

Name: \_\_\_\_\_KEY\_\_\_\_\_

**Phys.115 Practice Exam II**  
**20 October 2004**

Please do not turn the page until you are told to do so. When you do so, make sure the you have all three problems on your copy of the test.

In order to get credit on a problem, you must show your work. If you only write down an answer without the work leading up to it, you will get no credit for it, even if it is the right answer.

1. A 2.0-kg pistol fires a 1.0-g bullet with a muzzle speed of 1000 m/s. The bullet then strikes a 10-kg wooden block resting on a horizontal frictionless surface. The block and the embedded bullet then slide across the surface.



- (a). (5 points) What is the kinetic energy of the bullet as it travels toward the block?

$$KE = \frac{1}{2}mv^2 = \frac{1}{2}(1.0 \times 10^{-3} \text{ kg})(1000 \text{ m/s})^2 = 500 \text{ J}$$

- (b). (5 points) The explosive charge in the pistol acts for 0.001 s. What is the average force exerted on the bullet while it is being fired?

$$J = F\Delta t; F = \frac{\Delta p}{\Delta t} = \frac{(1000 \text{ m/s})(1.0 \times 10^{-3} \text{ kg})}{0.001 \text{ s}} = 1000 \text{ N}$$

- (c). (5 points) What is the speed of the "bullet + block" system immediately after the bullet is embedded in the block?

$$p_i = p_f; m_b v_b = (m_b + m_B) v_{b+B}$$

$$v_{b+B} = \frac{m_b v_b}{(m_b + m_B)} = \frac{(1000 \text{ m/s})(1.0 \times 10^{-3} \text{ kg})}{10.001 \text{ kg}} = 0.1 \text{ m/s}$$

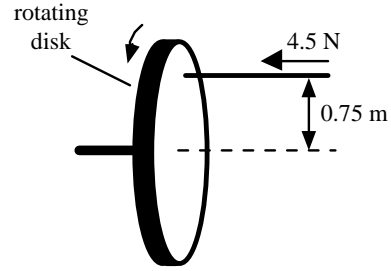
- (d). (5 points) If the coefficient of friction between the block and the surface is 0.25, in what distance will the "bullet + block" system stop?

$$W_f = \Delta E$$

$$-\mu(m_b + m_B)gx = 0 - \frac{1}{2}(m_b + m_B)v_{b+B}^2$$

$$x = \frac{v_{b+B}^2}{2\mu g} = \frac{(0.1 \text{ m/s})^2}{2(0.25)(9.8 \text{ m/s}^2)} = 2 \times 10^{-3} \text{ m}$$

2a.(10 points) A uniform disk of radius 1.2 m and mass 0.60 kg is rotating at 25 rad/s around an axis that passes through its center and is perpendicular to the disk. A rod makes contact with the rotating disk with a force of 4.5 N at a point 0.75 m from the axis of rotation as shown. The disk is brought to a stop in 5.0 s. What is the coefficient of kinetic friction for the two materials in contact? ( $I_{\text{disk}}=1/2mr^2$ )

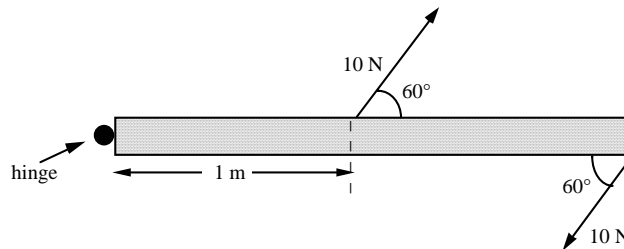


$$\omega_f = \omega_i + \alpha t; \alpha = \frac{-25 \text{ rad/s}}{5.0 \text{ s}} = -5 \text{ rad/s}^2$$

$$\sum \tau = I\alpha; \tau = I\alpha; -\mu F_N r = I\alpha$$

$$\mu = \frac{I\alpha}{-F_N r} = \frac{\frac{1}{2}mR^2\alpha}{-F_N r} = \frac{\frac{1}{2}(0.60 \text{ kg})(1.2 \text{ m})^2(-5 \text{ rad/s}^2)}{(-4.5 \text{ N})(0.75 \text{ m})} = 0.64$$

2b. (10 points) The drawing shows the top view of a door that is 2 m wide. Two forces are applied to the door as indicated.



What is the magnitude of the net torque on the door with respect to the hinge?

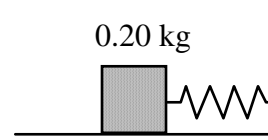
$$\sum \tau = -(10 \text{ N})\sin 60^\circ(2 \text{ m}) + (10 \text{ N})\sin 60^\circ(1 \text{ m}) = -8.7 \text{ Nm}$$

$$|\tau| = 8.7 \text{ Nm}$$

3.

When a 0.20-kg block is suspended from a vertically hanging spring, it stretches the spring from its original length of 0.050 m to 0.060 m.

The same block is attached to the same spring and placed on a horizontal, frictionless surface. The block is then pulled so that the spring stretches to a total length of 0.10 m. The block is released at time  $t = 0$  s and undergoes simple harmonic motion.



a. (4 points) What is the frequency of the motion?

$$mg = kx; k = \frac{mg}{x} = \frac{(0.20\text{kg})(9.8\text{m/s}^2)}{0.010\text{m}} = 196\text{N/m}$$

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi} \sqrt{\frac{196\text{N/m}}{0.20\text{kg}}} = 5\text{Hz}$$

b. (4 points) Please give an expressions for the displacement of the block as a function of time.

$$x = A \cos \omega t = 0.050\text{m} \cos(2\pi(5\text{Hz})t) = 0.050 \cos(10\pi)$$

c. (4 points) What is the speed of the block each time the spring is 5.0 cm long?

$$v = v_{\max} = \omega A = (31.4\text{rad/s})(0.050\text{m}) = 1.57\text{m/s}$$

d. (4 points) What is the maximum acceleration of the block?

$$a_{\max} = \omega^2 A = (31.4\text{rad/s})^2(0.050\text{m}) = 49.3\text{m/s}^2$$

e. (4 points) What is the total mechanical energy of the system at any instant?

$$E = PE_{el} = \frac{1}{2} kx^2 = \frac{1}{2} (196\text{N/m})(0.050\text{m})^2 = 0.245\text{J}$$