Name ________________

Physics 160 Lab Time ________________

Exam 3 – Energy and Momentum

November 17, 2010

- This is a closed book examination.
- You may use a 3x5 index card that you have made with any information on it that you would like. You must have your name, lab section and the date on your index card.
- There is extra scratch paper available.
- Please fill out the Scantron sheet completely
    - Include your test code.
    - Include your Dragon ID
    - Include your name
- Mark your exam and include explanations where needed. This will help you learn from your exam as well as provide any verification of your scantron sheet.
- Please make sure to fill out each "Problem Solving Sheet" completely
    - Include your test code
    - Include your Dragon ID
    - Include your name
    - Include your lab time
- Your explanation/work for the worked problems is worth ¾ of the points. You must use a separate "Problem Solving Sheet" for each problem.

A general reminder about problem solving:

1. Visualize - draw a picture
2. Pick a coordinate frame
3. Create a simplified picture – schematic with vectors describing motion
    a. 2D Motion: separate vectors into components
    b. Force Problem: create a simplified free body diagram
    c. Energy Problem: create energy level diagram(s)
4. Write down what you know – create separate columns for different directions
5. Write down what you don't know and/or what you want to know
6. List mathematical relationships
7. Combine mathematical formulas, Simplify and Solve
8. Check your answer – Is it reasonable? Are the units correct?

- Show all work!

Name ________________

The next five questions concern an object that is dropped from a tall building. Immediately after it is dropped the object has a total energy of 15 kJ. The zero of the gravitational potential energy is taken to be at the base of the tall building. Consider the object when it has fallen 1/3 of the building's height so it is 2/3 of the building's height from the ground.

1. Ignoring air drag, the object's total energy is
   - A. greater than 15 kJ
   - (B) equal to 15 kJ
   - C. equal to 10 kJ
   - D. equal to 5 kJ
   - E. zero Joules

Energy is conserved so TE=15kJ always.

2. Ignoring air drag, the object's kinetic energy is
   - A. greater than 15 kJ
   - B. equal to 15 kJ
   - C. equal to 10 kJ
   - (D) equal to 5 kJ
   - E. zero Joules

Energy is conserved. TE=KE+PE since PE=mgh when you are 2/3 of the height 1/3 of energy must be KE.

3. Ignoring air drag, the object's gravitational potential energy is
   - A. greater than 15 kJ
   - B. equal to 15 kJ
   - (C) equal to 10 kJ
   - D. equal to 5 kJ
   - E. zero Joules

Energy is conserved. TE=KE+PE since PE=mgh when you are 2/3 of the height 2/3 of energy must be PE.

4. <u>Including</u> air drag, the object's total energy is
   - A. greater than 15 kJ
   - B. equal to 15 kJ
   - (C) less than 15 kJ
   - D. zero Joules
   - E. less than zero Joules

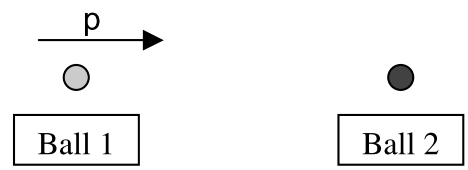
Energy is not conserved here. You are losing energy due to friction so TE<15kJ

5. Ignoring air drag, the velocity of this 3 kg object right before it hits the ground is
   - A. 10 km/s
   - (B) 100 m/s
   - C. 32 m/s
   - D. 10 m/s
   - E. 3.2 m/s

Energy is conserved. All the energy is KE at the bottom. $KE= \frac{1}{2}mv^2$ so $v=(2\ KE/m)^{1/2}$

Name ________________

The next two questions concern the collision of two balls drawn schematically to the right. Initially, the first ball is moving and the second ball is stationary. The collision is head-on; that is, the balls do not bounce at an angle.



6. Assume the collision is elastic and that both balls have the same mass. After the collision
   A. ball 1 moves to the left
   B. ball 1 stops
   C. ball 1 continues to move to the right
   D. the velocity of ball 1 is not able to be determined

Ball 1 will have to stop to conserve both momentum and energy.

7. Assume the collision is elastic and that ball 1 is much more massive than ball 2. After the collision
   A. ball 1 moves to the left
   B. ball 1 stops
   C. ball 1 continues to move to the right

Ball 1 continues to move to the right since there is a lot of momentum and ball 2 can not take it all and still conserve energy to conserve momentum.

The next three questions involve two carts that are identical except they have different masses. The mass of cart 1 is twice the mass of cart 2 ($m_1 > m_2$). Both carts start from rest.

8. The two carts are pushed with the same force for the same distance. Which cart has more work done on it? Neglect any effects due to friction.
   A. Cart 1 has more work done on it.
   B. Both carts have the same more work done on them.
   C. Cart 2 has more work done on it.
   D. Not enough information is given.

$W=F\,\Delta x=\Delta E$ same distance and force so same work done.

9. The two carts are pushed with the same force for the same amount of distance. Which cart has a greater kinetic energy after being pushed? Neglect any effects due to friction.
   A. Cart 1 has the greatest kinetic energy.
   B. Both carts have the same kinetic energy.
   C. Cart 2 has the greatest kinetic energy.
   D. Not enough information is given.

$W=F\,\Delta x=\Delta E=\Delta KE$ same distance and force so same ΔKE

10. The two carts roll down the same incline starting at the same height. Which cart has a greater kinetic energy at the bottom of the incline? Neglect any effects due to friction.
   A. Cart 1 has the greatest kinetic energy.
   B. Both carts have the same kinetic energy.
   C. Cart 2 has the greatest kinetic energy.
   D. Not enough information is given.

Energy is conserved TE=KE+PE At top of incline heavy cart has more PE=TE so at bottom of incline heavy cart will still have more energy – which is now KE. Force s greatest on heavy cart.

Name ________________

11. The area under the force vs distance graph is the work.
   - (A.) True
   - B. False

> W=F Δx so the area under the Force vs distance graph is work

The next two questions involve two balls that are identical except they have different masses. Ball one is more massive than ball two ($m_1 > m_2$). Neglect any effects due to air drag.

12. The balls are dropped from the same height. Which ball has the greater velocity right before hitting the ground?
   - A. Ball one has a greater velocity.
   - (B) Ball one and two have the same velocity.
   - C. Ball two has a greater velocity.

> $mg=F_g=ma$ so $a=g$ and both balls experience the same acceleration so v is same.

13. The balls are thrown with the same initial velocity straight up into the air. Which ball has <u>more energy</u> at the top of their trajectory?
   - (A) Ball one has more energy.
   - B. Ball one and two have the same energy at the top.
   - C. Ball two has more energy.

> $KE=\frac{1}{2}mv^2$ so the heavy ball starts out with more energy. Energy is conserved $mgh=PE_f=KE_i=\frac{1}{2}mv^2$ thus $h=v^2/2g$. Both balls reach the same height so the heavy one has more energy .

14. A bouncy ball and a clay ball of identical mass are thrown at a wall with the same velocities. Assume both balls interact with the wall for the same amount of time. Which ball exerts a greater force on the wall?
   - A. The clay ball.
   - (B) The bouncy ball.
   - C. Both balls exert the same force.
   - D. Not enough information is given.

> $F\Delta t=\Delta p$ and $p=mv$ The bouncy ball has twice the change in momentum so F is greater (assuming Δt is the same)

15. How long must a 20 N force be applied to stop a 2000 kg object moving at 4 m/s?
   - A. 1600 seconds
   - B. 800 seconds
   - (C) 400 seconds
   - D. 200 seconds
   - E. Depends on the type of force

> $F\Delta t=\Delta p$ and $p=mv$ $v_i=4$m/s and $v_f=0$m/s thus $\Delta t=-mv_i/F$

16. You are lifting a 9.0 kg bag of rice onto a truck. You bend your knees and lift the bag 2.0 meters into the back of the truck. How much work did you do lifting this bag?
   - A. 353 J
   - (B) 176 J
   - C. 88.2 J
   - D. 0 J

> $W=F\Delta x$ you are applying the force in the same direction as your lift so $W=mg\,\Delta x=(9.0\text{kg})(9.8\text{ m/s}^2)(2\text{m})$

Name ________________

17. You walk across the room carrying a 4 kg textbook. You hold the textbook a constant distance, 1.2 m, from the floor and cover 10 m at a constant velocity of 2 m/s. How much work has the gravitational force done on the book when you were moving?
   A. 940 J
   B. 470 J
   C. 94 J
   D. 47 J
   E. 0 J

W=FΔx the gravitational force is perpendicular to the direction as your lift so W=mg Δx=(9.0kg)(9.8 m/s^2)(2m)

18. If you are far from the surface of the earth can you use PE_G=mgh for the gravitational potential energy?
   A. True
   B. False

$PE_G=GM_Em/R_E$ When h is a noticeable fraction of the earth's radius, R_E, you can not use the approximation (mgh)

19. What is the kinetic energy of a 750 kg vehicle traveling at a constant 35 m/s up a steep hill (30 degree angle).
   A. Depends on the distance traveled
   B. 920 kJ
   C. 460 kJ
   D. 230 kJ
   E. 0 J (since the velocity is constant)

Kinetic Energy = KE = ½mv^2
= ½ (750 kg) (35m/s)^2

20. If there are no external forces acting on a system then the mechanical energy is conserved.
   A. True
   B. False

FΔx = W= ΔE so if F=0 then ΔE=0 so $E_i=E_f$=constant

Do the next two problems using separate problem solving sheets. There are extra problems solving sheets available if you need one.

21. [10 PTS] A truck carrying a load of sugar beets is halfway up a 20 m tall hill when it runs out of gas (stopping the engine). If the truck is traveling at 13.5 m/s (and there are no frictional losses) will it make it over the top of the hill? Would it help to throw out some beets (or a cat) to reduce the mass?

22. [10 PTS] Suppose that a 0.149 kg baseball is traveling at 40.0 m/s. Suppose you stop the ball in 0.031 second. What is the average force you feel?