Name: ________________________________ Page 1 Score _______

Final Exam:
You have 1 hour and 48 minutes to complete this exam

7 Multiple Choice and 6 Problems on 9 Pages, not counting the equation sheet

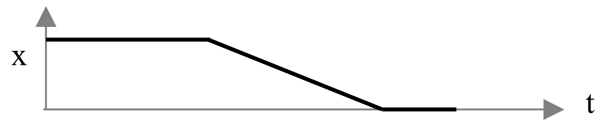
Please write your name and circle the name of your recitation instructor on the first page.

Please show your work on the problems to ensure full credit or to increase partial credit. It isn't necessary to show work for multiple choice questions; grading is full credit for a correct answer and zero for an incorrect answer.

Please use the back of the same page that the problem is on to complete that problem if you need more room.

Multiple choice	______
Page 4	______
Page 5	______
Page 6	______
Page 7	______
Page 8	______
Page 9	______
Total	______

1. (4) Which sentence below is the correct interpretation of the graph shown?



A) The object rolls along a flat surface. Then it rolls forward down a hill, and then finally stops.

B) The object doesn't move at first. Then it rolls forward down a hill and finally stops.

C) The object is moving at constant velocity. Then it slows down and stops.

D) The object doesn't move at first. Then it moves backwards and then finally stops.

E) The object moves along a flat area, moves backwards down a hill, and then it keeps moving.

2. (4) A woman exerts a constant horizontal force on a box. As a result, the box moves across a horizontal floor at a constant speed "v_o." The constant horizontal force applied by the woman

A) has the same magnitude as the weight of the box.

B) is greater than the weight of the box.

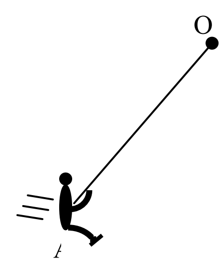
C) has the same magnitude as the total force which resists the motion of the box.

D) is greater than the total force which resists the motion of the box.

E) is greater than either the weight of the box or the total force which resists its motion.

3. (4) The figure shows a boy swinging on a rope, starting at a point higher than A. Consider the following distinct forces:

1. a downward force due to gravity
2. a force exerted by the rope from A to O
3. a force in the direction of the boy's motion
4. a force pointing from O to A.



Which of the above forces act on the boy when he is at position A?

A) 1 only.

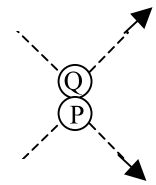
B) 1 and 2.

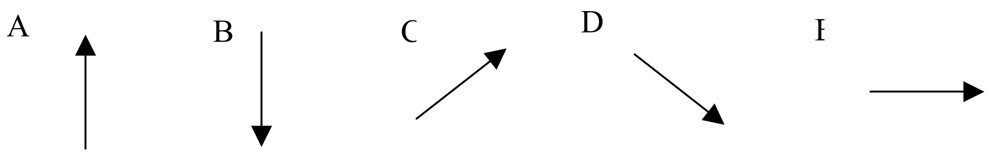
C) 1 and 3.

D) 1, 2, and 3.

E) 1, 3, and 4.

4. (4) The diagram at the right shows a collision between two pool balls. Which arrow best represents the direction of the impulse applied to ball Q by ball P during the collision?





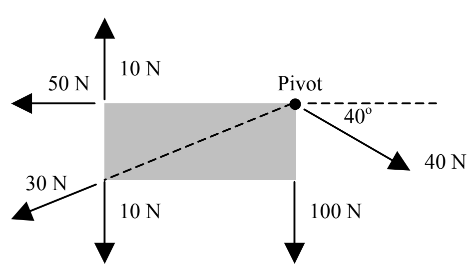
5. (4) Four people run up the stairs: Bill, mass 80 kg, runs up a 10-m high flight in 10 s.
Andrew, mass 80 kg, runs up a 10-m high flight in 8 s.
Kathy, mass 64 kg, runs up a 10-m high flight in 8 s.
Harold, mass 80 kg, runs up a 20-m high flight in 25 s.
Rank the people according to their power outputs, from smallest to largest.

A) Kathy < Harold < Bill = Andrew
B) Andrew < Bill = Kathy < Harold
C) Harold < Bill = Kathy < Andrew
D) Bill < Andrew = Kathy < Harold
E) Kathy < Andrew < Bill < Harold
F) Kathy < Harold = Bill = Andrew
G) Harold < Bill < Andrew = Kathy
H) Bill = Andrew = Kathy < Harold

6. (4) Two buckets spin around in a horizontal circle on a frictionless bearing, as shown. Suddenly, it begins to rain. As a result,

A) The buckets speed up, due to conservation of energy
B) The buckets slow down, due to conservation of energy
C) The buckets remain at the same speed, due to conservation of energy
D) The buckets speed up, due to conservation of angular momentum
E) The buckets slow down, due to conservation of angular momentum
F) The buckets remain at the same speed, due to conservation of angular momentum

7. (4) The magnitude of the total torque acting upon the object shown in the diagram is



A) 0   B) 10 N m   C) 20 N m
D) 58 N m   E) 120 N m

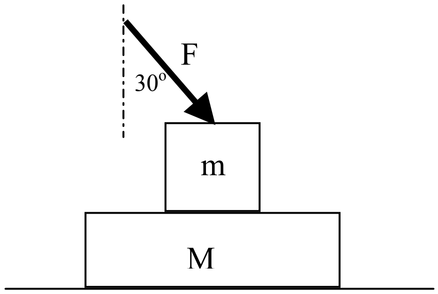
8. (15) A Ferris wheel spins such that the linear speed of a rider is 0.5 m/s. If the distance from the rider to the center of the wheel is10.0 m, what is the normal force exerted on a 50-kg rider by the seat when she is at the very bottom of the ride?

9. (20) Write down, but **<u>DO NOT SOLVE</u>**, a set of equations that when solved would yield the answer to the following problem:

A ball of mass m is moving to the right at a speed 3v. It collides head-on with a ball of mass 2m that is moving to the left with a speed v. If the collision is perfectly elastic, what are the speed and direction of each ball immediately after the collision?

Please put a box around your answer.

10. (20) In the situation below, there is sliding friction between the blocks with a coefficient of μ_k. There is no friction between the bottom block and the floor. Find an expression for the acceleration of the bottom block, in terms of the given information.



Please put a box around your answer.

11. (20) An amusement park wants to install a ride called the “Rump Roaster,” which shoots the rider from a spring on a level teflon surface which then turns into a 55 degree (from horizontal) Teflon coated slide, which is 10 m long. After the slide, the riders skid to a stop (warming up as well…) on a rubber, horizontal surface that is 15m long. The rider sits in a teflon bag during the ride, so the friction coefficient is very low until they reach the rubber surface, where the coefficient of friction is 0.65. If the spring constant is 10,000 N/m, what is the most it can be compressed so that an 80-kg rider will not slide off the end of the ride?

12. (20) Write down, but **<u>DO NOT SOLVE</u>**, a set of equations that when solved would yield the answer to the following problem:

A ladder of mass M and length L leans against a frictionless wall. The coefficient of static friction between the foot of the ladder and the ground is μ_s. What is the maximum angle, θ, that the ladder can make with the wall without slipping?

Please put a box around your answer.

13. (20) Wile E. Coyote (super genius) is at it again. This time he has attached an 80-kg anvil to the end of a very long massless rope and wrapped it around a pulley that is a solid disk with a mass of 50 kg. The pulley is attached to the 100-m high edge of a cliff above the road below. If he releases the anvil at the moment the roadrunner is 300 m away along the road, what would need to be the speed of the roadrunner for him to be hit by the anvil? (Assume that the rope is longer than 100 m.)

Potentially Useful Information

$$x_f = x_i + v_i t + \frac{1}{2}at^2$$

$$v_f = v_i + at$$

$$v_f^2 = v_i^2 + 2a\left(x_f - x_i\right)$$

$$v = \frac{dx}{dt}$$

$$a = \frac{dv}{dt}$$

$$\sum \vec{F} = m\vec{a}$$

$$w = mg$$

$$F_s = -k\Delta x$$

$$f_k = \mu_k N$$

$$f_s \leq \mu_s N$$

$$a = \frac{v^2}{r}$$

$$v = \omega r$$

$$I = \sum_i m_i r_i^2 = \int r^2 dm$$

$$I_{disk} = \frac{1}{2}MR^2$$

$$I_{hoop} = MR^2$$

$$I_{sphere} = \frac{2}{5}MR^2$$

$$I_{rod,end} = \frac{1}{3}ML^2$$

$$I_{rod,center} = \frac{1}{12}ML^2$$

$$\vec{F}_{12} = -\vec{F}_{21}$$

$$\vec{p} = m\vec{v}$$

$$\Delta\vec{p} = \vec{F}\Delta t = \vec{J}$$

$$\vec{p}_i = \vec{p}_f$$

$$E_i + W = E_f$$

$$W = \vec{F} \cdot \Delta\vec{x} = F\Delta x \cos\theta$$

$$W = \int_{x_i}^{x_f} \vec{F} \cdot d\vec{x}$$

$$U_G = mgy$$

$$K = \frac{1}{2}mv^2$$

$$K = \frac{1}{2}I\omega^2$$

$$U_S = \frac{1}{2}k(\Delta x)^2$$

$$U_{\text{int}} = f\Delta x$$

$$P = \frac{\Delta E}{\Delta t}$$

$$P = \vec{F} \cdot \vec{v}$$

$$\vec{\tau} = \vec{r} \times \vec{F} = rF\sin\theta$$

$$\vec{L} = \vec{r} \times \vec{p}$$

$$L = I\omega$$

$$L = mvr$$

$$g = 9.8N/kg = 9.8m/s^2$$