Early E. C.: / 1
Total HW Points Unit 8: / 22
Total Lab Points Unit 8: / 18
Unit 8 Apps.: / 5
Late, Incomplete, No Work, No Units Fee? Y / N

Unit 8 – Momentum, Impulse, & Collisions

Essential Fundamentals of Momentum, Impulse, & Collisions

1. Momentum is conserved in both elastic, and inelastic collisions.

Add more here!

Equation Sandbox

In Unit 8, some of the following equations will be used. Practice isolating variables to prepare for it.

Possible 8.1 Pts: 5
Late, Incomplete, No Work, No Units Fee: -1 - 2 -3
Final Score: / 5

8.1 Problems – Momentum and Impulse
Sections 6.1 of your book.

1. A. If a 60.0-kg woman is riding in a car traveling at 90.0 km/h, what is her linear momentum relative to the ground?

   B. What is her momentum relative to the car?

2. A 0.150-kg baseball travelling with a positive horizontal speed of 4.50 m/s is hit by a bat and then moves with a speed of 34.7 m/s in the opposite direction. What is the change in the ball's momentum?

3. A. In a football game, a lineman usually has more mass than a running back. Will a lineman always have more momentum? Explain your answer.

   B. Who has greater momentum, a 75-kg running back moving at 4.5 m/s, or a 120-kg lineman moving at 3.0 m/s? Prove your answer mathematically.

Possible 8.2 Pts:	4
Late, Incomplete, No Work, No Units Fee:	-1 - 2 -3
Final Score:	/ 4

8.2 Problems – Impulse
Section 6.3 of your book.

1. A pool player imparts an impulse of 3.2 N•s to a stationary 0.25-kg cue ball with a cue stick. What is the speed of the ball just after impact?

2. When hit by a batter, a 0.20-kg softball receives an impulse of 3.0 N•s. With what horizontal speed does the ball move away from the bat?

3. A loaded tractor-trailer with a total mass of 5.0 E 3 kg traveling at 3.0 km/h hits a loading dock and comes to a stop in 0.64 s. What is the magnitude of the average force exerted on the truck by the dock?

4. An automobile with a linear momentum of 3.0 E 4 kg•m/s is brought to a stop in 5.0 s. What is the magnitude of the average braking force?

Possible 8.3 Pts:	**4**
Late, Incomplete, No Work, No Units Fee:	-1 - 2 -3
Final Score:	**/ 4**

8.3 Problems – Conservation of Linear Momentum

Section 6.3 of your book.

1. A 60.0-kg astronaut floating at rest in space outside a space capsule throws his 2.0 kg hammer such that it moves with a speed of 10.0 m/s relative to the capsule. What happens to the astronaut, qualitatively and quantitatively?

2. To get off a frozen, frictionless lake, a 65.0-kg person takes off her 0.150-kg shoe and throws it horizontally, directly away from the shore with a speed of 2.00 m/s. If the person is 5.00 m from the shore, how long does she take to reach it?

3. A. An explosion of a 10.0-kg bomb releases only two pieces. The bomb was initially at rest and a 4.00-kg piece travels due west at 100.0 m/s immediately after the explosion. What are the speed and direction of the other piece immediately after the explosion?

   B. How much kinetic energy was released in this explosion? (Hint: Refer to Unit 7.3 notes).

Possible 8.4 Pts:	6
Late, Incomplete, No Work, No Units Fee:	-1 - 2 -3
Final Score:	/ 6

8.4 Problems – Collisions

Section 6.4. of your book.

Wizard Challenge Alert!

1. A. A truck (mass = 1500 kg) traveling at 6.5 m/s collides with a stationary car (mass 950 kg) and sticks to it. How fast were the two vehicles traveling just after impact?

   B. How much kinetic energy did the truck have before the collision?

   C. How much kinetic energy did the joined vehicles have after the collision?

   D. What was the change in kinetic energy?

2. A 4.0-kg ball with a velocity of 4.0 m/s in the +x-direction collides head-on elastically with a stationary 2.0-kg ball. What are the velocities of the balls after the collision?

3. A 145 g blob of clay traveling 3.4 m/s hits a larger, stationary blob and sticks to it. How much mass would the stationary blob need in order for the resulting speed of the joined blobs to be 1.1 m/s?

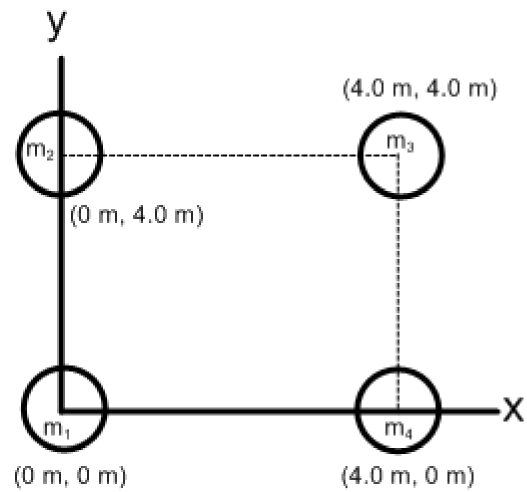
Possible 8.5 Pts: 3
Late, Incomplete, No Work, No Units Fee: -1 - 2 -3
Final Score: / 3

8.5 Problems – Center of Mass
Section 6.5 of your book.

1. A. Find the average center of mass of the Earth-Moon system. You will have to use values in your resources to answer this problem, or find them on the net.

   B. Where is that center of mass relative to the surface of the Earth?

2. Locate the center of mass of the system shown in the figure if $m_1 = 1.0$ kg, $m_2 = 2.0$ kg, $m_3 = 3.0$ kg, and $m_4 = 4.0$ kg.



AP Physics 1	Unit 8.2 Lab - Balancing Can Activity
Reminder: Update Table of Contents	Correction Credit: Half

Balancing Can Lab (8.1) Scoring Guide		
Table of Contents, Title/Date, Detailed Synopsis, Two Purposes		/ 2
Mission 1: Data Table	Table Present	/ 2
	Can Volume	/ 1
	Min/Max Volume	/ 1
	Maximum Volume	/ 1
	Average Volume	/ 1
	% Range	/ 2
Analysis	Can Profile	/ 1
	Exact Center Marked	/ 2
	x/y Length Labels	/ 2
Question 1: Difficulties determining center of mass.		/ 3
Work Not Shown Fee:		-1 -2 -3
Late Lab Fee:		-4
Total:		**/ 18**

Overview

One of the better party tricks around is the famous gravity-defying can-balancing trick, where you have an aluminum can with just the right amount of pop in it so that it will balance on the bottom edge at an angle.

Be careful about which surface you choose to do this trick on (important documents, computer keyboards, etc)! If you have too much or too little pop the can will tip over, spilling all over and getting you in trouble!

Materials

Empty Aluminum Can	Tap Water
100 ml Graduated Cylinder	10 ml Graduated Cylinder
2 mL Graduated Pipette	Short Metric Ruler

Mission 1 – Measurement and Data Table.

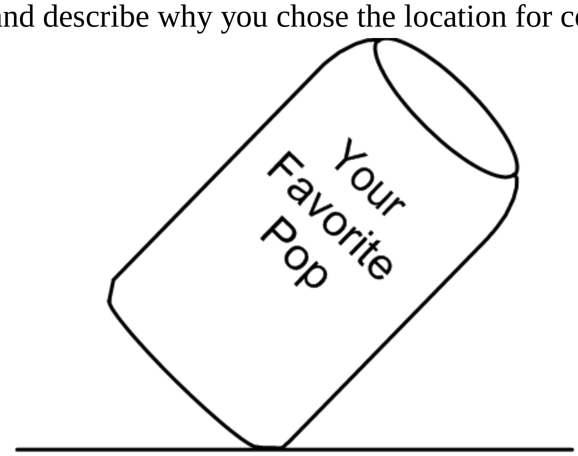
Determine how much total water can fit into your empty can. Report volume measurements to the nearest 0.5 mL. Determine the MINIMUM volume of water for the can to balance. Determine the MAXIMUM volume of water for the can to balance. Determine the AVERAGE volume of water for the can to balance. Determine the percentage range (minimum % to maximum %) of filling you can have for the can to balance.

Analysis

1. Try and determine the exact center of mass within the can as it is on its edge with an average volume of water inside ((x,y) coordinates). Draw your can's profile in your booklet (with an average water level indicated), with length labels to help your analysis, and define your coordinate system so that I know what you mean. For this, use the "by guess and by golly" method: using math would require more information than you obtained, as well as involving more difficult math that you have.

Question: Rephrase and write in full sentences for full credit.

1. Explain the difficulties you encounter when trying to determine the can/water system's exact center of mass, and describe why you chose the location for center of mass.



AP Physics 1	Unit 8 - Momentum, Impulse, Collisions				
Application Problems, AP Test Preparation Questions					
Presentation Points:	/ 5	Late Fee:	-2	Completion (Booklet Check)	/ 5

Your grade on this problem set depends on the presentation you provide for your assigned problems, and whether **<u>all</u>** problems are complete when you submit your Booklet at the end of the Unit.

Application Problems

1. What is the momentum of a 455 gram bullet traveling at 440 m/s? How fast would you have to be going to equal that?

2. An exploding mass imparts an impulse of 230 N•s to a stationary 1.4 kg piece of shrapnel. What is the speed of the shrapnel just after the explosion? How much kinetic energy does the shrapnel have?

3. A 65.3-kg man standing on a frictionless surface throws a 7.26-kg shot put horizontally. The shot put's kinetic energy is 12.2 J upon launch. How fast will the man be moving in the opposite direction as he throws it?

4. A dropped rubber ball hits the floor with a speed of 6.2 m/s and rebounds to a height of 0.59 m. What percent of the initial kinetic energy was lost in the collision?

5. Find the average center of mass in the earth-sun system. Information to solve this problem is at the back of your Booklet. How far away from the surface of the sun is this point?

AP Test Questions

1. An object of mass 2 kg has a linear momentum of magnitude 6 kg x m/s. what is this object's kinetic energy?
   a) 3 J b) 6 J c) 9 J d) 12 J

2. A ball of mass 0.5 kg, initially at rest, acquires a speed of 4 m/s immediately after being kicked by a force of strength 20 N. For how long did this force act on the ball?
   a) 0.01 s b) 0.1 s c) 0.2 s d) 1 s

3. A box with mass 2 kg accelerates in a straight line from 4 m/s to 8 m/s due to the application of a force whose duration is 0.5 s. Find the average strength of this force.
   a) 4 N b) 8 N c) 12 N d) 16 N

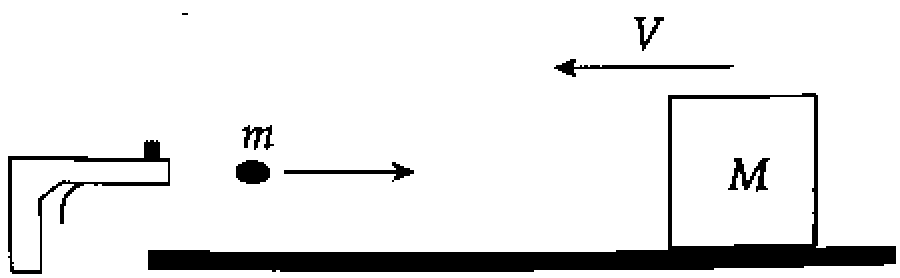
4. A ball of mass *m* traveling horizontally with velocity *v* strikes a massive vertical wall and rebounds back along its original direction with no change in speed. What is the magnitude of the impulse delivered by the wall to the ball?
   a) ½ *mv* b) *mv* c) 2*mv* d) 4*mv*

5. Two objects, one of mass 3 kg and moving with a speed of 2 m/s and the other of mass 5 kg and speed 2 m/s, move toward each other and collide head-on. If the collision is perfectly inelastic, find the speed of the objects after the collision.
   a) 0.25 m/s b) 0.5 m/s c) 0.75 m/s d) 1 m/s

6. Object 1 moves toward Object 2, whose mass is twice that of Object 1 and which is initially at rest. After their impact, the objects stick together and move with what fraction of Object 1's initial kinetic energy?
   a) 1/18   b) 1/9   c) 1/6   d) 1/3

7. Two objects move toward each other, collide, and separate. If there was no external force acting on the objects, but some kinetic energy was lost, then
   a) the collision was elastic and total linear momentum was conserved.
   b) the collision was elastic and total linear momentum was not conserved.
   c) the collision was not elastic and total linear momentum was conserved.
   d) the collision was not elastic and total linear momentum was not conserved.

8. A wooden block of mass M is moving at speed V in a straight line. How fast would a bullet of mass m need to travel to stop the block (assuming that the bullet became embedded inside)?



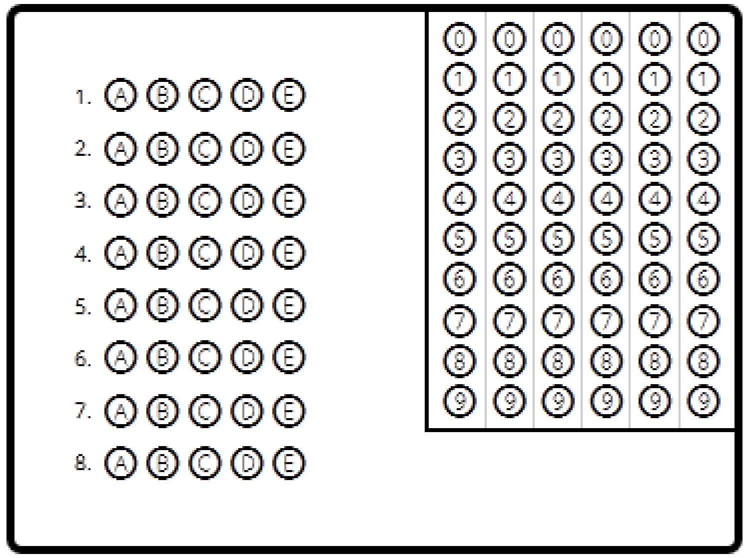
   a) mV/(m + M)   b) mV/M   c) MV/M)   d) V(m + M)/m

9. Which of the following best describes a perfectly inelastic collision free of external forces?
   a) Total linear momentum is never conserved.
   b) Total linear momentum is sometimes conserved.
   c) Kinetic energy is never conserved.
   d) Kinetic energy is always conserved.

AP Physics 1	Unit 8 Review - Momentum, Impulse, Collisions						
Points:	**/ 16**	**Late or Incomplete Fee:**	**-2 -4 -6**	**Correction Credit:**		**Final Score:**	

Solve these problems here, THEN enter your responses in the bubble sheet provided.

Each question is worth two points.



1. The linear momentum of a runner in a 100-m dash is 7.50 E 2 kg•m/s. If the runner's speed is 10.0 m/s, what is his mass?

A) 55.0 kg B) 65.0 kg
C) 75.0 kg D) 80.0 kg
E) 85.0 kg

2. What is the momentum of a 7.1-kg bowling ball traveling at 12 m/s?

A) 1.69 kg•m/s B) 55.9 kg•m/s C) 85.2 kg•m/s D) 94.2 kg•m/s E) 98.1 kg•m/s

3. A stationary 8.20-kg object receives an impulse of 14.2 N•s. With what horizontal speed will it move away from the impulse generating object?

A) 2.50 m/s B) 1.73 m/s C) 1.44 m/s D) 2.13 m/s E) 2.35 m/s

4. On frictionless ice, a 75-kg skater pushes his 45-kg female partner. Her velocity after the push is 1.5 m/s. What is the man's velocity?

A) 0.90 m/s B) 0.75 m/s C) 1.2 m/s D) 1.1 m/s E) 2.4 m/s

5. A 12.5 m/s, 50.0 kg wrecking ball hits another, smaller stationary one (35.0 kg). How fast will the smaller wrecking ball go as a result of the interaction? Assume an elastic collision.

A) 0.0 m/s B) 17.9 m/s C) 12.5 m/s D)15.2 m/s E) 14.7 m/s

6. Two cars collide and stick together in an intersection. The first car has a mass of 2300 kg and initially was traveling at 14.5 m/s. If the second car was at rest and had a mass of 1800 kg, how fast are both cars moving immediately after the collision?

A) 7.3 m/s B) 6.4m/s C) 9.6 m/s D) 8.1 m/s E) 10.7m/s

7. Two masses have masses of 13.2 kg and 4.80 kg, and are connected 4.5 meters apart from each other. How many meters from the first (13.2-kg) mass is the center of mass?

A) 0.9 m B) 1.2 m C) 1.8 m D) 3.3 m E) 2.3 m

8. Find the x-y coordinates for the center of mass for this three-body system:

A) (1.2, 2.5) B) (2.8, 2.3) C) (2.3, 3.0)
D) (2.3, 2.3) E) (2.3, 1.2)