Name (last name first) ________________________________________________

Last 3 Digits of Student ID Number: ___ ___ ___

Answer all questions, beginning each new question in the space provided. Show all work. Show all formulas used for each problem prior to substitution of numbers. Label diagrams and include appropriate units for your answers. Write your name and section number at the top of each page in the space provided and write the name of your section instructor in the place provided in the cover sheet. You may use an alphanumeric calculator (one which exhibits physical formulas) during the exam as long as you do not program any formulas into memory. By using an alphanumeric calculator you agree to allow us to check its memory during the exam. Simple scientific calculators are always OK!

Score on each problem:

1. (15) ___

2. (6) ___

3. (6) ___

4. (6) ___

5. (8) ___

6. (9) ___

Total Score (out of 50 pts) ___

Total Score (scaled up to 100 pts) ___

Be Prepared to Show your Student ID Card

A Formula Sheet Is Attached To The Back Of This Examination
For your convenience you may carefully remove it from the Exam. Please take it with you at the end of the exam or throw it in a waste basket. Thank you!
Problem 1: (15 points - 3 points each - no partial credit – in each question, put a circle around the letter that you think is the best answer.)

1-1. Two vectors with magnitudes $A$ and $B$ have a dot product $AB/2$. The angle between the two vectors is:

(a) $0^\circ$  (b) $30^\circ$  (c) $45^\circ$  (d) $60^\circ$  (e) $90^\circ$

1-2. A truck, initially at rest, rolls down a frictionless hill of height $h$ and reaches a speed $v$ at the bottom. To achieve a speed of $2v$ at the bottom, how high must the hill be?

(a) $h/2$  (b) $h$  (c) $\sqrt{2}h$  (d) $2h$  (e) $4h$

1-3. A planet of mass $m$ is at a distance $d$ from a star. Another planet of mass $4m$ is at a distance $2d$ from the star. Which force vector best represents the direction of the total gravitation force on the star due to the two planets?

(a) 1  (b) 2  (c) 3  (d) 4  (e) 5

1-4. If 1 Joule of work is needed to accelerate a car from rest to a speed $v$, the work needed to accelerate the car from a speed $v$ to a speed $2v$ is:

(a) 1 Joule  (b) 2 Joules  (c) 3 Joules  (d) 4 Joules  (e) 5 Joules

1-5. The velocity of a particle moving along the x-axis changes from $v_1$ to $v_2$. For which of the following values of $v_1$ and $v_2$ is the total work done on the particle negative? [Hint: Use the work-kinetic energy theorem.]

(a) $v_1 = +3$, $v_2 = +7$
(b) $v_1 = -3$, $v_2 = +7$
(c) $v_1 = -3$, $v_2 = -7$
(d) $v_1 = +3$, $v_2 = -7$
(e) $v_1 = -7$, $v_2 = +3$
Problem 2: (6 points) An escalator moves 10 people (60 kg each) per minute from the first floor of a store to the second floor, 5 m above. Neglecting any energy loss due to friction, what is the average power required?

Problem 3: (6 points) If \( g \) is the acceleration due to gravity at the surface of the earth of radius \( R \), at what height above the surface of Earth is the acceleration due to gravity equal to \( g/10 \)?
Problem 4: (6 points) As seen in the movie clip in class, James Bond, who "weighs" 75 kg, jumps off with zero initial speed from the top of a dam with a bungee cord tied to his ankle. The total drop is 220 m. At some time during the jump, the bungee cord starts stretching. Bond reaches the bottom with an instantaneous speed of zero. What is the elastic potential energy stored in the bungee cord at the instant he reaches bottom?

Problem 5: (8 points) A block is seen to slide down a rough ramp at constant speed.
(a) (3 pts) What forces act on the block as it slides (draw arrows on the diagram)?
(b) (2 pts) Which of these forces do work on the block?
(c) (3 pts) What is the net work done by all forces on the block as it slides from the top of the ramp to the bottom of the ramp?
Problem 6: (9 points)
A ball of mass 3.0 kg, at one end of a string of length 0.7 m, rotates in a vertical circle. At the top of the circle, it has a speed of 3.5 m/s. The ball changes speed as it rotates.
(a) [2 pts] Draw all the forces on the ball when it is in the position shown in the figure.
(b) [1 pt] What is the work done by the string tension force on the ball as it goes from the top of the circle to the bottom of the circle?
(c) [3 pts] What is the change in gravitational potential energy of the ball as it goes from the top of the circle to the bottom of the circle?
(d) [3 pts] Use energy conservation to find the speed of the ball at the bottom of the circle.