Physics Unit 3
Momentum and Collisions

Did you...

- Present? If not, you are today!
- Turn in your slides on GC?
- Fill out the reflection on GC?

Today's Class

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1. Wrap Up Presentations and Reflections
2. Pass back papers and notebooks
3. Collisions Unit Introduction and Phenomenon


1
KTRH
23


2


3


4
prime
23
14
NFL

$V_f = V_i + at$

$\Delta x = V_i t + \frac{1}{2} a t^2$

$V_f^2 = V_i^2 + 2a\Delta x$

Yes! The variable is in the equation.	No! The variable is not in the equation.

Flipped Lessons for this Unit

- https://www.youtube.com/watch?v=AQ9STNJQQ_g
- https://www.youtube.com/watch?v=TXJTjtvL7PA
- https://www.youtube.com/watch?v=zSAqf9z6csk
- https://www.youtube.com/watch?v=DLN3C_JfYjw
- https://www.youtube.com/watch?v=GkWi_2h7sRA
- https://www.youtube.com/watch?v=Eho6uhJKuJE
- https://www.youtube.com/watch?v=Y2BCNO9Go5o

Track Falling Objects

- Open up Vernier Video Analysis and click on “Ball Drop”
- Switch to 2 frames and track the ball drop
- Scale based on the meter stick above the window
- Set the origin to where the ball groups
- Click on 2 graphs in the upper right corner
- Get rid of the x axes
- Save your two graphs and answer the questions in your notebook
  - What do you think the slopes of each graph tell you?
  - What could we figure out from this graph?
  - If we did this situation ourselves, what could we change?

Collisions and Falling Objects

- How do falling objects simulate a car crash?
- What variables can we change about a falling object?

Tracking Gravity

- With your group, choose one of the variables we brainstormed
  - Height dropped
  - Mass of Ball
- Record a video of each of the different situations (3 different times)
  - Height should be 0.5 or more
- Make sure to include a meter stick for your scale

Track Falling Objects

- Open up Vernier Video Analysis
- KEEP AT 1 frame and track the ball drop
- Scale based on your meter stick
- Set the origin to where the ball drops
- Click on 2 graphs in the upper right corner
- Remove the x data (click on the y axis of each graph)
- Save your graphs and answer the questions in your notebook
  - What do you think the slopes of each graph tell you? (slope = rise/run)
  - What do your data tell you about the relationship between your variable and the graphs?

Choose a pair of graphs (d vs t) (v vs. t)

– – –

Word Problem Boot Camp!

Warm Up: A runner starts from rest and accelerates to 4 m/s in 3.2 seconds. What is the acceleration of the person? How much distance did they travel? **Write down everything you know from this problem.**

To Do

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1. Vocab Update
2. Kinematic Equations

You will need a calculator

Wednesday- Guest Speaker (6th)

Friday- Check in Question Motion Equations

What about those other speed equations?

S = dis/t v = disp/t

They are average.

I drive 400 miles over 3 hours. What is my average speed? But wait… sometimes I’m driving at 70 mph and 20 mph...

How to do a word problem

1) Read the problem and draw a picture
2) Underline important information
3) Write down your knowns and unknowns with units
4) Determine which equation to use
5) Rearrange the equation to solve for your unknown variable (if needed)***
6) Plug in your numbers (with units)
7) Do some math
8) Write your answer with units and circle it

*** Rearranging is not required, but highly recommended for students who take AP Physics in the future or challenge themselves further

Try it out (student walks across room by speeding up)- time student over a distance

Velocity initial=

Distance =

Time =

Acceleration =

Final velocity=

A runner starts from rest and accelerates to 4 m/s in 3.2 seconds. What is the acceleration of the person? How much distance did they travel?

A runner starts from rest and accelerates to 4 m/s in 3.2 seconds. What is the acceleration of the person? How much distance did they travel?

A car is traveling at 20 m/s sees a stop light 50 m away and slows down until it is at rest. What is the acceleration of the car? How long does it take to slow down to rest?

A car speeds up with an acceleration of 5 m/s^2 over 100 m. What is the final velocity? Time?

#1 A snake, initially at rest, slithers across the jungle to catch a mouse. It takes him 10 seconds to move 33 m. What is his acceleration? Final velocity?

#2 The mouse sees the snake when he is slithering towards him and starts to run with an acceleration of 7 m/s^2 over the same 10 seconds. How much distance does the mouse move?

Three Situations

- Something is just dropped
- Something is thrown down
- Something is thrown upwards and comes back down

A ball is thrown down with an initial velocity of 6 m/s and hits the ground 1.6 m below. What is the velocity it hits the ground? How long does it take to hit the ground?

A ball is dropped from a height of 3 m. Acceleration on Earth is equal to gravity = 9.81 m/s^2. How long does it take to reach the ground? Final Velocity?

Warm Up: A ball is dropped on a new planet and you want to figure out the gravity on this planet. It takes 12 seconds to drop 6 meters. (You don’t know acceleration in this one!)

1. What is the gravity (acceleration) on this planet?
2. What would be the final velocity on the new planet?

Practice Questions

1. A cyclist is moving at 10 m/s and applies the brakes, coming to a stop in 20 m. What was the acceleration? Time to stop?
2. A car accelerates from rest to 30 m/s in 6 seconds. What is the acceleration? Distance?
3. A ball is dropped on a new planet and you want to figure out the gravity on this planet. It takes 12 seconds to drop 6 meters. (You don't know acceleration in this one!) What is the gravity (acceleration) on this planet? What would be the final velocity on the new planet?
4. A ball is thrown upwards with an initial velocity of 2.5 m/s. When it reaches the top, it has a velocity of 0. What is the time to reach the top? Distance?

A ball is thrown upwards with an initial velocity of 3 m/s and then comes back down into your hand. How far did it go up? How much time did it take to reach the top?
Extension- Time to go up and down? Displacement up and down?

A ball is dropped from a 100 m tall building. Final Velocity? Time?
The same ball is now thrown down with an initial velocity of 1 m/s. How did the final velocity and time change?

Friday 1/31 Physics

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1. Warm Up
2. Practice Packet Horizontal and Vertical Motion (Page 5-8)
3. Wet Road Stopping Distance- on GC

Check in Question MONDAY!

Warm Up: A person starts from rest and drives with an acceleration of 3 m/s^2 for 10 seconds. What is their final velocity?

D = 10 seconds A = 3

v1=0 Vf = ?

I am choosing the third equation

Is the student correct? Make corrections if they are wrong!

Monday, February 3- Physics

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1. Check In Question
2. Wet Road Stopping (on GC)
3. Newton’s Second Law and Kinematics

Tuesday, February 4- Physics

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Warm Up: Take out your Wet Road Stopping Assignment on Google Classroom.

1. Pass Back Check In Question
2. Wet Road Stopping Discussion
3. Newton's Second Law and Kinematics
4. Collision Predictions?

- Force: Push or pull
- Unit: Newtons (N)
- Vector (number, unit and direction)

Motion and Forces

You are running around a track. You start from rest and run for 20 seconds 100 meters (speeding up). What is your acceleration? (use kinematics) Your mass is 75 kg.

F=ma

Impact Lab- Motion and Forces!

Suppose you want to determine the force mathematically (quantitative) and conceptually (qualitative in the sand) as you drop different balls of different masses. You can also drop the masses from different heights

- How could you set up this experiment? Procedure?
- How could you organize your data?
- What are variables you could measure?
- How could you find the force? (Hint: F=ma)

Physics: Welcome back!

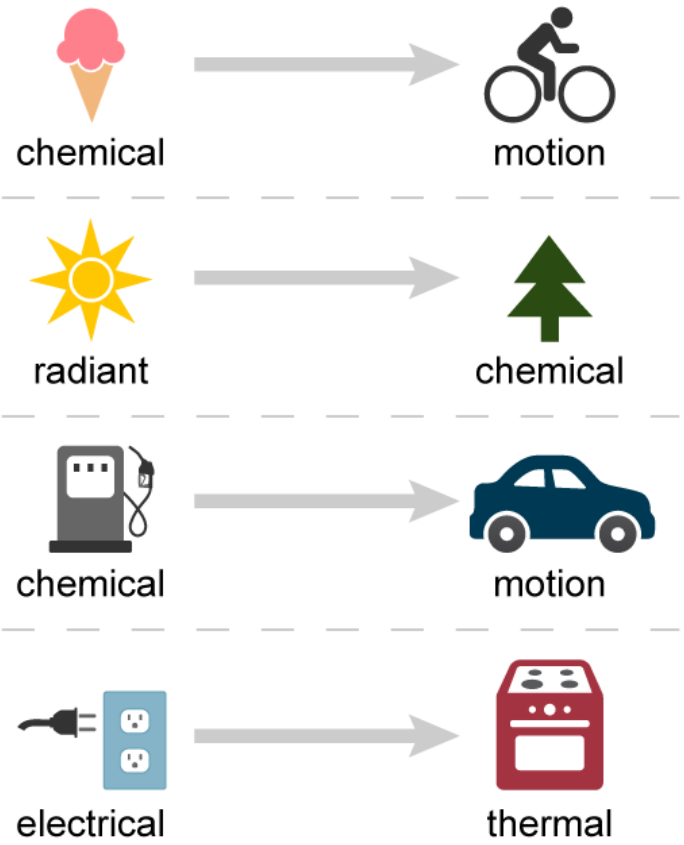
Agenda

- ❑ Warm Up
- ❑ Energy Exploration
- ❑ Conservation of Energy Mini Lesson
- ❑ Conservation of Energy Partner Practice

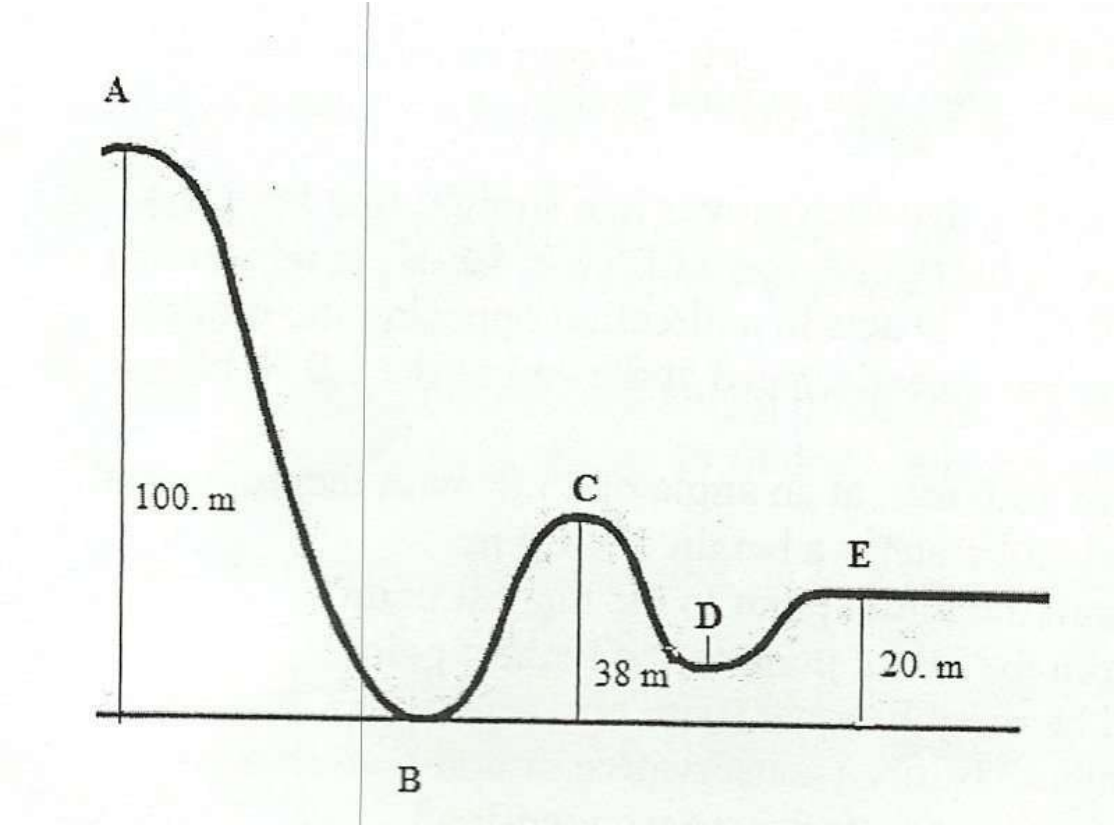
Warm Up

- ➔ When you hear “energy” what do you think of?
- ➔ What types of energy can you think of?

Energy transformations



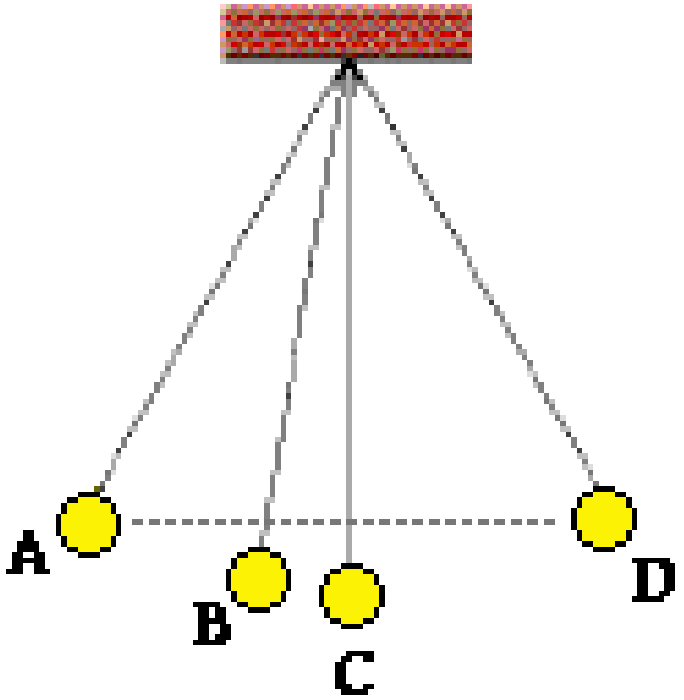
Greatest PE? KE? Both?



Warm Up

A pendulum swings back and forth (with no friction). C is the lowest point and A and D are the highest points.

1. When does it have maximum kinetic energy?
2. When does it have maximum potential energy?
3. When does it have both kinetic and potential?
4. What data could you take about this scenario?



Conservation of Energy

PE + KE (before) = PE + KE (after)

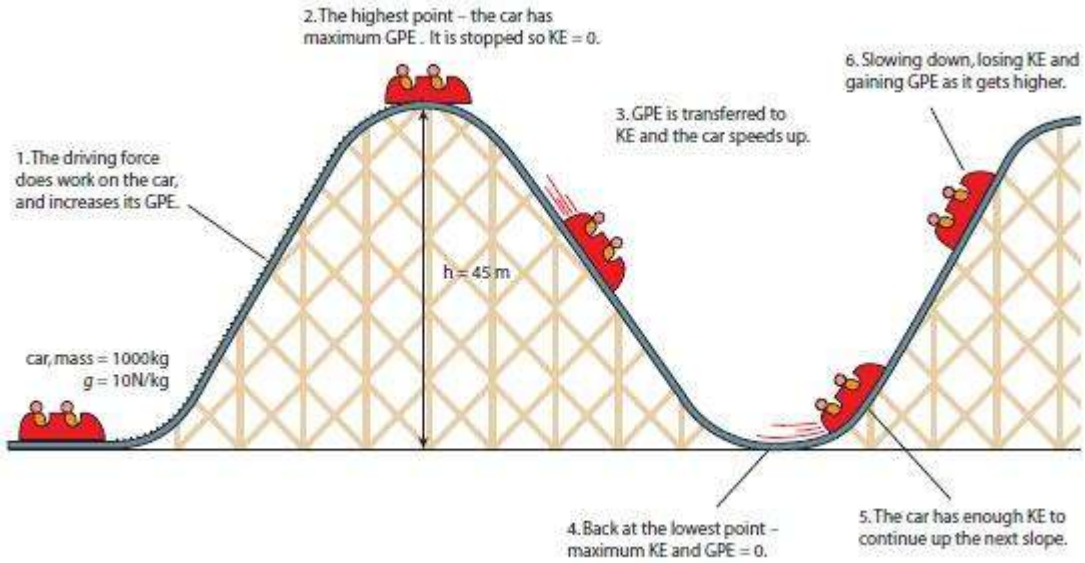


Fig. 9.16 Transferring energy from GPE to KE and back again.

Kinetic & Potential Energy

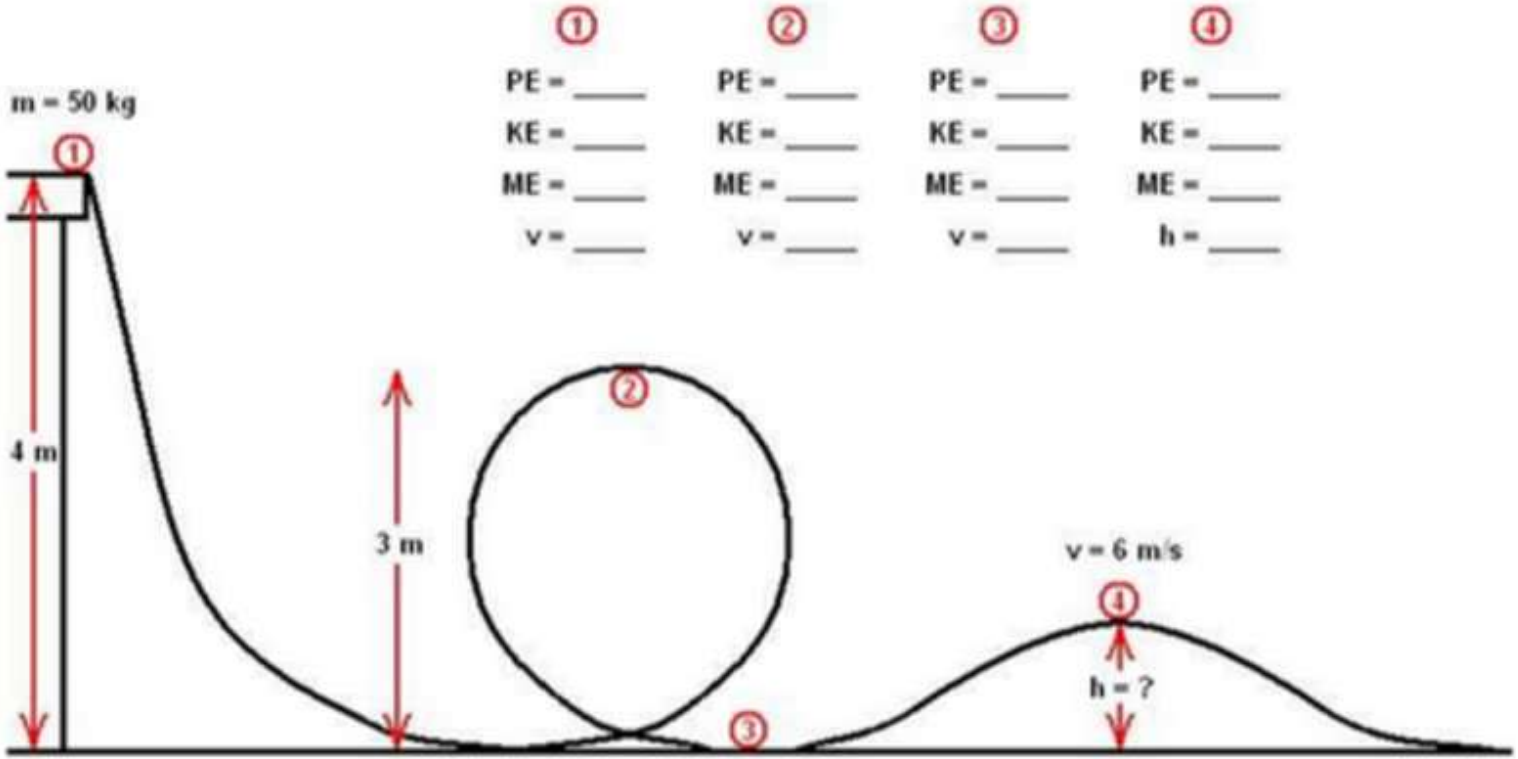
$$KE = \frac{1}{2} mV^2 \qquad PE = mgh$$

Energy Formula in Physics

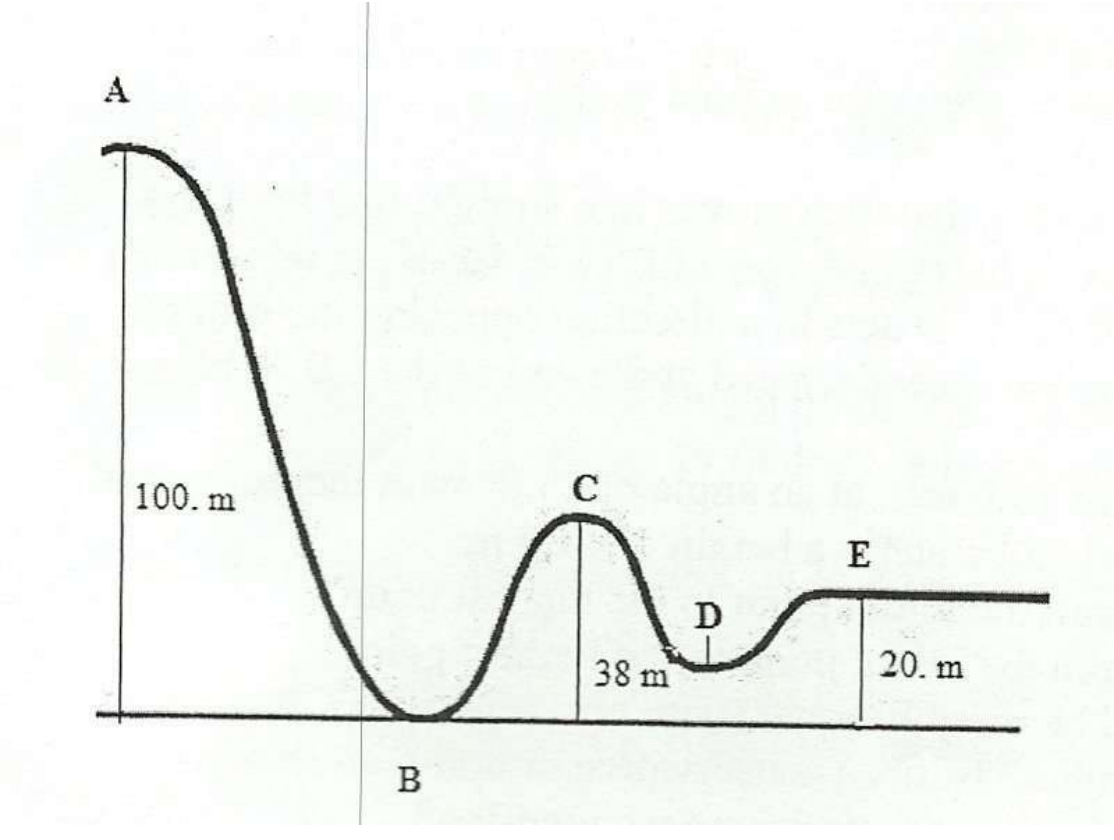
Practice Problem

A 0.3 kg ball is dropped from 2.5 m and falls to the ground.

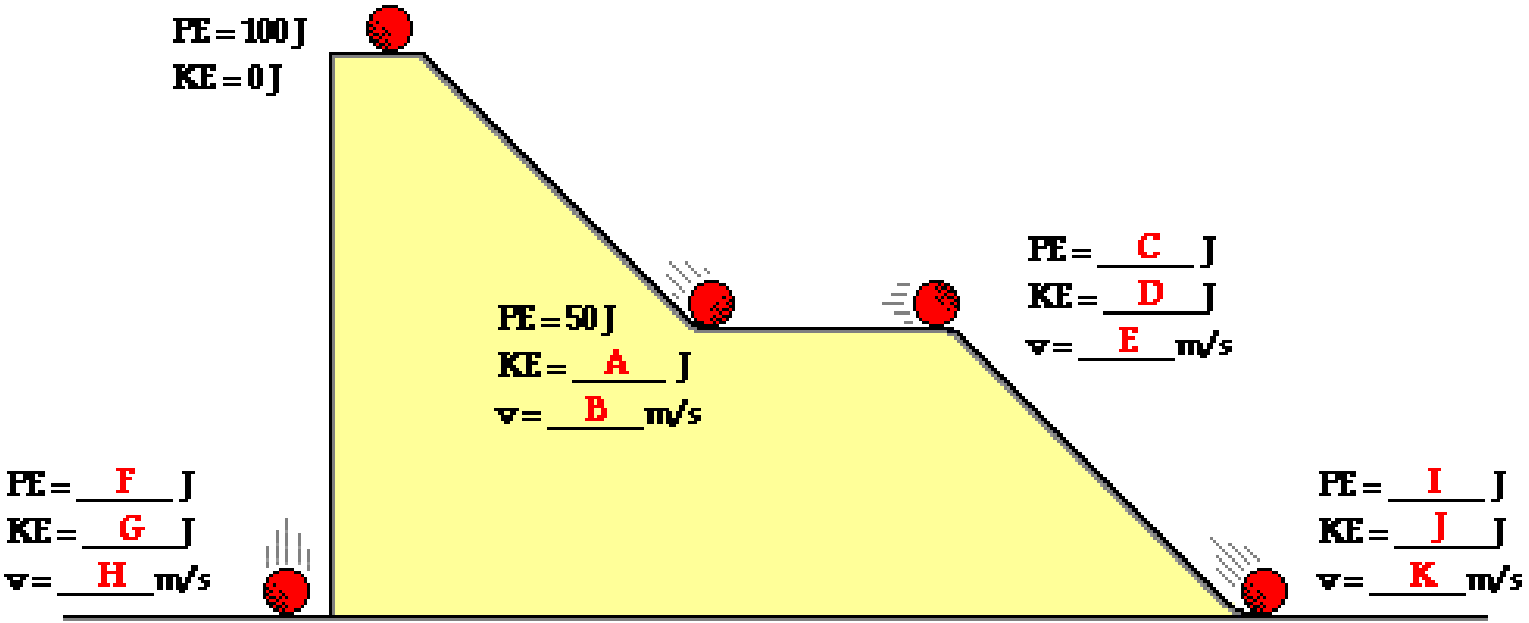
1. How much PE does it have when it drops?
2. What is the total energy?
3. What is the KE and PE when it hits the ground?
4. What is the velocity when it hits the ground?
5. What is the potential and kinetic energy halfway down the drop? What is the velocity at this point?

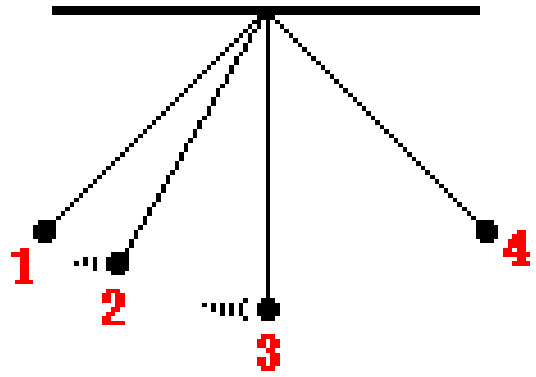

① PE = ____ KE = ____ ME = ____ v = ____
② PE = ____ KE = ____ ME = ____ v = ____
③ PE = ____ KE = ____ ME = ____ v = ____
④ PE = ____ KE = ____ ME = ____ h = ____
m = 50 kg
①
4 m
3 m
②
③
v = 6 m/s
④
h = ?

Find the potential, kinetic, velocity and height at each point. D has a height of 10m. The mass of the cart is 1000 kg.



Solve for letters A-K. Use KE and PE equations and the conservation of energy! Mass = 1 kg





Position 1	Position 2	Position 3	Position 4
PE = 6 J	PE = 3 J	PE = 0 J	PE = 6 J
KE = 0 J	KE = 3 J	KE = 6 J	KE = 0 J
h = A m	h = B m	h = D m	h = F m
v = 0 m/s	v = C m/s	v = E m/s	v = 0 m/s

Practice Time!

- Practice Packet Pages 12-13
- Review and start to plan the Energy Loss Lab posted on Google Classroom

Warm Up

Suppose you drop a 0.1 kg ball from 2 meters. When it bounces back up the rebound height is 1.1 meters.

- What is the initial potential energy?
- What is the total energy of the system?
- What is the potential energy when it bounces back up?
- What is the difference between the total energy and rebound energy?

Friday!

Sit with your partner, take out your notebook and the lab sheet on Google Classroom!

- Take your data today!
- Work on your lab write up

Work Time on Friday and Tuesday (No School Monday)

- Peer review on Wednesday
- Mini Lab write up due Wednesday end of class!

Teachers Notes

- There are six carts- make sure students are in random groups of 3-4 students.
- If the cart plungers release, hold down the button, push in the plunger until it is flush then release the button. We are not using these in the experiment.
- Explosions- students do different plunger depths to explode in the middle. Make sure that they don’t do all the way to click 3… it will go off the track

Can also do as class demos

Inelastic Collisions

1. Turn the cars so the velcro sides are facing each other.
2. Gently push the carts towards each other and observe the result. You can try this with different initial velocities.
3. Add a weight to the blue cart. Repeat and observe.
4. Add another weight to the blue cart. Repeat and observe.
5. Now place the blue cart without any weights in the middle and gentle push the red cart towards it. Observe. You can try this with different initial velocities.
6. Now add a weight to the red cart. Repeat and observe.
7. Now add a second weight to the red cart. Repeat and observe.

Elastic Collisions

1. Make sure the magnetic sides of the carts are facing each other.
2. Gently push the carts towards each other and observe the result. You can try this with different initial velocities but be gentle with the carts.
3. Add a weight to the blue cart. Repeat and observe.
4. Add another weight to the blue cart. Repeat and observe.
5. Now place the blue cart in the middle with no weights and gently push the red cart towards it. Observe. You can try this with different initial velocities.
6. Now add a weight to the red cart. Repeat and observe.
7. Now add a second weight to the red cart. Repeat and observe.

Explosions!

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1. Your teacher will instruct you how to set this up…
    a. Start together then explode by clicking the buttons at the same time.
    b. Perform experiment with the same mass and velocity.
    c. Try using different clicks on the plungers (different initial velocities).
    d. Perform this experiment with one mass added to the blue cart.
    e. Perform this experiment with a second mass added to the cart.

Wrap Up

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1. Define each type of collision in your own words.
2. Why does the name make sense for each type of collision?
3. Draw an example of each one.
4. Find a real life example of each type of collision.

Friday, February 7- Physics

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1. Complete your Mini Labs next door in the lab.
2. Complete the Mini Labs Check Wrap Up Questions on Google Classroom.
3. Work on PhET Collisions on GC

Monday, February 10- Physics

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1. Complete mini labs from next door if needed.
2. Complete the Mini Labs Check Wrap Up Questions on Google Classroom- due today!
3. Work on PhET Collisions on GC- due Tuesday!

Motion Vocab!

- Momentum
  - p (lower case p)
  - Mass in motion
  - Vector
  - Kg m/s
  - $p = mv$
- Kinetic Energy
  - K
  - Energy of Movement
  - Scalar
  - J (Joules)
  - $K = \frac{1}{2} m v^2$

Tuesday, February 11- Physics

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1. Collisions Mini Labs Wrap Up Questions- on GC (past due)
2. PhET Collisions (due today)- Part 1 and 2 only

Both must be completed for class tomorrow!

Types of Collisions

- Inelastic
- Elastic
- Explosions

Conservation of Momentum?

Conservation of Kinetic Energy?

Open up PhET Collisions to Part 3!

Prediction Chart: Complete after the PhET simulation and Mini Lab are done.

Situation	Elastic	Inelastic
Same Mass, same velocities		
Different Masses, Same velocities		
Same masses, one at rest		
Different masses,		

Situations	Explosion
Same masses, same velocities	
Different masses, same velocities	
Same masses, different velocities	

Prediction Chart: Complete after the PhET simulation and Mini Lab are done.

Situation	Elastic	Inelastic
Same Mass, same velocities	Bounce back with the same velocity	STOPS
Different Masses, Same velocities	Bounce off, more mass goes slower	Sticks, slows down
Same masses, one at rest	Transfers to other mass, initial velocity same	Sticks, slows down

Situations	Explosion
Same masses, same velocities	Same distance traveled
Different masses, same velocities	More mass doesn't move as much
Same masses, different velocities	Faster moves more

Inelastic Equation

Inelastic

$$\mathbf{m_1v_1 + m_2v_2 = (m_1+m_2)\ v_f}$$

$m_1 = 3$ kg

$m_2 = 4$ kg

$v_1 = 1$ m/s

$v_2 = 0$ m/s

$V_f = ?$

Inelastic Equation

Inelastic

$$\mathbf{m_1v_1 + m_2v_2 = (m_1+m_2)\ v_f}$$

$m_1 = 3$ kg

$m_2 = 3$ kg

$v_1 = 1$ m/s

$v_2 = -1$ m/s

$V_f = ?$

Inelastic Collisions

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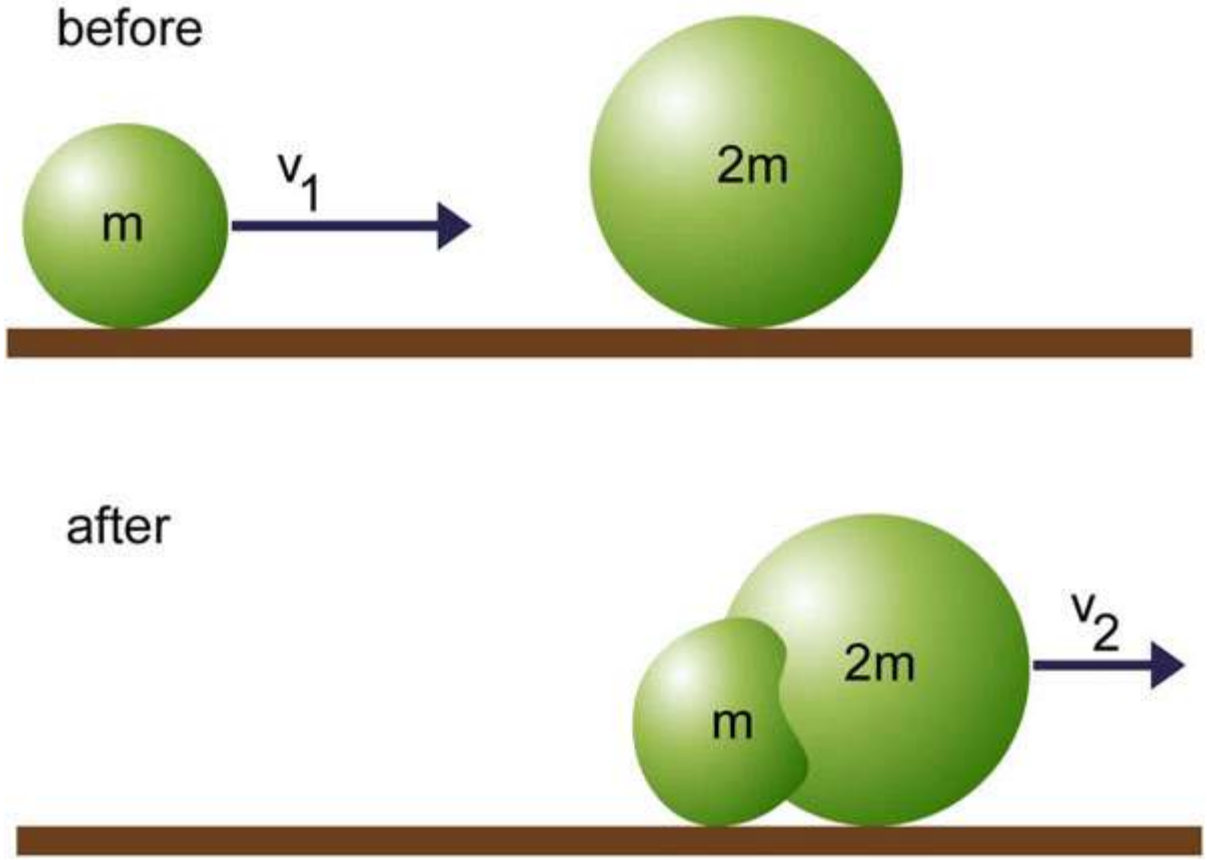
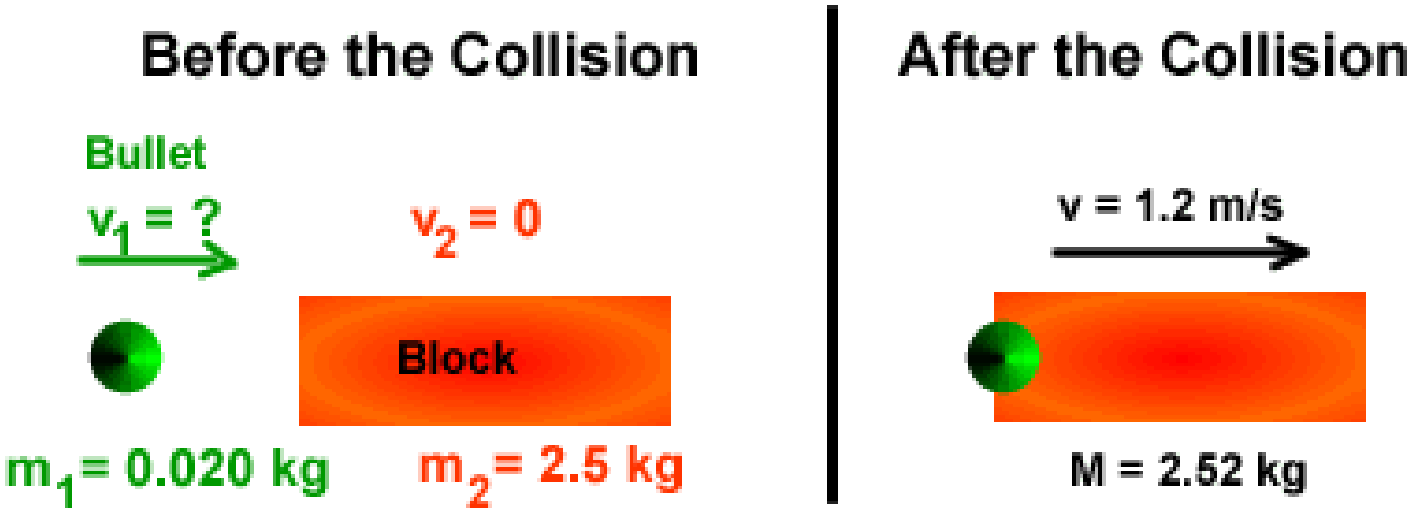
m = 1 kg

2m = 2 kg

V1 = 4 m/s

V2 =?




Before the Collision
Bullet
v_1 = ?
v_2 = 0
Block
m_1 = 0.020 kg
m_2 = 2.5 kg
After the Collision
v = 1.2 m/s
M = 2.52 kg

Practice- Page 14 Inelastic

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Warm Up- Wednesday

A large object and small object collide and bounce off each other. They collide with the same velocities. Which one will move more after the collision? Why?

Assessment Thursday

- How to find momentum (p = mv)
- Outcomes of elastic and inelastic collisions

Elastic Equation

$$\mathbf{m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}}$$

$m_1 = 10$ kg

$m_2 = 2$ kg

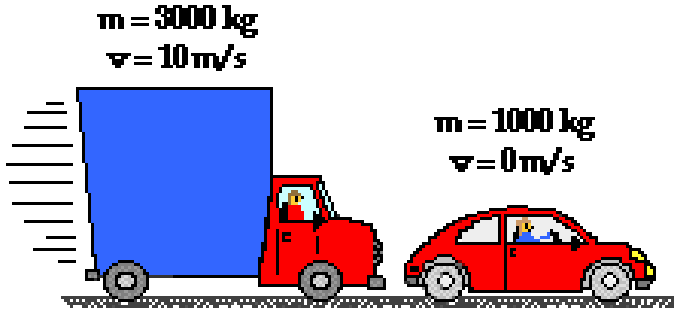
$v_{1i} = 3$ m/s

$v_{2i} = -3$ m/s

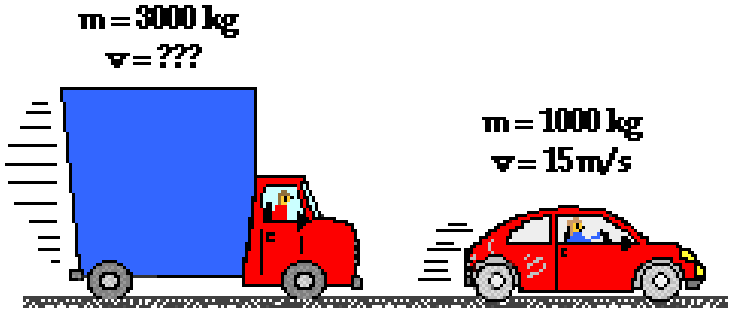
$v_{1f} = 1$ m/s

$v_{2f} = ?$

BEFORE



AFTER



$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$$

m_1 =

m_2 =

v_{1i} =

v_{2i} =

v_{1f}=

v_{2f}=

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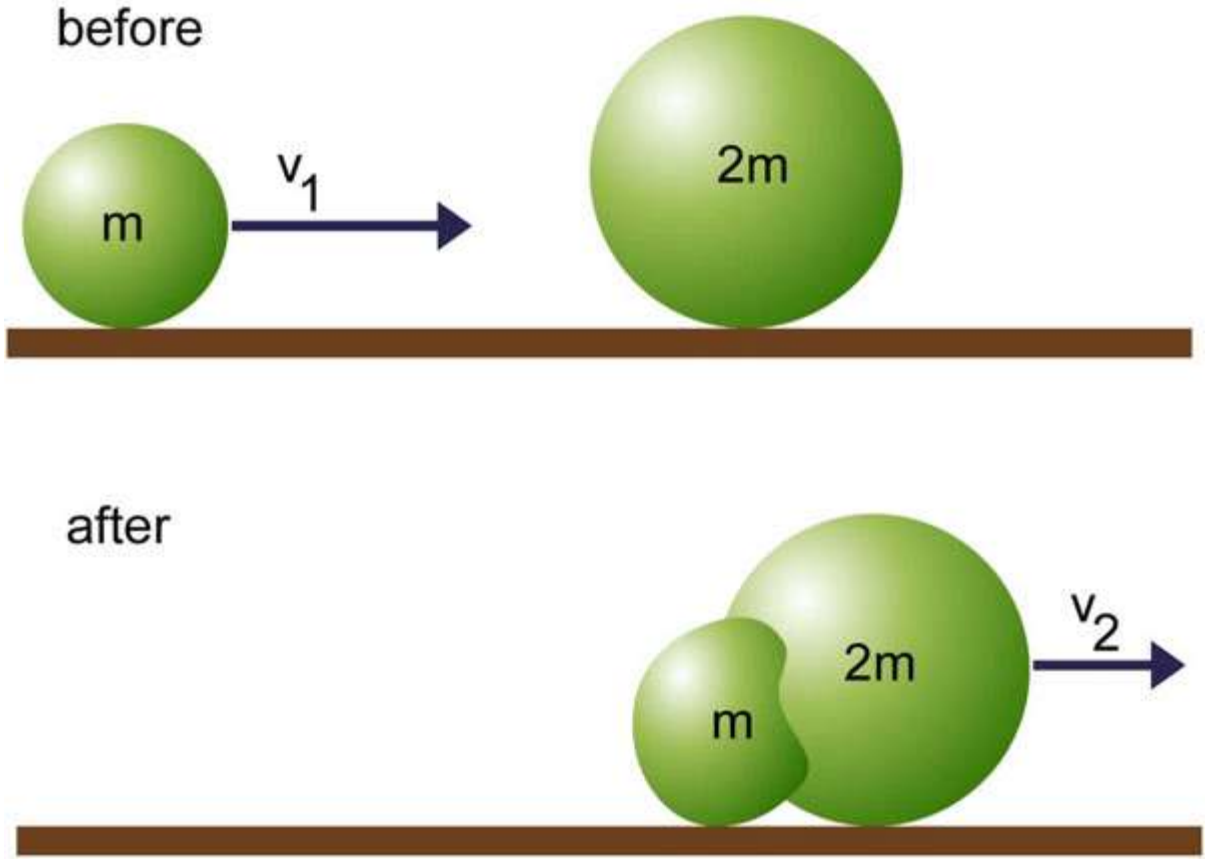
m = 1 kg

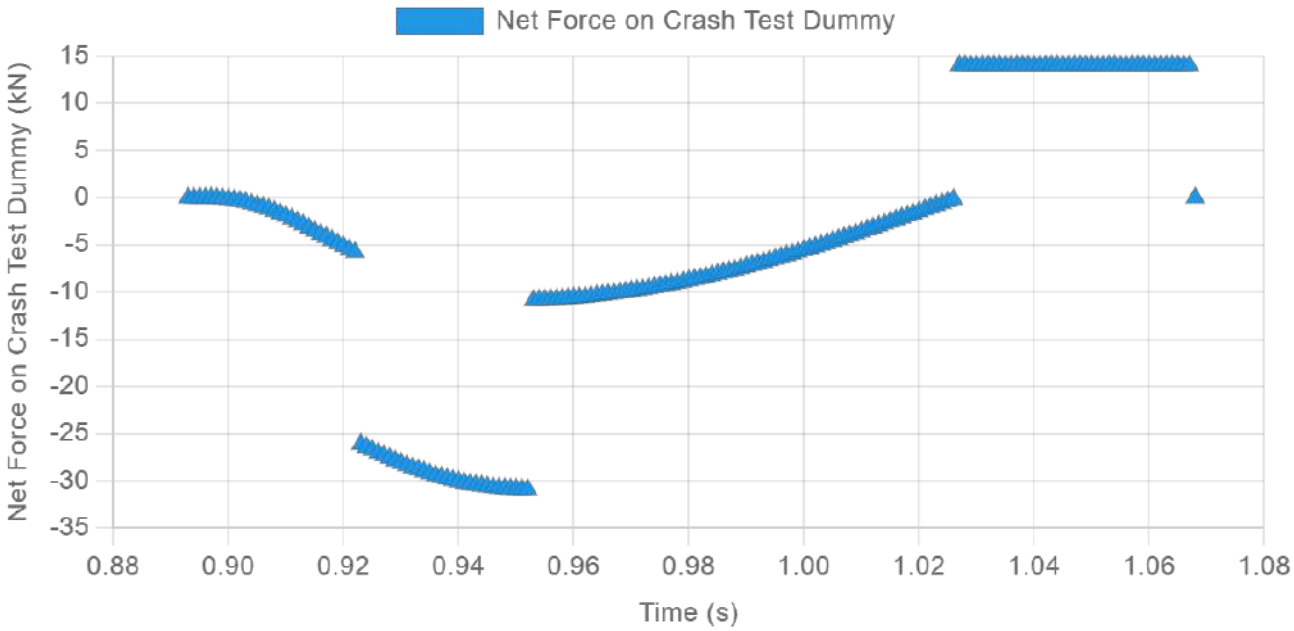
2m = 2 kg

V1 = 4 m/s

V2 =?



Impulse


Net Force on Crash Test Dummy
Net Force on Crash Test Dummy (kN)
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
0.88
0.90
0.92
0.94
0.96
0.98
1.00
1.02
1.04
1.06
1.08
Time (s)

Develop and Use a Model to Explain the Data

With your class

$$F = \frac{m \times \Delta v}{\Delta t}$$

Impulse (Change in Momentum)

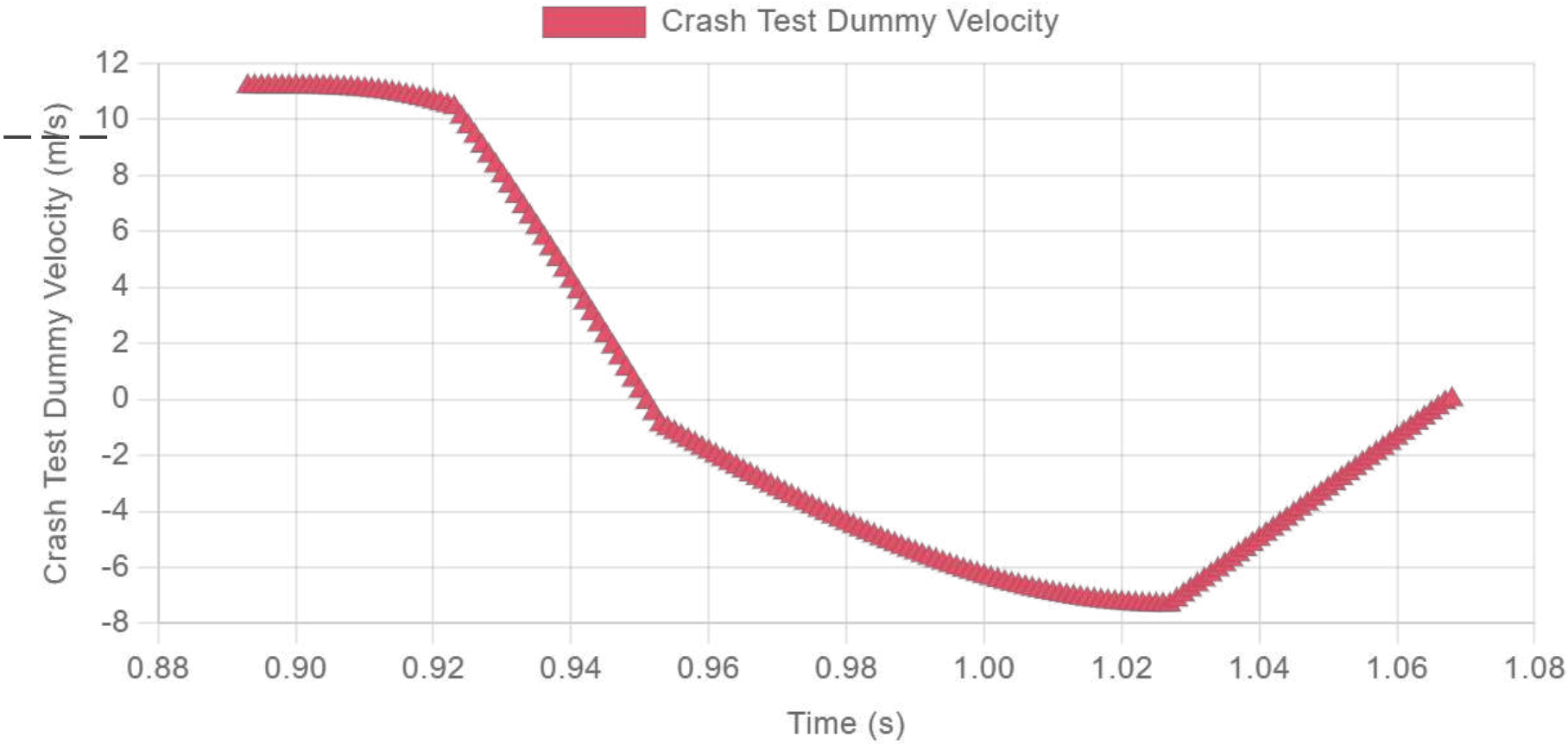
$$\Delta p = I = F*\Delta t$$

I =

Δp =

F =

Δt =


Crash Test Dummy Velocity
Crash Test Dummy Velocity (m/s)
12
10
8
6
4
2
0
-2
-4
-6
-8
0.88
0.90
0.92
0.94
0.96
0.98
1.00
1.02
1.04
1.06
1.08
Time (s)

What about energy?

Kinetic energy- Energy of motion

$K = \frac{1}{2} m v^2$

Elastic Collisions

The mass of the boy is 120 kg and the mass of the girl is 60 kg. He is running at 3 m/s and she is running at 5 m/s. The boy's final velocity is zero. What is the final velocity of the girl?

Pay attention to direction.

Elastic Collisions

$M_1 = M_2 = 70$ kg

$v_{1i} = v_{2i} = 5$ m/s

Assuming M_1 final velocity is 4 m/s, what is the final velocity of M_2 ?

Let’s say we roll a 5 kg (about 12 lbs, the smallest size) bowling ball at 1.5 m/s. How much momentum does it have?

How fast would we have to roll a 3 gram ping pong ball for it to have the same momentum?

A 60 kg person is running at 4 m/s and comes to a stop in 2 seconds.

What is the change in momentum?

What is the force needed to slow down?

A 0.15 kg baseball is thrown at 60 m/s towards a bat and changes speed to −50 m/s. The force on the baseball is −1000 N. How much time will it take to switch directions?

AP Physics 1

- Full year course
- Learn more in depth about motion, forces, energy, momentum, circular motion and gravitation, rotational motion and simple harmonic motion
- Slower pace than other AP courses
- Must be DONE with Algebra 2- 10th, 11th and 12th graders
- Counts as Senior Math Credit
- Physics not required
- Focus on mathematical relationships, lab design and data analysis.
- AP Physics 2 MIGHT be offered in the future
- Like physics but math isn’t your strongest subject? You just need to be dedicated and willing to learn!