Question No. 1 of 10

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question #01	Question 1. A bullet of mass m and velocity v collides with a wooden block that rests on a horizontal surface. A similar bullet collides with a rubber block that has the same mass as the wooden block. In which case does the block move more? (A) The wooden block moves more. (B) The rubber block moves more. (C) They move equal amounts. (D) None of the above. It cannot be determined with the information given.
Feedback on Each Answer Choice	A. Incorrect! Since the bullet would embed in the wood block, this would be a smaller change in momentum than if it had bounced off the rubber block.
	B. Correct! Since the rubber block will cause the bullet to bounce back, its momentum will be changed more. Thus, the momentum of the block will change more. This means it will slide a greater distance.
	C. Incorrect! Since the rubber block would cause the bullet to change its motion even more than simply stopping, there would be a greater impulse on the bullet and block.
	D. Incorrect! Although exact numbers aren't given for the masses and velocities, we can predict the results based on a relative change in momentum.
Solution	In comparing the two situations, the important thing to note is the change in momentum. For the wooden block, the bullet will embed and come to a stop. This results in a change in momentum for the bullet, and a corresponding change in momentum for the block. This causes the block to slide. However, the rubber block will cause its bullet to bounce back instead of just coming to a halt. This results in a greater change in momentum, thus the block feels a greater impulse and slides farther.

Question No. 2 of 10

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.	
Question #02	Question 2. Sally has a mass of 50 kg. She is rolling along on roller skates at 5 m/s. Her friend Debbie has a mass of 70 kg (also on roller skates) and is moving towards her at 1 m/s. They meet, and hang onto each other. What is the magnitude and direction of their velocity after they collide? (A) 2.66 m/s (B) 180 m/s (C) 3 m/s (D) 1.5 m/s
Feedback on Each Answer Choice	A. Incorrect! When you use the velocity of Debbie at 1 m/s, it must be the opposite sign of Sally since they are moving in opposite directions.
	B. Incorrect! That would be the momentum of the combination of skaters, but that isn't their velocity. Use P = m x v and conservation of momentum.
	C. Incorrect! That would be the average of the two initial speeds, but since they have differing masses, you must do more than just average the two together. Use P = m x v and conservation of momentum.
	D. Correct! Use P = m x v and conservation of momentum. This is like a hit and stick collision. mv+mv=(m+m)v This is the total momentum of the two skaters as they hold onto each other. Be sure to make one of the two initial velocities negative since they are moving in opposite directions. You could pick either direction as positive, but your final answer would have the sign of Sally's initial movement.
Solution	This is a hit and stick collision. $m_1v_1+m_2v_2=(m_1+m_2)v_3$ When substituting, make sure to make one of the initial velocities negative since the two skaters are moving in opposite directions. Actually, it doesn't even matter which direction you make +, as long as you are consistent. 50kg(5m/s)+(70kg)(-1m/s)=(50kg+70kg)v Simplify: 250 kgm/s-70 kgm/s=120kgv 180kgm/s=120kgv v=1.5 m/s The positive sign of your answer indicates the skater combination is moving in the initial direction of Sally.

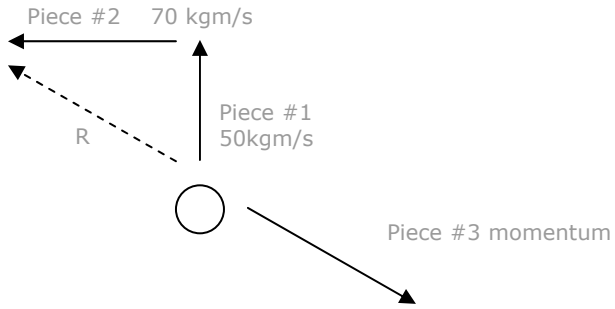
Question No. 3 of 5

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.	
Question #03	Question 3. A baseball player steps up to the plate and hits a 0.15 kg fast ball traveling at 36 m/s, the impact caused the ball to leave his bat with a velocity of 45 m/s in the opposite direction. If the impact lasted for 0.002 sec, what force did he exert on the baseball? (A) 6075 N (B) 3250 N (C) 1125 N (D) 675 N
Feedback on Each Answer Choice	A. Correct! Use F x t = m x v. Be sure to use the correct value for the change in velocity. The two velocities given in the problem are in opposite directions. Consider it the difference between +36 m/s and -45 m/s. That is a change in velocity of 81 m/s.
	B. Incorrect! Use F x t = m x v. Be sure to use the correct value for the change in velocity.
	C. Incorrect! Use F x t = m x v. Be sure to use the correct value for the change in velocity.
	D. Incorrect! The two velocities given are in opposite directions. Don't make both of them positive since that isn't represented in the situation or problem. One of the velocities given must be negative.
Solution	Step by step complete solution (the long version). This can be any format, whatever you can type in Word. $F \times \Delta t = m \times \Delta v$ Rearranging: $F = m \times \Delta v / \Delta t$ $F = m(v_f - v_i) / \Delta t$ Be sure to use the correct value for the change in velocity. The two velocities given in the problem are in opposite directions. Consider it the difference between +36m/s and -45 m/s. That is a change in velocity of 81m/s. Substituting: F = 0.15 kg(-45 m/s-36 m/s)/.002s $F = 6075 \text{ kg m/s}^2$ F = 6075 N

Question No. 4 of 10

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.	
Question #04	Question 4. A 300 kg motorboat is turned off as it approaches a dock and it coasts in toward the dock at 0.50 m/s. Joe, mass is 62.0 kg, jumps off the front of the boat with a speed of 5 m/s. What is the velocity of the boat after Joe jumps? (A) -0.43 m/s (B) -0.53 m/s (C) 1.5 m/s (D) 0 m/s, stationary
Feedback on Each Answer Choice	A. Correct! Set the momentum of Joe and the boat before the jump equal to their momentum after the jump. Solve for the single variable you don't know. P boat before + P Joe before = P boat after+ P Joe after Substitute all the information you have. Find the velocity of the boat after the collision. Since all objects are moving the in the same direction initially, you may assign all the velocities given as positive.
	B. Incorrect! Initially, the boat and Joe are moving at 0.5 m/s. Be sure to account for both of their momentums before the jump.
	C. Incorrect! Set the momentum of Joe and the boat before the jump equal to their momentum after the jump. Solve for the single variable you don't know.
	D. Incorrect! Set the momentum of Joe and the boat before the jump equal to their momentum after the jump. Solve for the single variable you don't know.
Solution	This is similar to an explosion collision. However, there is movement before the explosion. The momentum before is still equal to the momentum after the jump. $P_{before}=P_{after}$ $m_{joe}\,v_1 + m_{boat}\,v_2 = m_{joe}\,v_3 + m_{boat}\,v_4$ Substituting: (62 kg)(0.5 m/s) + (300 kg)(0.5 m/s) = (62 kg)(5 m/s) + (300 kg)(v) Simplify: 31 kg m/s + 150 kg m/s = 310 kg m/s + 300 kg v 181 kg m/s = 310 kg m/s + 300 kg v -129 kg m/s = 300 kg v v=-0.43m/s The negative sign means the boat moves in the opposite direction compared to its initial movement that we made the positive direction.

Question No. 5 of 10

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.	
Question #05	Question 5. An explosive detonates and breaks into three 1 kg chunks. One piece flies north at 50 m/s. Another piece flies west at 70 m/s. What is the speed of the final chunk? (A) 120 m/s (B) 86 m/s (C) 45 m/s (D) 20 m/s
Feedback on Each Answer Choice	A. Incorrect! The direction must be taken into account. The particles aren't flying in the same direction so you can't just add the speeds as scalars.
	B. Correct! Add the momentum vectors of the two given chunks. The final piece must be equal and opposite to that resultant since the total of all three must equal 0. The momentum of the explosive was zero before it went off.
	C. Incorrect! The direction must be taken into account. The particles aren't flying in the same direction so you can't just add the speeds as scalars.
	D. Incorrect! The direction must be taken into account. The particles aren't flying in the same direction so you can't just add the speeds as scalars.
Solution	Before the device explodes, it isn't moving so there is zero momentum. Even after it explodes, the momentum of all the pieces must add up to zero since momentum is conserved. Be sure the momentum vectors are being added, not the velocities.  Find the resultant of the first two. The momentum of the third piece must be equal and opposite to this resultant, R. Use the Pythagorean theorem, $R=\sqrt{(70kgm/s^2+50kgm/s^2)}=86kgm/s$ Finally, since the momentum is known, use the given mass to find the velocity, P=mv 86kgm/s=1kgv v=86m/s

Question No. 6 of 10

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.	
Question #06	Question 6. A spring is compressed between two 1 kg masses at rest. When the spring is released, the masses travel apart at 5 m/s. What is the momentum of the masses? (A) 0 N·s (B) 5 N·s (C) 10 N·s (D) None of the above
Feedback on Each Answer Choice	A. Correct! The direction of the momentum of each mass must be taken into account. The momentum of one mass is equal and opposite to the momentum of the other mass, so the total momentum is zero.
	B. Incorrect. Add the momentum vectors of the two given masses.
	C. Incorrect. The direction must be taken into account. The particles aren't flying in the same direction so you can't just add the momentum as scalars.
	D. Incorrect. One of the above choices is correct, so this choice may be rejected.
Solution	Before the masses are released, they aren't moving so there is zero momentum. Even after they are released, the momentum of all the pieces must add up to zero since momentum is conserved. Even without using conservation, the momentum can be shown to be zero as shown below. $\vec{p}_{\text{tot}} = \vec{p}_1 + \vec{p}_2$ $= (1\text{ kg}) \times (5\text{ m/s}) + (1\text{ kg}) \times (-5\text{ m/s})$ $= 0$

Question No. 7 of 10

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question #07	Question 7. A 100 kg person stands on a 1000 kg rail car at rest. If the person jumps off at 1.0 m/s parallel to the rail track, what is the speed of the rail car immediately after? (A) 0 m/s (B) 0.1 m/s, toward the person (C) 0.1 m/s, opposite the person (D) 1.1 m/s, opposite the person
Feedback on Each Answer Choice	A. Incorrect. The direction of the momentum of each mass must be taken into account. Although the total momentum of the system is zero, the momentum of the rail car is none zero.
	B. Incorrect. Add the momentum vectors of the two given masses. This value of the momentum has the right magnitude, but the wrong direction.
	C. Correct! The momentum of the rail car and person together must add to zero, which is the total initial momentum of the system. The momentum of the rail car is equal and opposite to the momentum of the person. The momentum of the person is 100 N·s, so the velocity of the rail car is (-100 N·s)/(1000 kg) = -0.1 m/s. The negative sign represents the fact that the velocity of the rail car will be oppositely directed to the velocity of the person.
	D. Incorrect. You cannot use the combined mass of the person and the rail car when considering the momentum of the system.
Solution	Before the person jumps off, the initial momentum of the system (which includes rail car and the person) is zero. After the person jumps off, the final momentum of the system must still be zero. The only unknown is the final velocity of the rail car, which will be denoted as v. $\vec{p}_{tot}=\vec{p}_1+\vec{p}_2$ $0=(100\text{ kg})\times(1.0\text{ m/s})+(1000\text{ kg})\times v$ $-100\text{ N}\times\text{s}=(1000\text{ kg})\times v$ $-0.1\text{ m/s}=v$ The final velocity of rail car is 0.1 m/s, opposite the direction of the person's velocity. The negative sign takes into account the direction of the v.

Question No. 8 of 10

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question #08	Question 8. A 100 g puck hits a wall straight on at 1 m/s and bounces back in the direction in which it came at the same speed. If the collision took place in 10 ms, what is the average force exerted on the wall? (A) 0 N (B) 10 N (C) 20 N (D) None of the above
Feedback on Each Answer Choice	A. Incorrect. The change in momentum of the puck is not zero, so the average force imparted on the wall will be nonzero.
	B. Incorrect. The change in the momentum of the puck is not the final momentum of the puck, but twice the final momentum of the puck. The correct answer will be twice this value.
	C. Correct! The change in the momentum of the puck is $2 \times (0.1 \text{ kg}) \times (1 \text{ m/s}) = 0.2 \text{ N·s}$, so the average force is $0.2/0.01 = 20$ N. See the solution below for a more detailed answer.
	D. Incorrect. One of the above choices is correct.
Solution	First, calculate the change in momentum, letting m be the mass of the puck and v being the velocity of the puck before colliding with the wall. $\Delta\vec{p}=\vec{p}_f-\vec{p}_i$ $\Delta\vec{p}=m(-\vec{v})-m\vec{v}$ $=-2m\vec{v}$ Recall the formula that relates average force, the time interval of the collision, and the change in momentum. Finally, substitute values and evaluate. $\bar{F}\Delta t=\lvert\Delta\vec{p}\rvert$ $\bar{F}=\frac{\lvert\Delta\vec{p}\rvert}{\Delta t}$ $=\frac{2mv}{\Delta t}$ $=\frac{2(0.1 \text{ kg})\times(1 \text{ m/s})}{0.01 \text{ s}}$ $=20 \text{ N}$

Question No. 9 of 10

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.	
Question #09	Question 9. Two gliders on an air track collide against each other and recoil back in opposite directions, without any deformation. Statement I: Momentum is conserved. Statement II: Total energy is conserved. Statement III: Kinetic energy is conserved. Which of the following choices is correct? (A) I and II (B) I and III (C) II and III (D) I, II, and III
Feedback on Each Answer Choice	A. Incorrect. Although momentum and total energy are always conserved in collisions, we must evaluate the validity of statement III.
	B. Incorrect. Although momentum is always conserved, and kinetic energy is conserved in elastic collisions, we must consider that total energy is also conserved.
	C. Incorrect. This choice may be eliminated because of the conservation of momentum.
	D. Correct! All statements I, II, and III are valid. See the solution below for a full explanation.
Solution	This question tests conceptual understanding. Linear momentum and total energy are always considered in collisions, so we know statements I and II are valid. Also, since the gliders recoil without any deformation, the collision may be classified as an elastic collision; thus, kinetic energy is also conserved. So statements I, II, and III are valid, and choice (D) is the correct answer.

Question No. 10 of 10

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.	
Question #10	Question 8 Sphere A collides with sphere B which was motionless on a horizontal table. During the collision, sphere A loses 10 Ns of momentum. Which of the following is a possible condition for sphere B after the collision? (A) mass = 5 kg, velocity = 5 m/s (B) mass = 10 kg, velocity = 5 m/s (C) mass = 1 kg, velocity = 20 m/s (D) None of these combination are possible due to the law of conservation of momentum
Feedback on Each Answer Choice	A. Incorrect! Consider the conservation of momentum. Momentum isn't gained or lost for an entire systems, it is just shuffled throughout that system.
	B. Incorrect! Consider the definition of impulse. Impulse is a change in momentum. If sphere A loses 10 units of momentum, sphere B must have a change that conserves momentum. Thus, sphere B should gain 10 units of momentum.
	C. Incorrect! Consider the definition of impulse. Impulse is a change in momentum. If sphere A loses 10 units of momentum, sphere B must have a change that conserves momentum. Thus, sphere B should gain 10 units of momentum.
	D. Correct! None of these combinations results in an impulse of 10 Ns, or 10 kgm/s. If one sphere loses 10 units of momentum, that momentum must show up somewhere else. In this case, sphere B would have to gain it.
Solution	Examine all of the possible combinations. We are looking for a selection that will provide a change in momentum of 10 kg m/s. This is the amount specified in the problem. If sphere A loses that much momentum, sphere B must increase that much momentum. This comes from the idea of conservation of momentum. Since 10 Ns equals 10 kg m/s, we are looking for an answer choice that represents a change in momentum of 10 kgm/s. None of the answer choices provide that. A correct answer choice might be: mass = 5kg, velocity = 2m/s. There are many possible correct answers, but none are listed in the choices.

Question No. 8 of 10

Instruction: (1) Read the problem statement and answer choices carefully (2) Work the problems on paper as needed (3) Pick the answer (4) Go back to review the core concept tutorial as needed.

Question #08	Question 8 Sphere A collides with sphere B which was motionless on a horizontal table. During the collision, sphere A loses 10 Ns of momentum. Which of the following is a possible condition for sphere B after the collision? (A) mass = 5 kg, velocity = 5 m/s (B) mass = 10 kg, velocity = 5 m/s (C) mass = 5 kg, velocity = 3 m/s (D) mass = 1 kg, velocity = 20 m/s (E) none of these combination are possible due to the law of conservation of momentum
Feedback on Each Answer Choice	A. Incorrect! Consider the conservation of momentum. Momentum isn't gained or lost for an entire system, it is just shuffled throughout that system.
	B. Incorrect! Consider the definition of impulse. Impulse is a change in momentum. If sphere A loses 10 units of momentum, sphere B must have a change that conserves momentum. Thus, sphere B should gain 10 units of momentum.
	C. Incorrect! Remember the definition of momentum, P=mv. This is also related to the concept of impulse, which is a change in momentum.
	D. Incorrect! Consider the definition of impulse. Impulse is a change in momentum. If sphere A loses 10 units of momentum, sphere B must have a change that conserves momentum. Thus, sphere B should gain 10 units of momentum.
	E. Correct! None of these combinations results in an impulse of 10 Ns, or 10 kgm/s. If one sphere loses 10 units of momentum, that momentum must show up somewhere else. In this case, sphere B would have to gain it.
Solution	Examine all of the possible combinations. We are looking for a selection that will provide a change in momentum of 10 kgm/s. This is the amount specified in the problem. If sphere A loses that much momentum, sphere B must increase that much momentum. This comes from the idea of conservation of momentum. Since 10 Ns equals 10 kgm/s, we are looking for an answer choice that represents a change in momentum of 10 kgm/s. None of the answer choices provide that. A correct answer choice might be: mass = 5kg, velocity = 2m/s. There are many possible correct answers, but none are listed in the choices.