

## Review Problems for Physics 111 Final Exam

1. A constant force  $F = (1, 0, 4)$  (in Newtons) acts on a particle which moves from point A with coordinates  $(0, 7, 4)$  to point B with coordinates  $(-2, 4, 6)$  (all in meters). Find the work (in J) done by the force  $F$  on the path AB.

Ans. 6  $\vec{F} = \langle 1, 0, 4 \rangle$   $\Delta x = \langle -2, 4, 6 \rangle - \langle 0, 7, 4 \rangle = \langle -2, -3, 2 \rangle$

$$W = \vec{F} \cdot \Delta x = \langle 1, 0, 4 \rangle \cdot \langle -2, -3, 2 \rangle$$

$$= 1(-2) + 0(-3) + 4(2) = \underline{6 \text{ J}}$$

2. In order to find the speed of a fast bullet, it is fired into a 4.0 kg wooden block on a horizontal surface. The bullet gets stuck in the block which starts moving with the speed of  $V_f = 2.5$  m/s. Find the original speed of the bullet  $V_i$  if its mass is 7.54 gram.

Ans. 1330

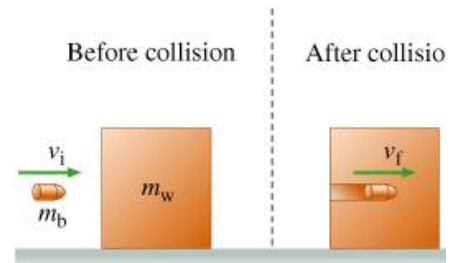
$$\hookrightarrow 0.00754 \text{ Kg}$$

Conservation of Momentum :

$$m_b v_i + m_w (0) = (m_b + m_w) v_f$$

$$\Rightarrow m_b v_i = (m_b + m_w) v_f$$

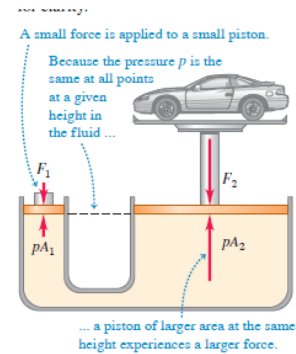
$$v_i = \frac{(0.00754 + 4)(2.5)}{0.00754} = 1328.76 \frac{\text{m}}{\text{s}}$$



3. For the hydraulic lift shown in figure, what must be the ratio of the diameter of the vessel at the car to the diameter of the vessel where the force  $F_1$  is applied so that a 1520 kg car can be lifted with a force  $F_1$  of just 125 N?

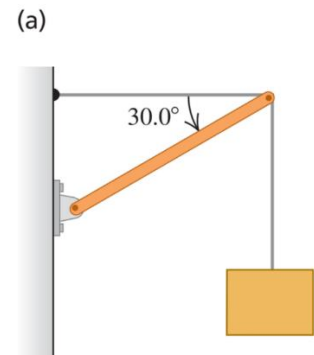
$$\frac{F_1}{A_1} = \frac{F_2}{A_2} \Rightarrow \frac{A_2}{A_1} = \frac{F_2}{F_1} = 12.16$$

$$\frac{\pi (D_2/2)^2}{\pi (D_1/2)^2} = 12.16 \Rightarrow \frac{D_2}{D_1} = \sqrt{12.16} = 3.48$$



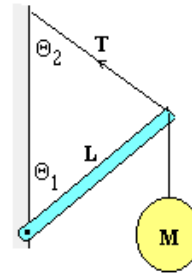
4. Find the tension  $T$  in each cable and the magnitude and direction of the force exerted on the strut by the pivot in the arrangement in figure below. Let  $W$  be the weight of the suspended crate full of priceless art objects. The strut is uniform and also has weight  $W$ .

Ans.  $T = 2.60W$ ;  $F = 3.27W$  and  $\theta = 37.6^\circ$

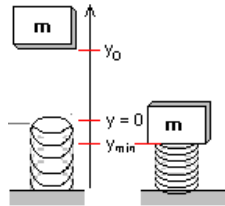


5. A uniform beam of length 5.5 m and negligible mass is attached to the vertical wall and supports a 120 kg ball as shown in the figure. If  $\theta_1 = 38^\circ$  and  $\theta_2 = 42^\circ$  what is the tension T in the cable?

Ans. **735 N**



6. A 5-kg ball is dropped from a height  $y_0$  above the top of a vertical spring whose spring constant is 2000 N/m. The spring is compressed 0.4 m. The height  $y_0$  is closest to  
**Ans. 2.86 m**



7. One force acting on a machine part is  $\vec{F} = (-5.00N)\hat{i} + (4.00N)\hat{j}$ . The vector from the origin to the point where the force is applied is  $\vec{r} = (-0.450m)\hat{i} + (0.150m)\hat{j}$ . (a) In a sketch, show  $\vec{r}$ ,  $\vec{F}$  and the origin. (b) Use the right-hand rule to determine the direction of the torque. (c) Calculate the vector torque for an axis at the origin produced by this force. Verify that the direction of the torque is the same as you obtained in part (b).

Ans.  $\vec{\tau} = (-1.05)\hat{k}$

8. A particle's velocity as a function of time is given by  $v_x(t) = dt + ct^2 + bt^3$  where  $d = 3.00 \text{ m/s}^2$ ,  $c = -4.00 \text{ m/s}^3$  and  $b = 2.00 \text{ m/s}^4$ . Calculate the instantaneous acceleration for  $t = 1.00 \text{ s}$ .

Ans.  $1.0 \text{ m/s}^2$

9. The position of a particle is given by  $x(t) = t^4/4 - t^3/3 + t - 27$  with  $x$  in meters and time  $t$  in seconds. Find the velocity in m/s at  $t = 0$

Ans.  $+1$

**10.** A block is placed on a inclined plane which makes 27 degrees with the horizontal. The kinetic friction coefficient between the block and the incline is  $\mu=0.4$ . Find the acceleration of the block in  $\text{m/s}^2$ .

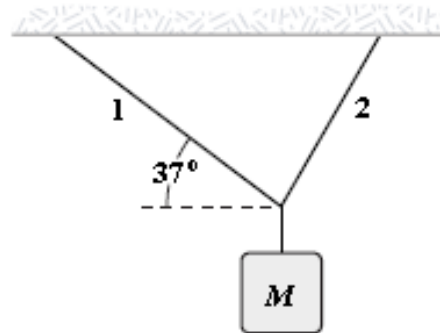
**Ans. 0.96**

**11.** A projectile is launched from the ground level with initial speed of 140 m/s at some angle to horizontal. What will be the speed of the projectile when it reaches elevation of 500 m (assume the launch angle is sufficient for the projectile to reach this elevation or higher; neglect air resistance). Hint: use energy conservation.

**Ans. 100**

12. An object of unknown weight is suspended as shown. The tension in rope 1 is 25 N, and the tension in rope 2 is 31 N. What is the weight of the suspended object?

**Ans. 39 N**

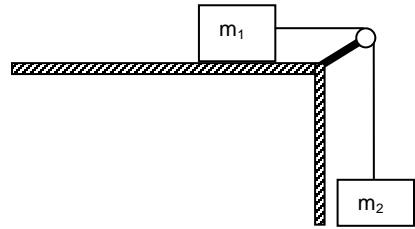


13. The planet Venus requires 225 days to orbit the sun, which has a mass  $M = 1.99 \times 10^{30}$  kg, in an almost circular trajectory. Calculate the radius of the orbit as it circles the sun.

**Ans.  $1.1 \times 10^{11}$  m**

14. In the sketch at right, assume that the pulley is massless and all surfaces are frictionless. What is the magnitude of the acceleration of mass  $m_1$  in terms of  $m_1$ ,  $m_2$ , and  $g$ ?

Ans.  $m_2g / (m_1 + m_2)$



15. For the arrangement shown in the sketch for problem 14 above, now assume that the coefficients of static and kinetic friction between  $m_1$  and the table are  $\mu_s = .2$  and  $\mu_k = .15$ . If  $m_1 = 10$  kg and  $m_2 = 5$  kg, find the magnitude of the acceleration of mass  $m_1$ .

Ans.  $2.29 \text{ m/s}^2$



**16.** A 6 kg particle with velocity  $\mathbf{v} = -2\mathbf{i} + 5\mathbf{j}$  is at  $x = 30$  m,  $y = 45$  m. What is the angular momentum of the particle about the origin?

**Ans. 1440k**

**17.** A wheel is rotating freely at angular speed 900 rev/min on a shaft whose rotational inertia is negligible. A second wheel, initially at rest and with three times the rotational inertia of the first, is suddenly coupled to the same shaft. What is the angular speed of the resultant combination of the shaft and two wheels?

**Ans. 225 rev/min**

**18.** Two bodies, x and y, have equal kinetic energies. The mass of x is nine times that of y. The ratio of the momentum of y to that of x is:

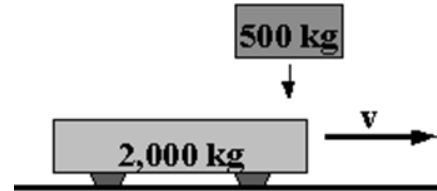
**Ans. 1:3**

**19.** A 10 kilogram bicycle wheel is rotating at 60 rev/min. It is essentially a thin hoop with a radius of 0.5 meters and a rotational inertia  $I = mr^2$ . How much work must be done to bring it to a stop?

**Ans. 49.35 J.**

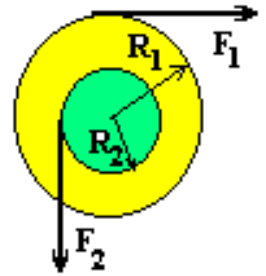
20. A 500-kg sack of coal is dropped vertically onto a 2,000-kg railroad flatcar which was initially moving at  $v = 11$  m/s toward the right, as shown. Just after the sack comes to rest on the flatcar, the speed of the flatcar is closest to:

Ans. 8.8 m/s



Problems 21, 22, 23

A solid cylinder of mass  $M = 10\text{kg}$  is pivoted about a frictionless axis through the center. A rope wrapped around the outer radius  $R_1 = 1\text{ m}$ , exerts a force  $F_1 = 5\text{ N}$  to the right. A second rope wrapped around another section of radius  $R_2 = 0.5\text{ m}$  exerts a force  $F_2 = 6\text{ N}$  downward.



21. The angular acceleration of the cylinder is closest to:

**Ans.  $-0.4\text{rad/s}^2$**

22. The angular velocity after first 5 seconds, if it starts from rest is closest to:

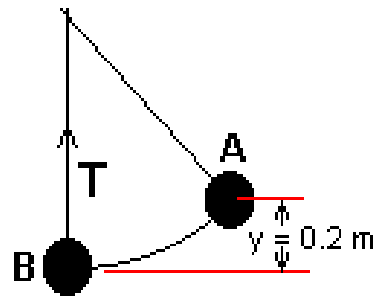
**Ans.  $-2\text{ rad/s}$**

23. The number of rotations the disk rotates through in the first 5 seconds, if it starts from rest is closest to:

**Ans. 0.8**

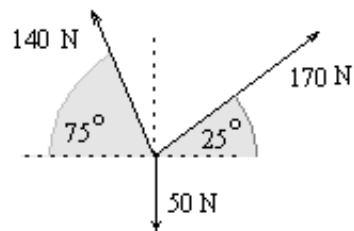
24. A simple pendulum consists of a 5-kg mass attached to a string of length 2 m. It is released from rest at A, 0.2 m above the lowest **point of** the swing. The tension in the string at the lowest point B is closest to:

**Ans. 60 N**



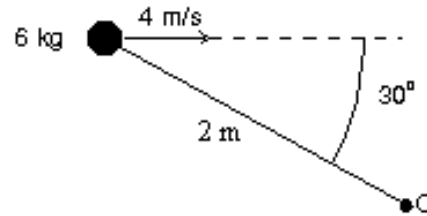
25. The magnitude of the resultant of the three forces shown in the figure is most nearly:

**Ans. 196N**



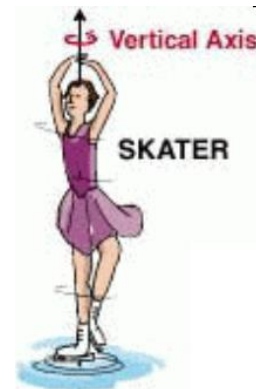
26. A 6-kg particle moves to the right at 4 m/s as shown. Its angular momentum in  $\text{kg} \times \text{m}^2 / \text{s}^2$  about the point O is:

**Ans.24**



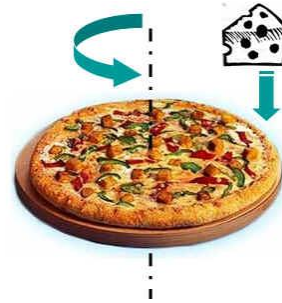
27. A figure skater goes into a spin, starting with her arms up and close to her body as shown. When she extends her arms horizontally sometime later:

**Ans. her angular velocity decreases.**



28. A pizza together with its pan is rotating about a vertical axis through its center. Its rotational inertia  $I = 2.0 \text{ kg}\cdot\text{m}^2$  and radius  $r = 50 \text{ cm}$ . The initial angular speed is  $4.0 \text{ rad/s}$ . A  $1.0 \text{ kg}$  chunk of Mozzarella cheese is initially at rest over the disk. It drops vertically onto the pizza from above and sticks to the edge. What is the angular speed of the pizza after the cheese becomes stuck to it?

Ans.  $3.56 \text{ rad/s}$

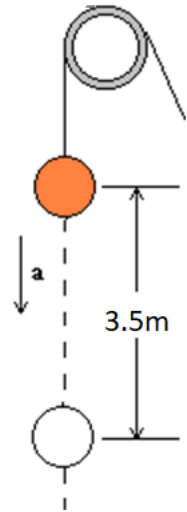


Problems 29, 30, 31,32

A cord is used to vertically lower an initially stationary block of mass  $M = 15 \text{ kg}$  at a constant downward acceleration of  $g/3$ . When the block has fallen a distance  $d = 3.5 \text{ m}$ .

**29.** Find the work done by the cord's force on the block. **Ans 343 J**

**30.** Find the work done by the gravitational force on the block. **Ans. 514.5 J**



**31.** Find the kinetic energy of the block. **Ans. 171 J**

**32.** Find the speed of the block. **Ans. 4.78 m/s**



33. A playground merry-go-round has a radius of 3.0 m and a rotational inertia of  $600 \text{ kg} \times \text{m}^2$ . It is initially spinning at 0.80 rad/s when a 20-kg child crawls from the center to the rim. When the child reaches the rim the angular velocity of the merry-go-round is:

**Ans. 0.61 rad/s**

Problems 34, 35

Water is flowing in a pipe with a circular cross section but with varying cross-sectional area, and at all points the water completely fills the pipe. At one point in the pipe the radius is 0.150 m.

34. What is the speed of the water at this point if water is flowing into this pipe at a steady rate of  $1.20 \text{ m}^3/\text{s}$ ?

**Ans. 17.0m/s**

35. At a second point in the pipe the water speed is 3.80 m/s. What is the radius of the pipe at this point?

**Ans. 0.317m**

**36.** What linear speed must an Earth satellite have to be in a circular orbit at an altitude of 107 km above earth's surface

**Ans.  $7.847 \times 10^3 \text{ m/s}$**

**37.** The planet Mars requires 2.48 years to orbit the sun, which has a mass of  $2 \times 10^{30} \text{ kg}$ , in an almost circular trajectory. Find the radius of the orbit of Mars as it circles the sun.

**Ans.  $2.745 \times 10^{11} \text{ m}$**

**38.** You are sitting in the front row in your physics class. a) Estimate the gravitational force that the instructor exerts on you. b) How does the magnitude that you estimate for this force compare with the gravity force exerted on you by the earth? (Estimates: Mass of instructor is 75 kg, your mass is 70 kg, distance between the two of you is 3.0 m.)

**a)Ans.  $3.9 \times 10^{-8} \text{ N}$**

**b)Ans.  $5.7 \times 10^{-11}$**