A.P. Physics – C

UNIT 4 TEST REVIEW

Center of Mass & Momentum
Chapter 9

*** In studying for your test, make sure to study this review sheet <u>along with your quizzes and homework assignments.</u>**

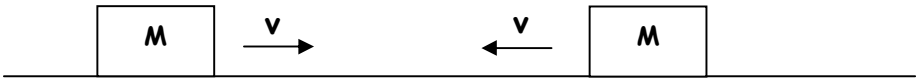
Multiple Choice Review: **On this portion of the test, you will not be allowed to use your calculator or AP formula sheet. (You may, however, use your AP table of information.) Approximate $g=10m/s^2$ for simplicity of calculations. No partial credit will be given.**

1. Two objects, A and B, initially at rest, are "exploded" apart by the release of a coiled spring that was compressed between them. As they move apart, the velocity of object A is 5m/s and the velocity of object B is -2m/s. The ratio of the mass of A to the mass of M, m_A/m_B, is…
a. 4/25 **b.** 2/5 **c.** 1/1 **d.** 5/2 **e.** 25/4

2. If one knows only the constant resultant force acting on an object and time during which this force acts, one can determine the…
a. change in momentum of the object.
b. change in velocity of the object.
c. change in kinetic energy of the object.
d. mass of the object.
e. acceleration of the object.

3. The force acting on a 5kg mass over a 2 second interval is given by $F(t)=3t^2$. Calculate the total impulse acting on the object over the 2 second interval.
a. 1.6Ns **b.** 8Ns **c.** 12Ns **d.** 40Ns **e.** 60Ns

4. A railroad car of mass m, moving at a speed v, collides with a second railroad car of mass M which is at rest. The two cars lock together and move along the track. What is the speed of the cars immediately after the collision?
a. $\frac{v}{2}$ **b.** $\frac{(m+M)}{v}$ **c.** $\frac{mv}{M}$ **d.** $\frac{mv}{(m+M)}$ **e.** $\frac{Mv}{m}$



5. The two blocks of masses M shown above initially travel at the same speed v but in opposite directions. Momentum is conserved as they collide and stick together. How much mechanical energy is lost to other forms of energy during the collision?

a. zero **b.** $\frac{1}{2}Mv^2$ **c.** Mv^2 **d.** $\frac{3}{4}Mv^2$ **e.** $\frac{3}{2}Mv^2$

6. A solid metal ball and a hollow plastic ball of the same external radius are released from rest in a large vacuum chamber. When each has fallen 1m, they both have the same…

a. inertia
b. momentum
c. change in potential energy
d. speed
e. kinetic energy

7. A 5kg ball approaches a wall at a speed of 4m/s. It then bounces off of the wall in the opposite direction at the same speed. What is the magnitude of the average force exerted on the ball if it is in contact with the wall for 0.1s?

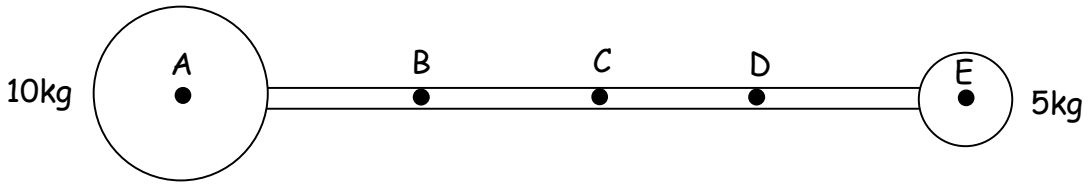
a. 0N **b.** 100N **c.** 200N **d.** 400N **e.** 500N

8. A 2kg object's velocity is initially (4î)m/s and its final velocity is (3ĵ)m/s. What is the object's change in momentum, in unit-vector notation?

a. (8î - 6ĵ)kgm/s
b. (8î + 6ĵ)kgm/s
c. (-8î + 6ĵ)kgm/s
d. (10î)kgm/s
e. (10ĵ)kgm/s

9. An object of mass M is moving to the right at a speed v when it explodes into two parts of equal size. How quickly is the center of mass of the 2-object system moving after the collision?

a. It is moving faster than speed v.
b. It is moving slower than speed v.
c. It is still moving at speed v.
d. This answer depends on the precise value of the speed v.
e. This answer depends on the precise value of the mass M.

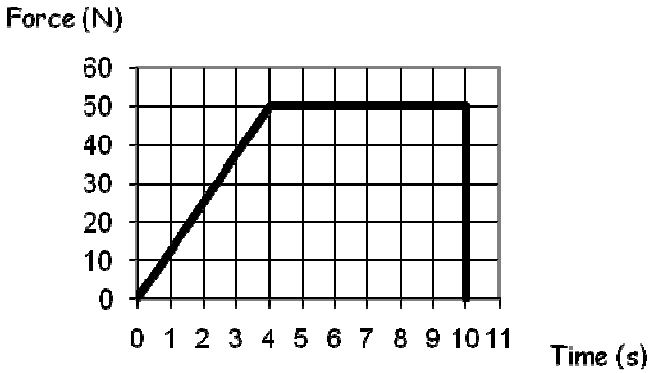


10. A 5kg sphere is connected to a 10kg sphere by a rigid rod of negligible mass, as shown in the above diagram. Which of the five lettered points best represents the center of mass of the sphere-rod combination?

a. A **b.** B **c.** C **d.** D **e.** E

11. The only force acting on an 8kg object varies as shown in the given graph. Determine the impulse acting on the object during the 10 second interval.

a. zero
b. 50Ns
c. 300Ns
d. 400Ns
e. 500Ns



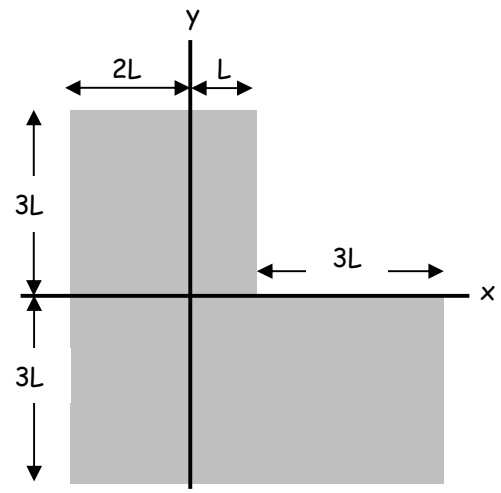
12. Assuming it started from rest at position 0m, the speed of the 8kg object in problem #11 at the end of the 10 second interval is closest to which one of the following?

a. zero **b.** 20m/s **c.** 50m/s **d.** 71m/s **e.** 100m/s

Problem Review: **On this portion of the test, you may use your calculator, AP formula sheet, and AP table of information. Partial credit will be given on these problems.**

13. A 5kg particle is located at the point (-3, 0) on an xy coordinate plane, and a 9kg particle is located at the point (6, 2). Calculate the x- and y-coordinates of the center of mass of the system.

14. What are the x- and y-coordinates of the center of mass for the uniform metal plate shown in the figure, if L=5cm?



15. A 0.12kg tennis ball is moving at a velocity of 18m/s along an x-axis. After it is hit, the ball is moving back at 20m/s at 32° above the negative x-axis. Calculate the magnitude and direction of the average force acting on the ball during the 32ms of contact time.

16. The force acting on a 3.2kg object is given by $F(t) = 4t - 2t^2$. Calculate the impulse on the object due to the force from time 1.2s to 4s, and also the average force during this same time interval.

17. Starting with only conservation ideas and the definition of an elastic collision, derive the following expression: $v_{1i} + v_{1f} = v_{2i} + v_{2if}$

18. A 30kg disk moving at 24m/s in the positive x-direction is exploded into three pieces. After the explosion, a 17kg piece moves at 35m/s in the positive x-direction, and a 10kg piece moves at 22m/s at 20° clockwise from the negative x-axis. Calculate the magnitude and direction of the velocity of the third piece after the collision.

19. What is the launch velocity of a 100g ball fired into a 250g ballistic pendulum, if the pendulum's center of mass is raised 23cm as it swings after the collision, assuming the pendulum catches the ball when they collide?

20. A 300g object slides down a frictionless 10^{o} incline and reaches the bottom with a speed of 4.3m/s, where it elastically collides with a 400g object at rest. After the collision, how far back up the incline (measured along the incline) does the 300g object slide before it comes to a stop?

21. Actual A.P. Physics C Free-Response Question (1993):
A massless spring with k=400N/m is fastened at its left end to a wall, as shown below. Initially, block A (m=4kg) and block B (m=2kg) rest on a horizontal surface, in contact with the spring but not compressing it. Block A is then moved to the left, compressing the spring 0.5m, while block B remains at rest.

a. Determine the elastic energy stored in the compressed spring.

Block A is then released and accelerates to the right toward block B. The surface is rough and the coefficient of kinetic friction between the surface and the blocks is μ=0.4. The two blocks collide instantaneously, stick together, and move to the right. Remember that the spring is not attached to block A, and determine the following.

b. The speed of block A just before it collides with block B.

c. The speed of both blocks just after they collide.

d. The horizontal distance the blocks move (after collision) before coming to rest.