled, the magnitude of the momentum of the object will be

A) 32.0 kg•m/s B) 64.0 kg•m/s
C) 128 kg•m/s D) 256 kg•m/s

$p = 64 kg\,m/s$ $p = mv$ direct

v x 2 means p x 2

$(64 kg\,m/s) \times 2 = 128 kg\,m/s$

233. Which quantity has both a magnitude and a direction?

A) inertia mass-scalar B) impulse-vector
C) speed-scalar D) time-scalar

magnitude & direction defines Vector
which one is a vector?

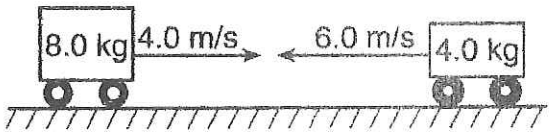
234. An air bag is used to safely decrease the momentum of a driver in a car accident. The air bag reduces the magnitude of the force acting on the driver by

A) increasing the length of time the force acts on the driver
B) decreasing the distance over which the force acts on the driver
C) increasing the rate of acceleration of the driver
D) decreasing the mass of the driver

$J = Ft$ $F = \frac{J}{t}$ or $F = \frac{\Delta p}{t}$

F_{net} is inverse to time
if t increases, F decreases

235. The diagram below shows an 8.0-kilogram cart moving to the right at 4.0 meters per second about to make a head-on collision with a 4.0-kilogram cart moving to the left at 6.0 meters per second.



Frictionless, horizontal surface

After the collision, the 4.0-kilogram cart moves to the right at 3.0 meters per second. What is the velocity of the 8.0-kilogram cart after the collision?

A) 0.50 m/s left B) 0.50 m/s right
C) 5.5 m/s left D) 5.5 m/s right

	before 1	before 2	after 1	after 2
m	8kg	4kg	8kg	4kg
v	4m/s	-6m/s	? = -.5m/s	v = p/m 3m/s
p	32kg m/s	-24kg m/s	-4kg m/s	12kg m/s
total	8kg m/s		8kg m/s	

$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$

$32 kg\,m/s + -24 kg\,m/s = 8 kg\,v_1' + 12 kg\,m/s$

$8 kg\,m/s = 8 kg\,v_1' + 12 kg\,m/s$

$-4 kg\,m/s = 8 kg\,v_1'$

$v_1' = -5 m/s$

236. When a 1.0-kilogram cart moving with a speed of 0.50 meter per second on a horizontal surface collides with a second 1.0-kilogram cart initially at rest, the carts lock together. What is the speed of the combined carts after the collision? [Neglect friction.]

A) 1.0 m/s B) 0.50 m/s
C) 0.25 m/s D) 0 m/s

	before 1	before 2	after 1	after 2
m	1kg	1kg	2kg	
v	.5m/s	0	? = .25m/s	
p	.5kg m/s		.5kg m/s	
total				

$m_1v_1 = (m_1 + m_2)v'$

$(1 kg)(.5 m/s) = (2 kg)v'$

$.5 kg\,m/s = 2 kg\,v'$

$v' = .25 kg\,m/s$

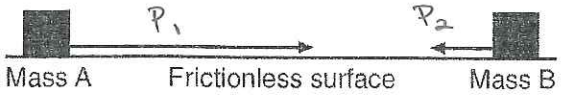
or use logic based on relationship

$v = p/m$ IF mass x 2 v ÷ 2

inverse relationship

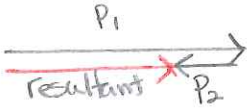
Skill 27-Conservation of Momentum

237. In the diagram below, scaled vectors represent the momentum of each of two masses, *A* and *B*, sliding toward each other on a frictionless, horizontal surface.



Which scaled vector best represents the momentum of the system after the masses collide?

A) ←
B) →
C) ←
D) →



momentum is a vector

Law of Conservation of momentum

$P_{before} = P_{after}$

238. A 0.050-kilogram bullet is fired from a 4.0 kilogram rifle that is initially at rest. If the bullet leaves the rifle with momentum having a magnitude of 20. kilogram•meters per second, the rifle will recoil with a momentum having a magnitude of

A) 1,600 kg•m/s B) 80. kg•m/s
C) 20. kg•m/s D) 0.25 kg•m/s

	B		A	
	1	2	Bullet	2
m	.05kg	4kg	.05kg	4kg
v	0			
P	0		20kgm/s	-20kgm/s
total				

239. The total momentum of a system that consists of a moving rocket and its exhaust gases will

A) decrease B) increase
C) remain the same

$P_{before} = P_{after}$

240. A 2-kilogram object traveling 10 meters per second north has a perfect elastic collision with a 5-kilogram object traveling 4 meters per second south. What is the total momentum after collision?

A) 0 kg-m/s B) 20 kg-m/s north
C) 20 kg-m/s south D) 40 kg-m/s east

	B		A	
	1	2	1	2
m	2kg	5kg		
v	10m/s	-4m/s		
P	20kgm/s	20kgm/s		
total		0		0

$m_1v_1 + m_2v_2 = P_{before}$

$P_{before} = P_{after}$

241. A 3.1 kilogram gun initially at rest is free to move. When a 0.015-kilogram bullet leaves the gun with a speed of 500. meters per second, what is the speed of the gun?

A) 0.0 m/s B) 2.4 m/s
C) 7.5 m/s D) 500. m/s

	B		A	
	1	2	1	2
m	3.1kg	.015kg	3.1kg	.015kg
v	0		2.4m/s	500m/s
P	0		-7.5kgm/s	7.5kgm/s
total	0		0	

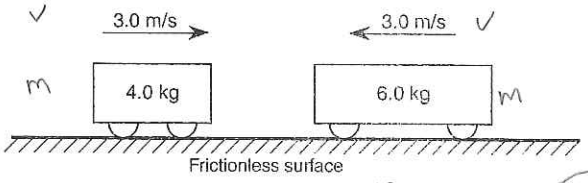
$0 = m_1v_1 + m_2v_2$

$0 = (3.1kg)(v_1) + (.015kg)(500m/s)$

$0 = (3.1kg)(v_1) + 7.5kgm/s$

$v_1 = 2.4m/s$

242. The diagram below shows a 4.0-kilogram cart moving to the right and a 6.0-kilogram cart moving to the left on a horizontal frictionless surface.



$P_1 = 12kgm/s$ $-18kgm/s - P_2 = -6kgm/s$

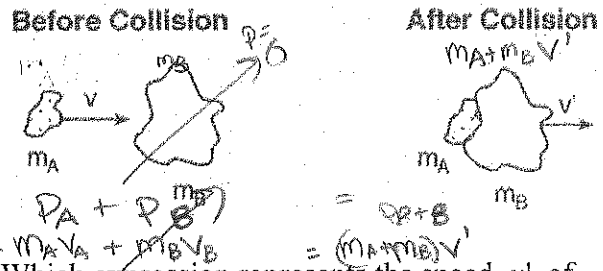
When the two carts collide they lock together. The magnitude of the total momentum of the two-cart system after the collision is

A) 0.0 kg•m/s B) 6.0 kg•m/s
C) 15 kg•m/s D) 30. kg•m/s

$P_{before} = -6kgm/s$

$P_{after} = -6kgm/s$

243. The diagram below represents two masses before and after they collide. Before the collision, mass m_A is moving to the right with speed v, and mass m_B is at rest. Upon collision, the two masses stick together.

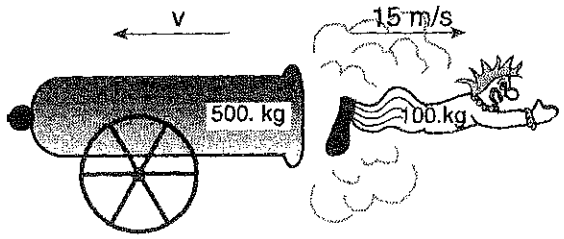


Which expression represents the speed, v', of the masses after the collision? [Assume no outside forces are acting on m_A or m_B.]

A) $\frac{m_A + m_B v}{m_A}$ B) $\frac{m_A + m_B}{m_A v}$

C) $\frac{m_B v}{m_A + m_B}$ D) $\frac{m_A v}{m_A + m_B}$

244. In the diagram below, a 100.-kilogram clown is fired from a 500.-kilogram cannon.

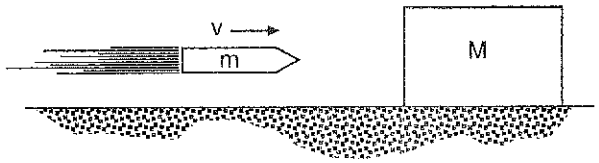


If the clown's speed is 15 meters per second after the firing, the recoil speed (v) of the cannon is

A) 75 m/s B) 15 m/s

C) 3.0 m/s D) 0 m/s

245. In the diagram below, a block of mass M initially at rest on a frictionless horizontal surface is struck by a bullet of mass 1 moving with horizontal velocity v.



What is the velocity of the bullet-block system after the bullet embeds itself in the block?

A) $\left(\frac{M + v}{M}\right) m$

B) $\left(\frac{m + M}{m}\right) v$

C) $\left(\frac{m + v}{M}\right) m$

D) $\left(\frac{m}{m + M}\right) v$

246. A 20-kilogram cart traveling east with a speed of 6 meters per second collides with a 30-kilogram cart traveling west. If both carts come to rest immediately after the collision, what was the speed of the westbound cart before the collision?

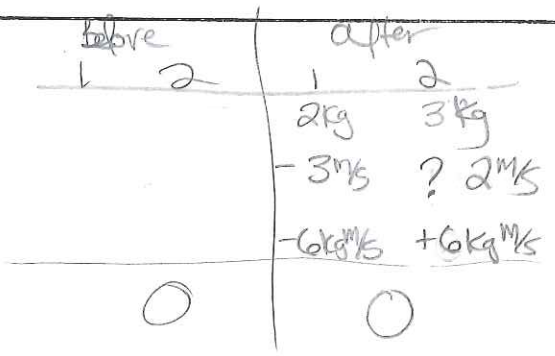
A) 6 m/s B) 2 m/s

C) 3 m/s D) 4 m/s

Skill 27-Conservation of Momentum

247. Two carts resting on a frictionless surface are forced apart by a spring. One cart has a mass of 2 kilograms and moves to the left at a speed of 3 meters per second. If the second cart has a mass of 3 kilograms, it will move to the right at a speed of

A) 1 m/s
B) 2 m/s
C) 3 m/s
D) 6 m/s



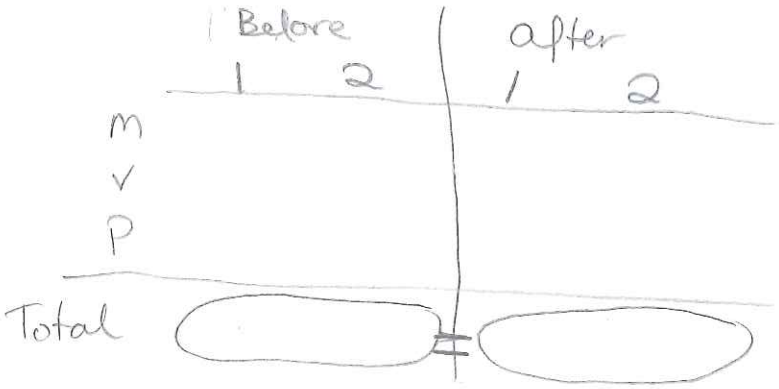
$0 = m_1v_1 + m_2v_2$

$0 = (2kg)(-3m/s) + (3kg)(v_2)$

$0 = -6kgm/s + 3kg(v_2)$

$v_2 = 2m/s$

total "p" does not change



for any object at rest $p = 0$