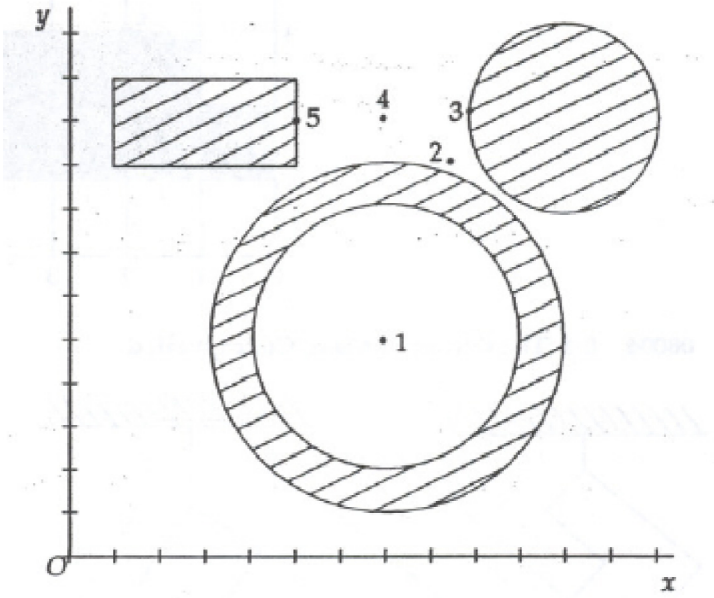
Name: _____ **Assignment Due Date: February 17, 2012**

AP Physics: Center of Mass Calculations and Intro to Momentum

Multiple Choice

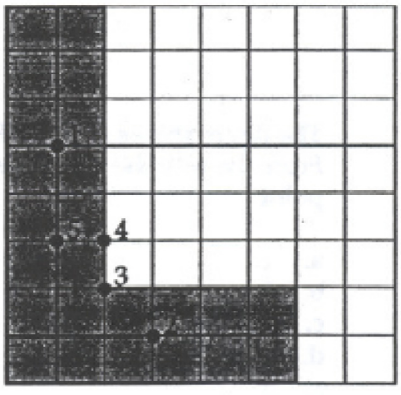
Identify the choice that best completes the statement or answers the question.

____ 1. The mass of the rectangle in the figure is *M*, the mass of the ring is *M*, and the mass of the circle is 3*M* The center of mass of the system with respect to the origin *0* is located at point



a. 1
b. 2
c. 3
d. 4
e. 5

____ 2. An L-shaped piece, represented by the shaded area on the figure, is cut from a metal plate of uniform thickness. The point that corresponds to the center of mass of the L-shaped piece is



a. 1
b. 2
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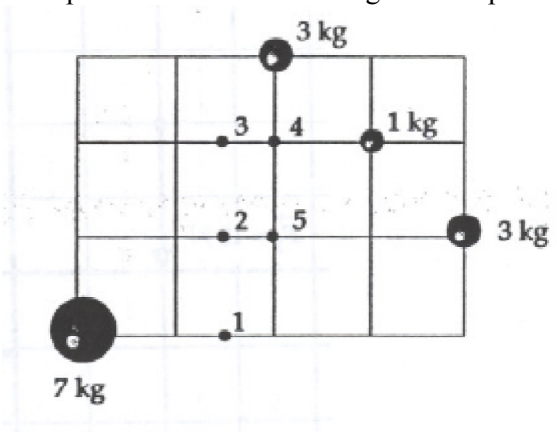
____ 3. The center of mass of the system of particles shown in the diagram is at point



a. 1
b. 2
c. 3
d. 4
e. 5

____ 4. The SI units of momentum are

a. kg·m·s
b. m^2/s
c. kg·s/m
d. kg/J
e. kg·m/s

Short Answer

5. Why does a wine glass survive a fall onto a carpet but not onto a concrete floor?

Problem

6. Three point masses of 2 kg each are located on the x axis at the origin, $x = 0.20$ m, and $x = 0.50$ m. Find the center of mass of the system.

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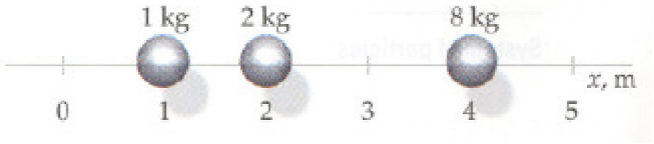
7. A 24-kg child is 20 m from an 86-kg adult. Where is the center of mass of this system?

8. Three objects of 2 kg each are located in the *xy* plane at points (10 cm, 0), (0, 10 cm), and (10 cm, 10 cm). Find the location of the center of mass.

9. Find the center of mass x_{cm} of the three masses in the figure below.



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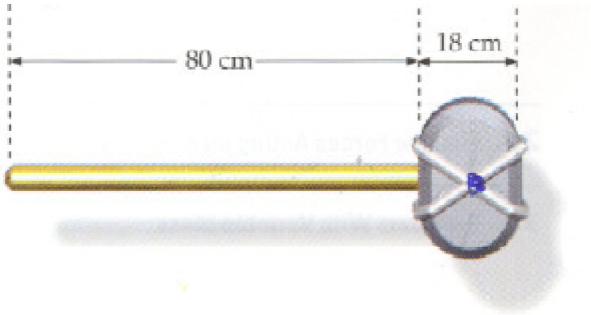
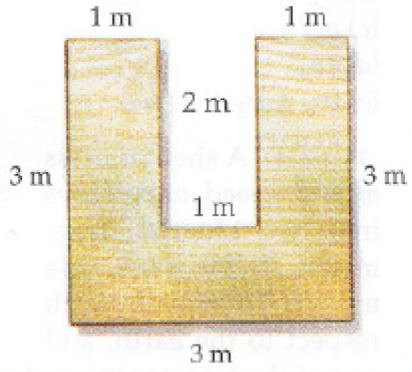
10. Alley Oop's club-ax consists of a symmetrical 8-kg stone attached to the end of a uniform 2.5-kg stick that is 98cm long. The dimensions of the club-ax are shown in the figure below. How far is the center of mass from the handle end of the club-ax?



11. The uniform sheet of plywood in the figure below has a mass of 20 kg. Find its center of mass.



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12. A 1500-kg car is moving westward with a speed of 20 m/s, and a 3000-kg truck is traveling east with a speed of 16 m/s. Find the velocity of the center of mass of the system.

13. A girl of mass 55 kg jumps off the bow of a 75-kg canoe that is initially at rest. If her velocity is 2.5 m/s to the right, what is the velocity of the canoe after she jumps?

14. Two masses of 5 kg and 10 kg are connected by a compressed spring and rest on a frictionless table. After the spring is released, the smaller mass has a velocity of 8 m/s to the left. What is the velocity of the larger mass?

15. A soccer ball of mass 0.43 kg leaves the foot of the kicker with an initial speed of 25 m/s. *(a)*What is the impulse imparted to the ball by the kicker? *(b)* If the foot of the kicker is in contact with the ball for 0.008 s, what is the average force exerted by the foot on the ball?

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Answer Section

MULTIPLE CHOICE

1. ANS: B REF: Tipler 4th ed Mult Choice Question Bank p.115 #1
2. ANS: D REF: Tipler 4th ed Mult Choice Question Bank p.115 #2
3. ANS: B REF: Tipler 4th ed Mult Choice Question Bank p.117 #5
4. ANS: E REF: Tipler 4th ed Mult Choice Question Bank p.120 #14

SHORT ANSWER

5. ANS:
   The average force on the glass is less when falling on a carpet because Δt is longer.

   REF: Tipler 4th ed. p.249 #44

PROBLEM

6. ANS:

   Use Equ. 8-4; note that $y_{cm} = 0$ $x_{cm} = [(2 \times 0 + 2 \times 0.2 + 2 \times 0.5)/6]\ \text{m} = 0.233\ \text{m}$

   REF: Tipler 4th ed. p.246 #2

7. ANS:

Use Equ. 8-4 $x_{cm} = (86 \times 20/110)\ \text{m} = 15.6\ \text{m}$

REF: Tipler 4th ed. p.246 #3

8. ANS:

Use Equ. 8-4 $x_{cm} = [(10 \times 2 + 10 \times 2)/6]\ \text{cm} = 6.67\ \text{cm};$
$y_{cm} = [(10 \times 2 + 10 \times 2)/6]\ \text{cm} = 6.67\ \text{cm}$

REF: Tipler 4th ed. p.246 #4

9. ANS:

Use Equ. 8-4 $x_{cm} = [(1 \times 1 + 2 \times 2 + 8 \times 4)/11]\ \text{m} = 3.36\ \text{m}$

REF: Tipler 4th ed. p.246 #5

10. ANS:

1. Locate CM of stick and of stone — By symmetry, $x_{cm}(\text{stick}) = 0.49$ m; $x_{cm}(\text{stone}) = 0.89$ m
2. Use Equ. 8-4 — $x_{cm} = [(2.5 \times 0.49 + 8 \times 0.89)/10.5]\ \text{m} = 0.795\ \text{m}$

REF: Tipler 4th ed. p.246 #6

11. ANS:

1. Find $x_{cm}(m_1)$, $y_{cm}(m_1)$ and $x_{cm}(m_2)$, $y_{cm}(m_2)$ — By symmetry, $x_{cm}(m_1) = 1.5$ m, $y_{cm}(m_1) = 1.5$ m and $x_{cm}(m_2) = 1.5$ m, $y_{cm}(m_2) = 2.0$ m
2. Determine m_1 and m_2 — $m_1 = 9\sigma$ kg, $m_2 = 2\sigma$ kg
3. Use Equ. 8-4 — $x_{cm} = (9\sigma \times 1.5 - 2\sigma \times 1.5)/7\sigma = 1.5$ m; $y_{cm} = (9\sigma \times 1.5 - 2\sigma \times 2.0)/7\sigma = 1.36$ m

REF: Tipler 4th ed. p.247 #9

12. ANS:

Let east be the positive i direction. $v_{cm} = (\Sigma m_i v_i)/M$ $v_{cm} = [(3000 \times 16 - 1500 \times 20)/4500]\ \text{m/s}\ i = 4\ \text{m/s}\ i$

REF: Tipler 4th ed. p.247 #19

13. ANS:

$F_{ext} = 0$; $\Sigma m_i v_i = 0$ $v_c = (55 \times 2.5/75)\ \text{m/s} = 1.83\ \text{m/s}$, opposite to girl's v

REF: Tipler 4th ed. p.248 #31

14. ANS:

$F_{ext} = 0$; $\Sigma m_i v_i = 0$ $\qquad$ $v_{10} = (5 \times 8/10)$ m/s = 4 m/s to right

REF: Tipler 4th ed. p.248 #32

15. ANS:

(*a*) Use Equ. 8-19 $\qquad$ $I = mv = 10.75$ N·s

(*b*) Use Equ. 8-20 $\qquad$ $F_{av} = 10.75/0.008$ N = 1344 N

REF: Tipler 4th ed. p.249 #45