ABRHS PHYSICS (H) NAME: KEY

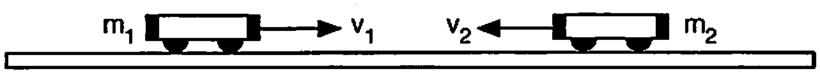
Test: *Momentum*

2012 2013

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

Questions 1 to 3 refer to the following:

A 1 kg cart (m_1) has an initial speed of 2 m/s. It has a head-on elastic collision with a 2 kg cart (m_2) that has an initial speed of 1 m/s.



2 + 1

1. A What is the total momentum of the carts?
   a. 0 kg·m/s. b. 1 kg·m/s. c. 2 kg·m/s. d. 3 kg·m/s. e. 4 kg·m/s.

2. D What is the total kinetic energy of the carts?
   a. 0 J. b. 1 J. c. 2 J. d. 3 J. e. 4 J.

3. B What is the velocity of the 1 kg cart after the collision?
   a. –2/3 m/s. b. –2 m/s. c. 0 m/s. d. 2/3 m/s. e. 2 m/s.

4. C If you drop a glass onto a stone floor, it will break. Why might the glass survive if the floor were carpeted instead?
   a. The carpet would decrease the impulse on the glass so that the forces would be smaller.
   b. The carpet would increase the impulse on the glass so that the forces would be smaller.
   c. While the carpet wouldn't change the impulse, it would make the time of the crash longer, which makes the forces smaller.
   d. The carpet just makes the forces smaller; everything else would otherwise be the same.

$25\hat{j}$

$50\hat{i} + \sout{25\hat{j}}$

5. E A 5 kg object with an initial velocity of 10**i** + 0**j** m/s experiences an impulse of 25**j** N·s during a collision that lasts 0.1 seconds. What is the final momentum (in kg·m/s) of the object?
   a. 500**i** + 250**j**. b. 5**i** + 2.5**j**. c. 50**i** + 250**j**. d. 50**i** + 2.5**j**. e. 50**i** + 25**j**.

6. B An object with an initial speed of 13 m/s has a two dimensional collision with a second object that is initially at rest. After the collision, the speed of the first object is 5 m/s and the speed of the second object is 12 m/s. Which of the following statements is true?
   a. The collision was clearly elastic, no matter what the masses of the objects were.
   b. The collision was elastic only if the objects had the same mass.
   c. Momentum could not have been conserved, no matter what the masses were.
   d. If the masses were the same, then somehow momentum was gained in the collision.

7. B Two carts with different masses are at rest on a level track. The spring plunger in one of the carts is released, and the two carts go off in opposite directions. Which of the following must be true?
   a. The carts will have equal and opposite momenta and equal kinetic energies.
   b. The carts will have equal and opposite momenta, but different kinetic energies.
   c. The carts will have the same kinetic energies, but different momenta.
   d. The carts will have the same kinetic energies and different momenta.

8. A Imagine two identical carts having a head-on elastic collision with the same initial speeds. After the collision, both carts would have reversed their velocities, but during the collision which of the following is true?
   I. Momentum is conserved even during the collision.
   II. Kinetic energy is conserved during the collision.
   a. I only. b. II only. c. both are true. d. neither is true.

9. C A 100 kg cannon fires a 2 kg cannonball with a speed of 150 m/s. What is the recoil speed of the cannon?
   a. 0 m/s. b. 2.94 m/s. c. 3.00 m/s. d. 3.06 m/s. e. none of those.

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(12 @ 5 100 total) ~~10 @ 5 90 total~~

Problem Solving: *Show all work.* (12 @)	=

10. A massive garbage truck collides with a bike carelessly left in the road. During the collision, which experienced the greater:
    a. Impulse? same
    b. Force? same
    b. Change in Velocity? bike
    d. Acceleration? bike
    e. Change in Momentum? same

11. A 3 kg object has an initial velocity of 5 m/s. It collides off another object, and has a final speed of 4 m/s. During the collision, the average force on the object was $F_x\mathbf{i} + 125\mathbf{j}$ N and lasted for 0.03 seconds. What was the horizontal component of the force?

$J = (F_x \hat{i} + 125 \hat{j})(.03)$

$J = F(.03)\hat{i} + 3.75\hat{j}$

$\vec{P}_i + \vec{J} = \vec{P}_f$

$(3)(4)\sin\theta = 3.75$

$\sin\theta = .3125$

$\theta = 18.2°$

$3(5) + F(.03) = (3)(4)\cos(18.2)$

$15 + (.03)F = 11.399$

$.03F = -3.6$

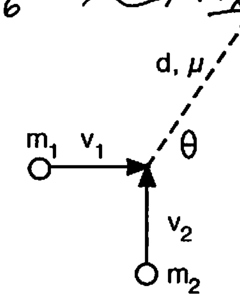
$F_x = -120 N$

no components −6

+120 −2

no mass −3

12. Two objects, m_1 and m_2, have initial velocities (v_1 and v_2) perpendicular to each other, as shown in the diagram. They collide and stick together. After the collision, they slide to a stop in a distance d because of a coefficient of friction of μ. After the collision, they move at the angle shown. What was the initial velocity of m_2?



Post Collision:

$\frac{1}{2}(m_1+m_2)v_f^2 = \mu(m_1+m_2)gd$

$v_f^2 = 2\mu g d$

$v_f = \sqrt{2\mu g d}$

P_y is conserved, so $m_2 v_2 = (m_1+m_2)v_f \sin\theta$

$v_2 = \frac{(m_1+m_2)\sqrt{2\mu g d}\sin\theta}{m_2}$

$K_1 + K_2 = \text{fric}$ −8

no components −6

g ≠ 10 −1

13. You are at rest next to a 150 kg astronaut who ~~is floating next to a 500 kg satellite~~ when the astronaut pushes the satellite away. The astronaut and satellite move apart with a realitve speed of 3 m/s. How fast is the astronaut moving after the push?

$150 v_1 = 500 v_2$

$v_1 + v_2 = 3$

$v_2 = 3 - v_1$

$150 v_1 = 500(3 - v_1)$

$3v_1 = 10(3 - v_1)$

$3v_1 = 30 - 10v_1$

$13v_1 = 30$

$v_1 = 2.31$ m/s

speed & velocity −3

~~1800~~

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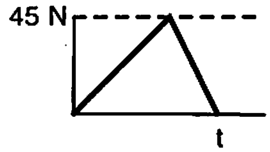
14. You drop an awesome superball (mass 50 grams) from a height of 2 meters. It has a perfectly elastic collision with the floor. The resulting net force on the ball as a function of time during the collision with the floor is shown in the diagram. How long did the collision last?



$mgh = \frac{1}{2}mv^2$

$v^2 = 2gh$

$v = \sqrt{2 \cdot 10 \cdot 2}$

$v = 6.32$ m/s

Post collision, $v_f = -v$

$p_i = (.05)(6.32)$

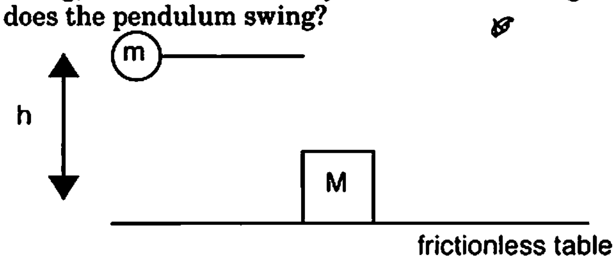
$p_f = (.05)(-6.32)$

$\Delta p = 0.633$

$0.633 = \frac{1}{2}(45)\,t$

$t = 0.028$ s

15. A 3.5 kg pendulum is pulled back to a height of h = 75 cm and released. At the bottom of its swing, it collides elastically with a mass of 5 kg initially at rest. After the collision, how high does the pendulum swing?



$v_i = \sqrt{2gH}$

$= \sqrt{2 \cdot 10 \cdot (.75)} = \sqrt{15}$

$v_i = 3.87$ m/s

$mgH = \frac{1}{2}Mv^2 + mgh$

$v_{2f} = \frac{2(3.5)}{8.5}(3.87) + 0$

$v_{2f} = 3.19$ m/s

$(3.5)(10)(.75) = \frac{1}{2}(5)(3.19)^2 + (3.5)(10)h$

$26.25 = 25.4 + 35h$

$.8175 = 35h$

$h = .0234$ m

$(v_{1f} = \frac{-1.5}{8.5}(3.87) + 0$

$v_{1f} = -.684$ m/s

$.467 = 2 \cdot 10 \cdot h$

rats!
$+ = v_{1i}$!!
$(- = v_{1f})$