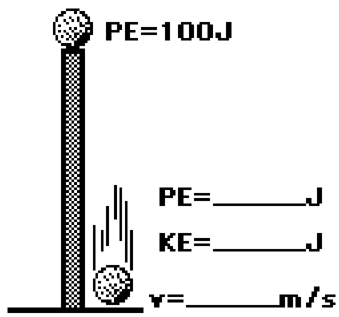
Energy Concepts

Read from **Lesson 2** of the **Work, Energy and Power** chapter at **The Physics Classroom:**

http://www.physicsclassroom.com/Class/energy/u5l2b.html
http://www.physicsclassroom.com/Class/energy/u5l2bb.html
http://www.physicsclassroom.com/Class/energy/u5l2bc.html

MOP Connection: Work and Energy: sublevel 7, 8, 9 and 10

1. Consider the falling motion of the ball in the following two frictionless situations. For each situation, indicate the forces doing work upon the ball. Indicate whether the energy of the ball is conserved and explain why. Finally, simplify the work-energy equation and use it to find the kinetic energy and the velocity of the 2-kg ball just prior to striking the ground.



Forces doing work?

____

TME Conserved: Yes or No?

Explanation: ____________________

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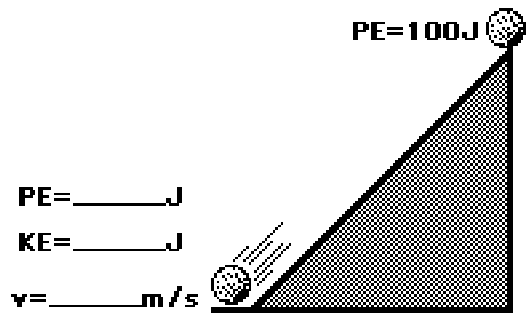
$KE_i + PE_i + W_{ext} = KE_f + PE_f$



Forces doing work?

____

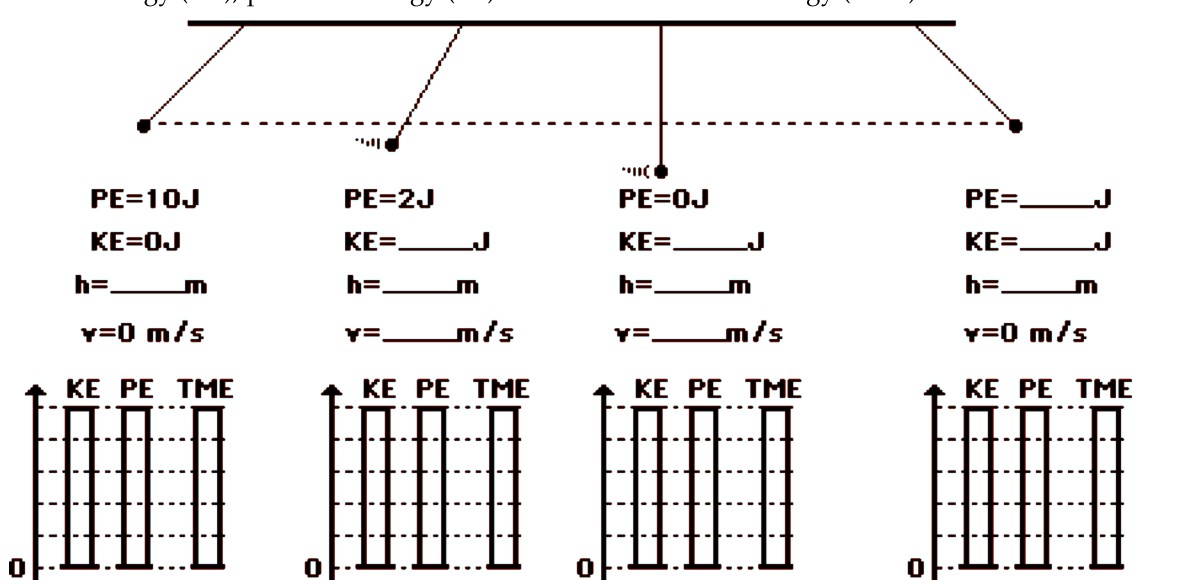
TME Conserved: Yes or No?

Explanation: ____________________

____

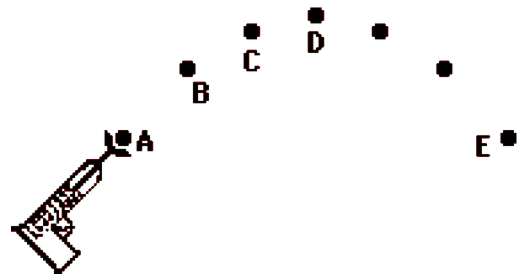
$KE_i + PE_i + W_{ext} = KE_f + PE_f$

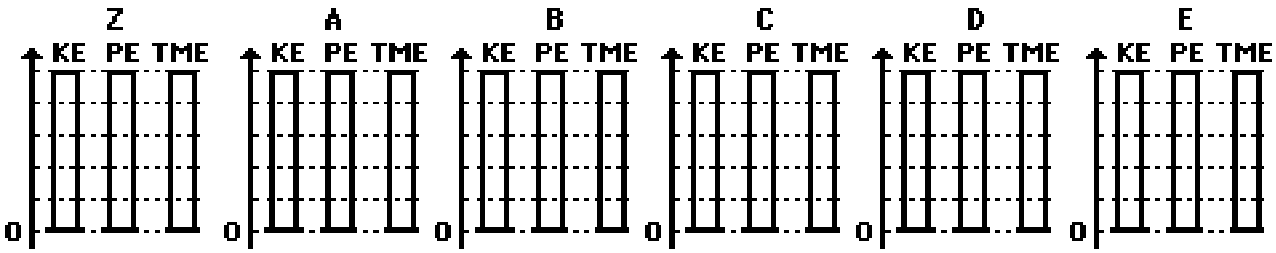
2. Use the work-energy relationship to fill in the blanks for the following system (m=2 kg). Neglect frictional forces. Finally, darken in the bars of the bar chart in order to demonstrate the amount of kinetic energy (KE), potential energy (PE) and total mechanical energy (TME).



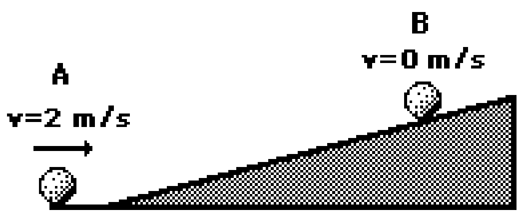
3. A dart is launched from a dart gun and subsequently follows a parabolic path typical of any projectile. Five positions in the trajectory of the dart are marked and labeled in the diagram at the right. For each of the five positions and for position Z, fill in the work-energy bar chart in the space below.

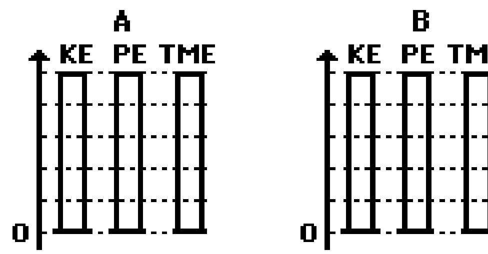
   Z: position of dart when springs are compressed.
   A: position of dart after release from springs.





4. A 2-kg ball moving at 2 m/s is rolling towards an inclined plane. It eventually rolls up the hill to a position near the top where it momentarily stops prior to rolling back down he incline. Assume negligible friction and air resistance. Construct an energy bar chart for the ball.

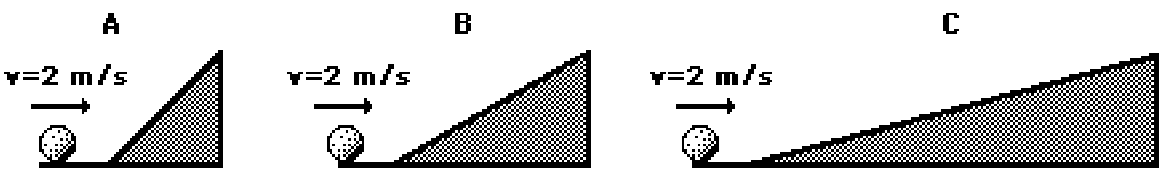




Simplify the equation below by canceling terms that are either zero or constant. Then use the equation to determine the height to which the ball rises along the incline before stopping.

$$\frac{1}{2} \bullet m \bullet v_i^2 \quad + \quad m \bullet g \bullet h_i \quad + \quad F \bullet d \bullet \cos\Theta \quad = \quad \frac{1}{2} \bullet m \bullet v_f^2 \quad + \quad m \bullet g \bullet h_f$$

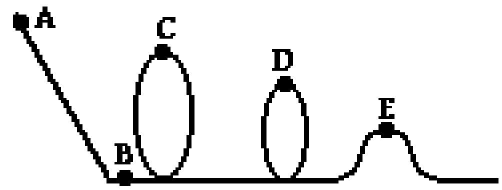
5. Three identical balls approach three different "frictionless" hills with a speed of 2 m/s. In which case - A, B, or C, (or a tie) - will the ball roll the highest? ________ Explain your answer.



6. Fill in the blanks in the following sentence:

   An object starts from rest with a potential energy of 600 J and free-falls towards the ground. After it has fallen to a height of one-fourth of its original height, its total mechanical energy is _______ J, its potential energy is _______ J, and its kinetic energy is _______ J.

Consider the diagram at the right in answering the next three questions. Five locations along a roller coaster track are shown. Assume that there are negligible friction and air resistance forces acting upon the coaster car.



7. Rank the five locations in order of increasing TME (smallest to largest TME). Use < and or = signs between the blanks.

   _____ ___ _____ ___ _____ ___ _____ ___ _____
   letter sign letter sign letter sign letter sign letter

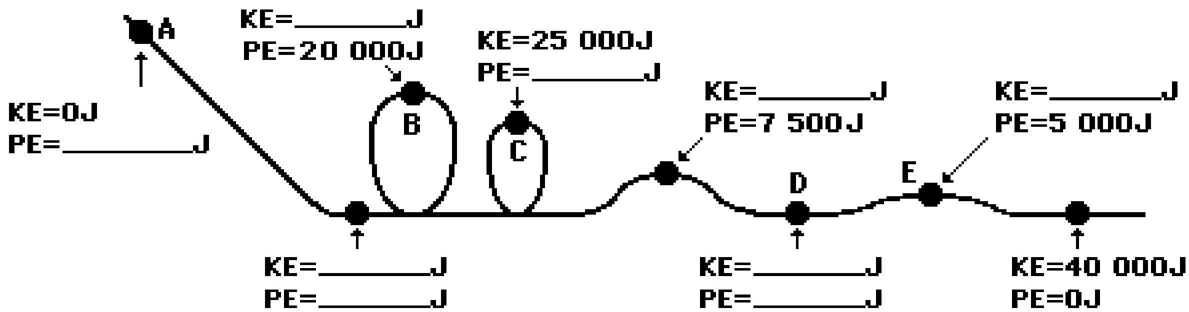
8. Rank the five locations in order of increasing PE (smallest to largest PE). Use < and or = signs between the blanks.

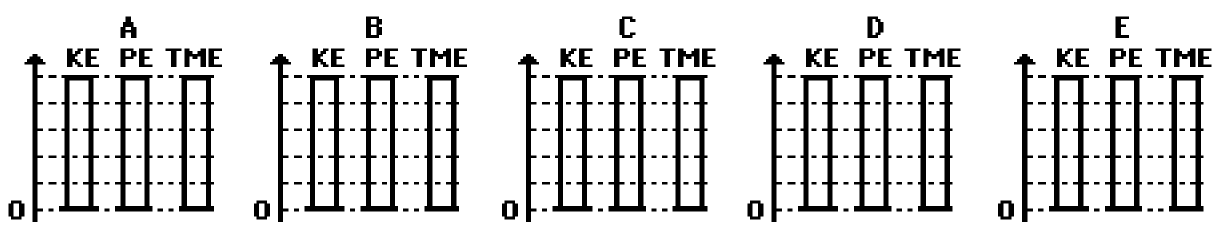
   _____ ___ _____ ___ _____ ___ _____ ___ _____
   letter sign letter sign letter sign letter sign letter

9. Rank the five locations in order of increasing KE (smallest to largest KE). Use < and or = signs between the blanks.

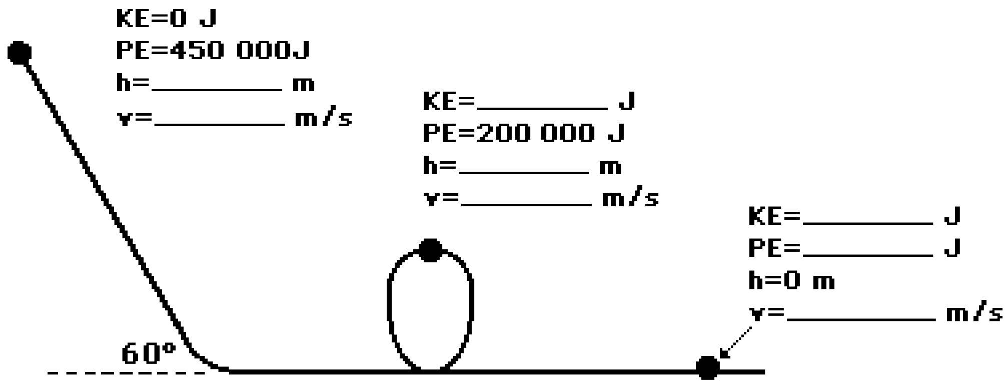
   _____ ___ _____ ___ _____ ___ _____ ___ _____
   letter sign letter sign letter sign letter sign letter

10. Use the law of conservation of energy (assume no friction nor air resistance) to determine the kinetic and potential energy at the various marked positions along the roller coaster track below. Finally, fill in the bars of the bar charts for positions A, B, C, D, and E.

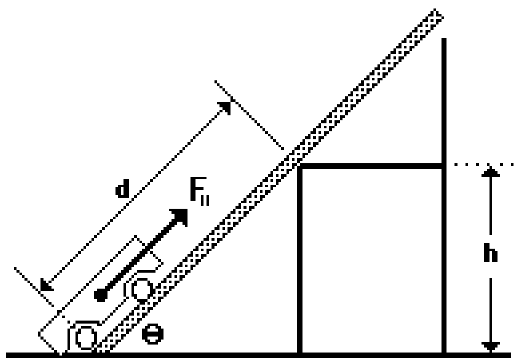




11. Use the law of conservation of energy (assume no friction) to fill in the blanks at the various marked positions for a 1000-kg roller coaster car.



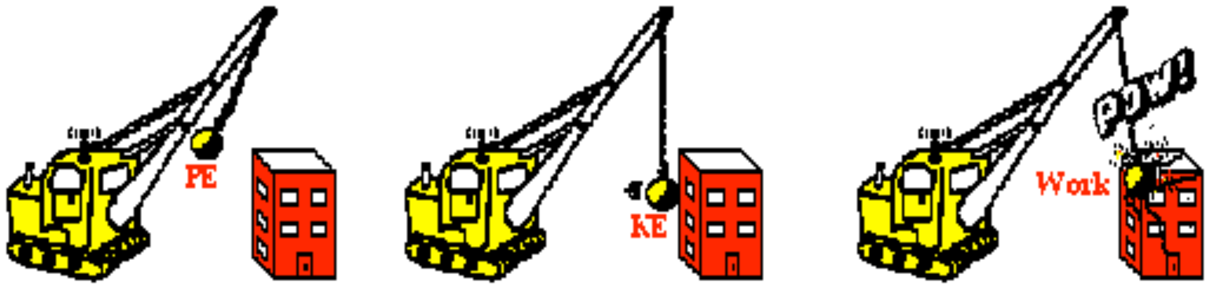
12. In a physics lab, a 3.0-kg cart was pulled at a constant speed along an inclined plane (with a force parallel to the plane) to a height of 0.500 m. The angle of incline was altered in each consecutive trial. It was found that each angle required the same amount of work to elevate the cart to the same height. Use your understanding of work, energy and dynamics to fill in the following table. (**HINT**: $F_{app} = F_{parallel} = m*g*\sin \Theta$.)



	Θ (°)	**h (m)**	**ΔPE (J)**	**$F_{parallel}$ (N)**	**d (m)**	**Work (J)**
a.	15	0.500 m				
b.	20	0.500 m				
c.	25	0.500 m				
d.	35	0.500 m				
e.	45	0.500 m				

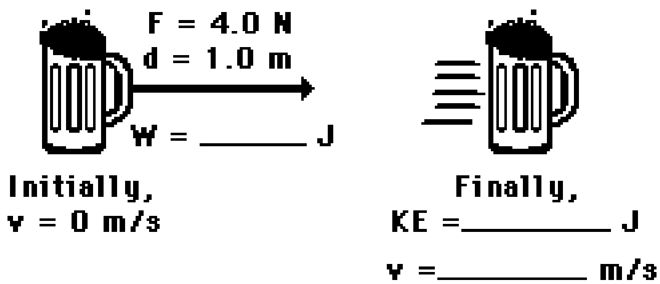
Show sample calculations below:

13. A wrecking ball is raised above its highest point (State A), possessing 6000 J of PE relative to its lowest location (State B). The wrecking ball strikes a building and comes to a resting position (State C). Determine the kinetic energy of the wrecking ball at state B. ______________ Determine the work done on the wrecking ball in going from State B to State C. ______________

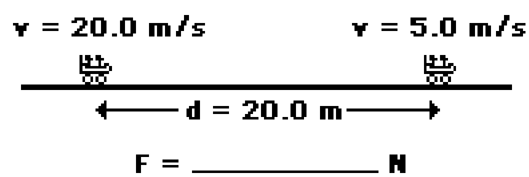


State A **State B** **State C**

14. Pete Zaria applies a 4.0-N force to a 1.0-kg mug of root beer to accelerate it over a distance of 1.0-meter along the counter top. Determine the work done by Pete on the mug and the mug's final kinetic energy and final velocity. **PSYW**

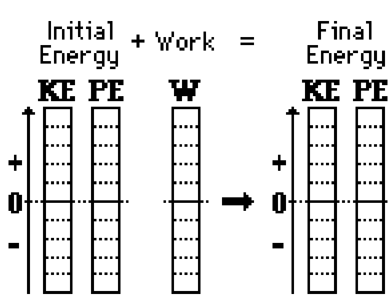


15. A 600-kg roller coaster car (includes passenger mass) is moving at 20.0 m/s. The hydraulic braking system in the track applies an external force to slow the car to a speed of 5.0 m/s over a distance of 20.0 meters. Determine the force that acts upon the car. **PSYW**

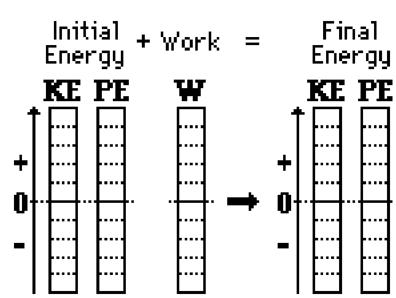


16. Construct work-energy bar charts for problems #14 and #15.

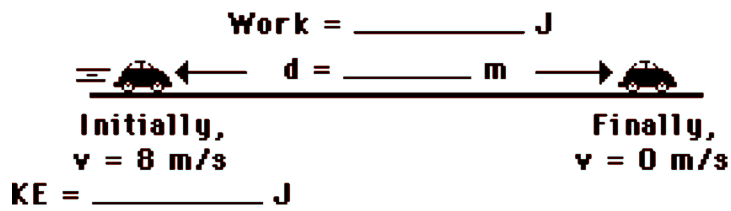
Problem #14



Problem #15

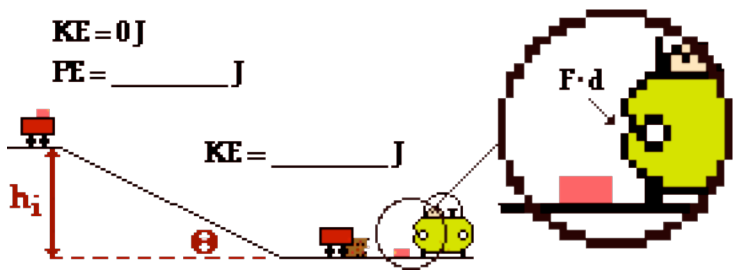


17. Vera is driving her 1000-kg car at a speed of 8.0 m/s. When Vera slams on the brakes, the ground exerts an 8000-N frictional force to bring the car to a stop. Determine the initial kinetic energy of the car, the work done by friction on the car, and the stopping distance of the car. **PSYW**



18. If Vera's speed (in question #17) were increased to 24.0 m/s, then what would be the new stopping distance? __________ In other words, how many times greater is the stopping distance if the speed is tripled? __________ Explain.

19. A 0.750-kg peach can is at rest in a shopping cart at the edge of a hill. A strong wind sets it into motion, sending down a 6.32-meter high hill. The cart hits a tree stump. But the peach can, being in motion, continues in motion until it finally collides with a car. Upon impact, the peach can exerts an average force of 721 N upon the car body. Fill in the blanks and determine the depth of the dent.



20. A 56.9 kg sledder descends an 8.21-meter high hill, encountering a friction force of 11.7 N. Fill in the blanks and determine the speed of the sledder after traveling the 31.7 meters to the bottom of the hill.