1. B The athlete imparts a certain impulse to the luge over the 5-s period that is equal to . This impulse tells us the change in momentum for the luge. Since the luge starts from rest, this change in momentum gives us the total momentum of the luge:The total momentum of the luge when the athlete jumps on is 2500 kg · m/s. Momentum is the product of mass and velocity, so we can solve for velocity by dividing momentum by the combined mass of the athlete and the luge:

2. B The area under a force vs. time graph tells us the impulse given to the rock. Since the rock is motionless at t = 0, the impulse given to the rock is equal to the rock’s total momentum. The area under the graph is a triangle of height 50 N and length 4 s:Calculating the rock’s velocity, then, is simply a matter of dividing its momentum by its mass:

3. D This is a conservation of momentum problem. The initial momentum of the system must be equal to the final momentum. The initial momentum of the system is: The final momentum of the system is the sum of the momentum of the box and of the skateboarder. Since the box is thrown in the opposite direction of the skateboard’s initial momentum, it will have a negative momentum. Because the final momentum and the initial momentum are equal, we know that the final momentum of the skateboarder minus the momentum of the box will equal 560 kg · m/s. With this information, we can solve for v , the skateboarder’s final velocity:

4. D The law of conservation of linear momentum tells us that the x -component of the system’s momentum must be equal before and after the collision. The x -component of the system’s momentum before the collision is the momentum of the large disc. The x -component of the system’s momentum after the collision is the x component of the momentum of both of the smaller discs put together. Since momentum is p = m v , and since the larger disc has twice the mass of the two smaller discs put together, that means that the velocity of the two smaller discs must be twice the velocity of the larger disc; that is, 50 m/s.

5. D We have equations for kinetic energy, KE = 1/2 mv 2, and momentum, p = mv , both of which include variables for mass and velocity. If we first solve for velocity, we can then plug that value into the equation and solve for mass:If v = 4 m/s, then we can plug this value into the equation for momentum to find that p = 4 m = 50 kg · m/s, and conclude that m = 12.5 kg.

6. B The law of conservation of momentum tells us that the initial momentum of the system is equal to the final momentum of the system. The initial momentum is p = mv , and the final momentum is , where is the final velocity of the two objects. Knowing that , we can solve for :

7. E Momentum is conserved in this collision. If the mass is moving with velocity v before impact and the twomass system is moving with velocity after impact, we know that . We also know that the kinetic energy of the two-body system is E = 1/2 . If we solve for , we find:From the equation , we can conclude that the initial velocity of the first body, v , is double . If the value for is given in terms of KE in the equation above, then the value of v is simply twice that, .

8. C Impulse is defined as the change in momentum. Since the hockey puck is initially at rest, its change in momentum is simply its momentum after it has been set in motion. In other words, the momentum of the puck in motion is equal to J .When the puck collides with the other object, momentum is conserved, so the system of the puck and the other object also has a momentum of J . This momentum is equal to the mass, m + M , of the system, multiplied by the velocity of the two-body system, . Solving for is now quite easy:

9. B The velocity of the center of mass of the system is the same as the total velocity of the system. To find the total velocity of the system, we need to find the total momentum of the system and divide it by the total mass of the system. The momentum of the first mass is = 10 kg · m/s to the right, and the momentum of the second mass is = 20 kg · m/s to the left. Therefore, the total momentum of the system is + = 10 kg · m/s to the left. Since the total mass of the system is 2 kg, we can find the total velocity of the system by dividing its momentum by its mass:

10. D The only energy in the system is the kinetic energy of the two masses. These can be determined through two easy calculations: Adding these two energies together, we find that the total energy of the system is 50 J + 200 J = 250 J.