Name: KEY

Test: *Momentum*

2011

Multiple Choice: *Choose the letter of the best answer. 3 points each.*

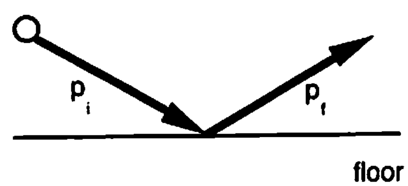
1. D You can throw an egg into a loosely held sheet as hard as you like, and it will not break (assuming your physics teacher does not let go of the sheet.) This is because
   a. The sheet decreases the kinetic energy of the egg.
   b. Physics teachers have magical powers.
   c. The sheet lessons the impulse on the egg, letting it survive.
   d. The sheet causes the time of the "collision" to increase.

2. B A firecracker is at rest on the ground when it explodes into lots of little pieces flying all directions. How can momentum be conserved in this explosion?
   a. Conservation of momentum doesn't apply in this case because of the release of chemical potential energy in the explosion.
   b. Momentum is a vector, so all the little momentums still add up to zero like the initial momentum.
   c. There was potential momentum stored in the firecracker and that it what was released in the explosion.
   d. It can't be conserved because nothing was moving and then there were things flying around all over the place.

$mv = (M-m)V_r$

3. D An unstable nucleus has mass M and is initially at rest. It ejects a particle of m with speed v. The recoil speed of the remaining nucleus is
   a. v. b. mv/M. c. mv/(m+M). d. mv/(M-m). e. (m+M)v/m.

4. D A tennis ball is thrown down at an angle onto the floor. It bounces off the floor with the same speed and angle. It's initial and final momentum are as shown in the diagram. Which of the following best represents the change in momentum of the tennis ball?



a. 

b. 

c. 

d. 

e. 

5. D A car of mass m has a momentum of p. If it stops in a time of t, the impulse needed to stop the car would be
   a. pt. b. pt/m. c. p/mt. d. p. e. p/m.

6. B A 2 kg object is initially at rest when it is kicked. If the impulse of the kick on the object was 40 Ns, then what is the final momentum (in kg m/s) of the object?
   a. 20. b. 40. c. 80. d. can't tell – you need to know how long the kick lasted.

7. E An inelastic collision is one in which
   a. momentum is not conserved but kinetic energy is conserved.
   b. the total impulse is equal to the change in kinetic energy.
   c. total mass is not conserved but momentum is conserved.
   d. neither momentum nor kinetic energy are conserved.
   e. momentum is conserved but kinetic energy is not conserved.

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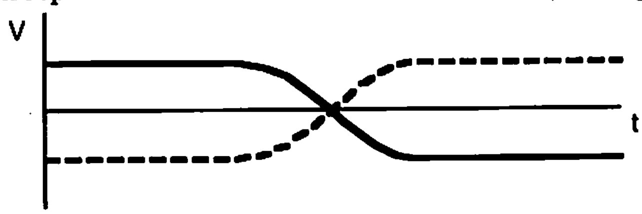
8. C A bullet is fired into a large block of wood, initially at rest and on a frictionless table. The bullet stays in the block of wood. Which of the following must be true?
   a. The kinetic energy of the bullet before the collision is the same as the kinetic energy of the wood and bullet after the collision.
   b. We can't tell anything about the momentum because we need to know if the collision was elastic or not.
   c. The momentum of the bullet before the collision is the same as the momentum of the wood and bullet after the collision.
   d. We can't tell anything about the kinetic energy because we need to know if the collision was elastic or not.

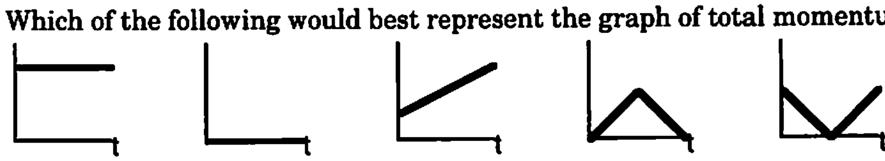
Problems 9 and 10 refer to the following:

Two identical frictionless carts on a horizontal track experience a head on collision, but don't actually touch each other because of the magnets in the ends of each cart. The following graph represents the velocities of the carts before, during and after the collision.



9. D Was the collision elastic?
   a. No, because there was no kinetic energy at one point in the collision.
   b. No, because the initial speeds were the same as the final speeds.
   c. Can't tell because you need some actual numbers.
   d. Of course it was.

10. B Which of the following would best represent the graph of total momentum for the collision?



a. b. c. d. e.

Problems 11 to 15 refer the following (which are only 2 points each.)

Here's the classic! A car driving down the highway smashes into a bug. Which experiences the greater (in terms of magnitude):

11. C Change in Velocity?
   a. the same. b. the car. c. the bug. d. can't tell.

12. A Impulse?
   a. the same. b. the car. c. the bug. d. can't tell.

13. A Change in momentum?
   a. the same. b. the car. c. the bug. d. can't tell.

14. C Acceleration?
   a. the same. b. the car. c. the bug. d. can't tell.

15. A Applied Force?
   a. the same. b. the car. c. the bug. d. can't tell.

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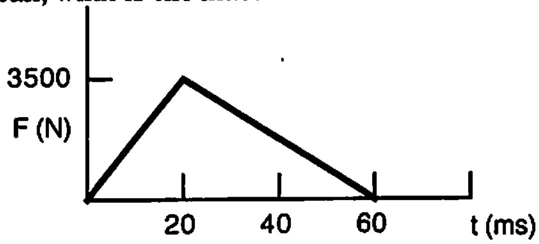
Problem Solving: *Show all work.*

16. A ball has an initial velocity of 25 m/s. It smashes into a wall, and bounces straight back with a speed of 15 m/s. If the diagram shows a graph of the magnitude of the force of the wall on the ball, what is the mass of the ball?



$\frac{1}{2}(3500)(.06) = m(25+15)$

$105 = 40m$

$m = 2.63$ kg

17. Two carts are at rest on a track. Cart A has a mass of 1.5 kg and cart B has a mass of 1.0 kg. A compressed spring is released, causing the two carts to fly apart with a relative speed of 1.7 m/s. From the test paper's reference, what are the velocities of the two carts?

$(1.5)v_A = (1.0)v_B$

$v_A + v_B = 1.7$

$1.5v_A = 1.7 - v_A$

$2.5v_A = 1.7$

$v_A = -0.68$ m/s & $v_B = +1.02$ m/s

messed up signs −2

18. A 5 kg object with an initial speed of 11 m/s collides and sticks to an object with a mass of 2 kg which was initially at rest. If there is a coefficient of friction of 0.4, how far do the combined masses slide before coming to rest?

$(5)(11) = (5+2)v_f$

$55 = 7v_f$

$v_f = 7.86$

$\frac{1}{2}mv^2 = \mu mgd$

$d = \frac{(7.86)^2}{2(.4)(10)}$

$d = 7.72$ m

−7 $K_i = K_f$

b

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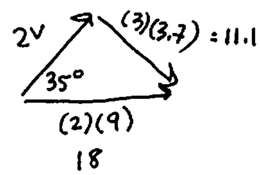
19. A 2 kg ball with an initial velocity of 9 m/s collides with a 3 kg ball initially at rest. The 3 kg ball has a final speed of 3.7 m/s and the 2 kg ball goes off at an angle of 35°. What is the final speed of the 2 kg ball?

-3

θ=95



$c^2 = a^2 + b^2 - 2ab\cos c$

$(11.1)^2 = (2v)^2 + (18)^2 - 2(2v)(18)\cos 35$

$123.2 = 4v^2 + 324 - 58.979v$

$0 = 4v^2 - 58.979v + 200.79$

$v = \dfrac{58.978 \pm \sqrt{(58.979)^2 - 4(4)(200.79)}}{2(4)} = \dfrac{58.978 \pm 16.306}{8}$

$v = 15.06$ or 5.334

or $\hat{i}$) $18 = 11.1\cos\theta + 2v\cos 35$

$0 = 11.1\sin\theta - 2v\sin 35$

20. A 20 kg object going to the right with a speed of 13 m/s has an elastic collision with a second object. After the collision, the 20 kg object is going to the left at 4 m/s, while the other one is going to the right with a speed of 7 m/s. What was the other mass and what was its initial velocity?

only p conserved -.5

① $(20)(13) + mV_i = (20)(-4) + m(7)$

$\frac{1}{2}(20)(13)^2 + \frac{1}{2}mv^2 = \frac{1}{2}(20)(4)^2 + \frac{1}{2}m(7)^2$

② $\dfrac{mv - 7m}{mv^2 - 7^2 m} = \dfrac{(20)(-4) - (20)(13)}{(20)(4)^2 - (20)(13)^2}$

or

$\Rightarrow v + 7 = -4 + 13$

$v + 7 = 9$

$v = 2$ m/s

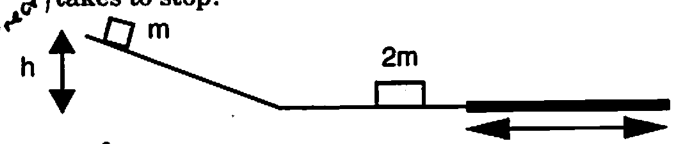
④ $260 + 2m = -80 + 7m$

$340 = 5m$

$m = 68$ kg

21. An object of mass m is initially at rest on a frictionless incline at a height of h. It then slides down, and collides and sticks to a mass of 2m at the bottom of the incline. After that, the masses slide to a stop in a level region with a coefficient of friction of μ. What is the distance d that it takes to stop?

no p -4 (if v_f all correct)



① $\frac{1}{2}mv^2 = mgh$

$v^2 = 2gh$

elastic $mgh = \frac{1}{2}(3m)v^2$ -.5

② $m\sqrt{2gh} = (m + 2m)v_f$

$v_f = \dfrac{m\sqrt{2gh}}{3m}$

$v_f = \frac{1}{3}\sqrt{2gh}$

⑤ $\frac{1}{2}Mv^2 = \mu Mgd$

$\frac{1}{2}\cdot\frac{1}{9}(2gh) = \mu g d$

$d = \dfrac{2h}{18\mu}$

$d = \dfrac{h}{9\mu}$

b