Name:

Physics 6A **Introduction to Physics** **Winter 2001**

Midterm Exam 2

February 23, 2001

Problem	Possible	Score
1–10	30	
11–15	20	
16	20	
17	15	
18	20	
Ver. A	Total	

- **Closed book. No notes.**
- **Calculators with cleared memory are okay.**
- ***Show your work on all calculations.***

You should have 3 sheets and 6 pages, with 18 questions and problems.
All numerical constants should be assumed to be accurate to two significant figures.

Equations for motion in one dimension with constant linear acceleration:

$x = x_0 + v_0 t + \frac{1}{2} a t^2$ $x = x_0 + \frac{1}{2}(v_0 + v) \cdot t$ $v = v_0 + at$ $v^2 = v_0^2 + 2a \cdot (x - x_0)$

Centripetal acceleration: $a_c = \frac{v^2}{r}$

Newton's second law: $\vec{a} = \frac{1}{m} \cdot \vec{F}_{\text{net}}$

Friction: $f_k = \mu_k F_N$ $f_s \le \mu_s F_N$

Work: $dW = F \cdot ds$ $F_x(x) = -\frac{dU}{dx}$

Mechanical Energy: $E = U + K$ $K = \frac{1}{2} m v^2$ Power: $P = \frac{dW}{dt} = F \cdot v$

Momentum: $p = mv$ Impulse: $J = \Delta p = F_{\text{avg}} \cdot \Delta t$

Mass on spring: $F = -kx$ $U = \frac{1}{2} k x^2$

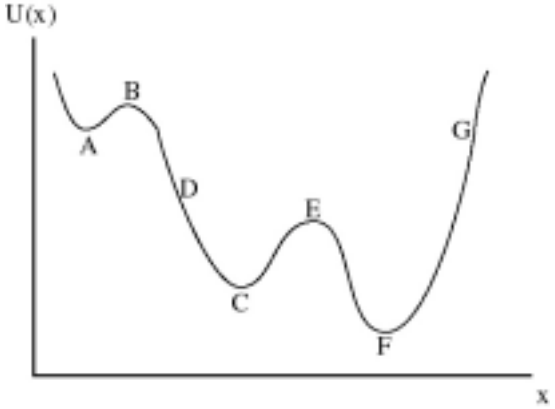
Gravity: g=9.8 m/s^2 $U = mgh$ Weight: $w = mg$

Center of mass: $r_{\text{cm}} = \frac{\sum_i m_i r_i}{\sum_i m_i}$

Rocket propulsion: $F = -v_{\text{ex}} \frac{dm}{dt}$ $v - v_0 = v_{\text{ex}} \ln \frac{m_0}{m}$

1) (3 pnts) A child pulls horizontally on a box placed on level ground with a force of 10 N, but the box does not move. If the box weighs 20 N, then which statement is true about the coefficient of static friction μ_s between the box and the ground?
   a) $\mu_s = 0.5$
   b) $\mu_s \geq 0.5$
   c) $\mu_s \leq 0.5$
   d) $\mu_s = 2.0$
2) (3 pnts) A golf ball is fired at a bowling ball initially at rest and bounces back elastically. Compared with the bowling ball, the golf ball after the collision has
   a) larger magnitude of momentum but less kinetic energy.
   b) larger magnitude of momentum and more kinetic energy.
   c) smaller magnitude of momentum and less kinetic energy.
   d) smaller magnitude of momentum but more kinetic energy.
3) (3 pnts) You wish to accelerate your car at a constant acceleration. To do so, the car's engine must
   a) maintain a constant power output.
   b) develop ever decreasing power.
   c) develop ever increasing power.
   d) maintain a constant turning speed.
4) (3 pnts) Suppose that a car with negligible rolling friction accelerates at constant power. In that case,
   a) the car's speed will be increasing while its acceleration is decreasing in magnitude.
   b) The car's speed will be increasing while its acceleration is increasing in magnitude.
   c) The car's speed will be decreasing while the acceleration is decreasing in magnitude.
   d) The car's speed will be decreasing while the acceleration is increasing in magnitude.
5) (3 pnts) A sled weighs 100 N and has a coefficient of static friction with the ground of μ_s=0.2. A child pushes horizontally on the sled on level ground with a force of 10 N. Which of the following is true?
   a) The sled starts to move.
   b) The friction force is zero.
   c) The sled remains stationary.
   d) The weight of the sled increases.
6) (3 pnts) If you exert a force of magnitude F on an object, the magnitude of the force that it exerts back on you depends upon the acceleration of the object relative to you.
   a) TRUE
   b) FALSE
7) (3 pnts) A platform is supported by two springs placed side by side, each with spring constant *k*. If you were to replace them by a single spring and still have the same support, you would need a single spring with spring constant
   i) $k/4$ ii) $k/2$ iii) k iv) $2k$
8) (3 pnts) Two carts are at rest on an air track, one with twice the mass of the other. You first accelerate one cart for 3 seconds and then the other for the same length of time with the same force. Then the momentum of the light cart is
   a) one fourth the momentum of the heavy cart.
   b) one half the momentum of the heavy cart.
   c) equal to the momentum of the heavy cart.
   d) twice the momentum of the heavy cart.
9) (3 pnts) In the previous situation, the kinetic energy of the light cart is
   a) less than that of the heavy cart.
   b) equal to that of the heavy cart.
   c) more than that of the heavy cart.
10) (3 pnts) A person attempts to knock over a large wooden bowling pin by throwing a ball at it. There are two balls of equal mass, but one is made of rubber that bounces off of the bowling pin and the other of a soft putty that sticks to the bowling pin. Which is most likely to knock over the pin?
   a) The rubber ball.
   b) The putty ball.
   c) They would be equal in that respect. It makes no difference.

11) (3 pnts) A car and a truck collide head on and stick together. Which undergoes the largest momentum change?
    a) The car.
    b) The truck.
    c) They undergo the same momentum change.
12) (3 pnts) Which of the two in the previous question undergoes the largest acceleration?
    a) The car.
    b) The truck.
    c) They undergo the same acceleration.
13) (3 pnts) A rock is suspended from a string and accelerates downward. Which statement is true regarding the tension in the string?
    a) The tension is less than the weight of the rock.
    b) The tension is equal to the weight of the rock.
    c) The tension is greater than the weight of the rock.
14) (7 pnts) Consider the following graph of the potential energy function of a particle acted on by a conservative force (and no other force).



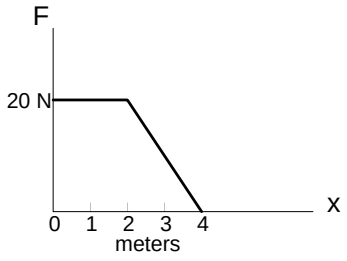
    a) Which of the points labeled A through G are points of unstable equilibrium?

    b) Which are points of stable equilibrium?

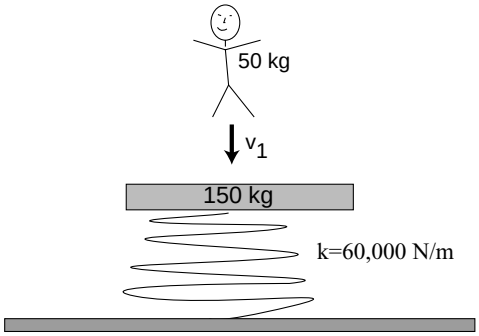
    c) Suppose that a particle is moving in the direction of positive x with total energy greater than the value of U(x) at point B. At which point A through G would the velocity of the particle be maximum?

    d) What is the direction of the force at point D? Positive x or negative x?

15) (4 pnts) A block is pushed 4 m across the floor by a force that varies with position according to the following graph. How much work is done by the force *F* during this process?



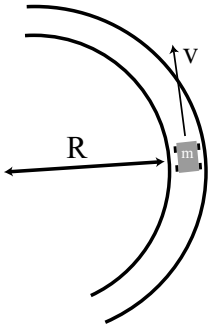
16) (20 pnts) A 50 kg woman falls from a ladder down onto a 150 kg platform, which rests in equilibrium upon a spring of negligible mass and spring constant *k*=60,000 N/m. After landing upon the platform, the spring is observed to compress by an amount $x_c = 0.10$ m.



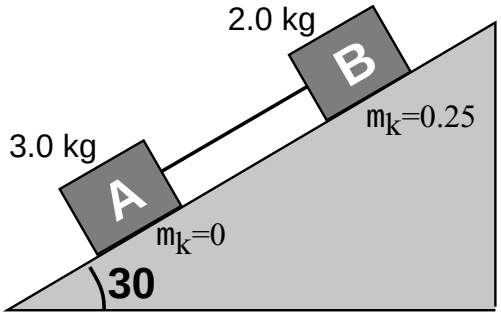
a) What was the speed, v_2, of the woman plus platform immediately after she landed but before the spring began compressing?

b) What was the speed, v_1, of the woman immediately before she landed? (Hint: it was a completely inelastic collision.)

17) (15 pnts) A flat (unbanked) curve in the highway has a radius of R=100 m. If the coefficient of static friction of the tires on the road is $\mu_s = 0.40$, what is the maximum speed v with which the car can go around the curve without sliding?



18) (20 pnts) Consider the two boxes shown in the figure below, with a coefficient of kinetic friction of 0.25 between Box B and the inclined plane and negligible friction between Box A and the inclined plane. The angle of the plane is 30°.



a) In the space above, draw a free body diagram for each box, showing all of the forces involved.
b) What is the magnitude of the acceleration of the system?

c) What is the tension in the cable connecting the boxes?