Physics 200 Name _____

Exam 2 – Gravity, Energy and Momentum

October 27, 2005

This is a closed book examination. There is extra scratch paper available. Explanations must be included with all answers – even multiple choice questions.

A general reminder about problem solving:

1. Draw a picture then create a simplified free body diagram with all forces
2. Write down what you know including coordinate frame
3. Write down what you don't know and/or want to know
4. List mathematical relationships
5. Simplify and solve
6. Check your answer – Is it reasonable? Are units correct?

- Show all work!

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.

1. [4 PTS] Ignoring air drag, the total energy after falling 1/3 of the building's height is
   A. greater than 15 kJ
   B. equal to 15 kJ
   C. equal to 10 kJ
   D. equal to 5 kJ
   E. zero joules
   F. less than zero joules

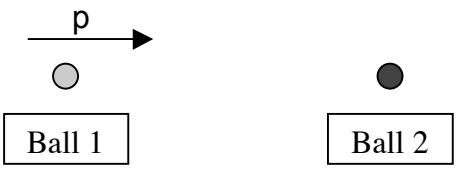
2. [4 PTS] Ignoring air drag, the kinetic energy after falling 1/3 of the building's height is
   A. greater than 15 kJ
   B. equal to 15 kJ
   C. equal to 10 kJ
   D. equal to 5 kJ
   E. zero joules
   F. less than zero joules

3. [4 PTS] Ignoring air drag, the gravitational potential energy after falling 1/3 of the building's height is
   A. greater than 15 kJ
   B. equal to 15 kJ
   C. equal to 10 kJ
   D. equal to 5 kJ
   E. zero joules
   F. less than zero joules

4. [4 PTS] Including air drag, the total energy after falling 1/3 of the building's height is
   A. greater than 15 kJ
   B. equal to 15 kJ
   C. less than 15 kJ

5. [4 PTS] 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
   F. not enough information given

The next four 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 for the first three questions; that is, the balls do not bounce at an angle.



6. [4 PTS] 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

7. [4 PTS] Assume the collision is elastic and that ball 2 is much more massive than ball 1. After the collision
   A. ball 1 moves to the left
   B. ball 1 stops
   C. ball 1 continues to move to the right

8. [4 PTS] 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

9. [8 PTS] After the collision ball 1 rebounds forward at an angle of 30° from the horizontal with ½ the magnitude of the initial momentum. What is the momentum of ball 2? Draw a diagram and explain.

10. [10 PTS] What is the minimum initial kinetic energy required to launch a 2 kg object into space from the Earth? Assume that you can ignore air drag. HINT: WHAT IS THE ESCAPE VELOCITY FOR AN OBJECT ON EARTH?

11. [20 PTS] Suppose that a 0.149 kg baseball is traveling at 40.0 m/s. How much work must be done on the ball to stop it? If it is brought to rest in 2.0 cm, what average force must act on the ball? What impulse is required to stop the ball? How long does it take to stop the ball?

12. [10 PTS] You are swinging a fluffy animal around your head on the end of a 3-meter long string. The string makes an angle of 10° from the horizontal. What speed is the animal traveling? Assume that you can ignore air drag.

Useful Data:
Mass of Earth = 6×10^{24} kg
Radius of the Earth = 6.4×10^{6} m
$G = 6.67 \times 10^{-11}$ Nm^2/kg^2