King Fahd University of Petroleum and Minerals

Department of Physics

PHYS101-052
MAJOR 2 EXAM
Test Code: **100**

13 December 2005 in Building 54
Exam Duration: 2hrs (from 6:00pm to 8:00pm)

Name:	
Student Number:	
Section Number:	

1. A 0.50 kg block slides down a frictionless 30° incline, starting from rest. The work done by the net force on this block after sliding for 4.0 s is:
   A) 37 J
   B) 20 J
   C) 0 J
   D) 49 J
   E) 96 J

2. A person lifts a 0.40 kg cup of water 0.64 m vertically up at constant velocity of 1.2 m/s. The work done on the cup of water by him is:
   A) 2.5 J
   B) 5.0 J
   C) 3.0 J
   D) 0 J
   E) -2.5 J

3. A man pushes a 50 kg crate a distance of 5.0 m upward along a frictionless slope that makes an angle of 30° with the horizontal. His force is parallel to the slope. The acceleration of the crate is 1.5 m/s^2 and is directed up the slope. The work done by the man is:
   A) 2800 J
   B) 1600 J
   C) 2000 J
   D) 3000 J
   E) 2300 J

4. A 20 N force acts horizontally on a 2.0 kg box initially (t = 0) resting on a frictionless floor. The rate at which this force is doing work at t = 2.0 s is:
   A) 600 W
   B) 80 W
   C) 400 W
   D) 100 W
   E) 200 W

5. A ball dropped from rest reaches a speed of 3 m/s just before it hits the ground. If the same ball is thrown downward from the same height with a speed of 4 m/s, its speed just before hitting the ground is
   A) 5 m/s
   B) 6 m/s
   C) 7 m/s
   D) 10 m/s
   E) 4 m/s

6. A varying force F_x acts on a particle of mass m = 2.0 kg as shown in Figure 1. Find the speed of the particle at x = 8.0 m, if the kinetic energy at x = 0 is 9.0 J.

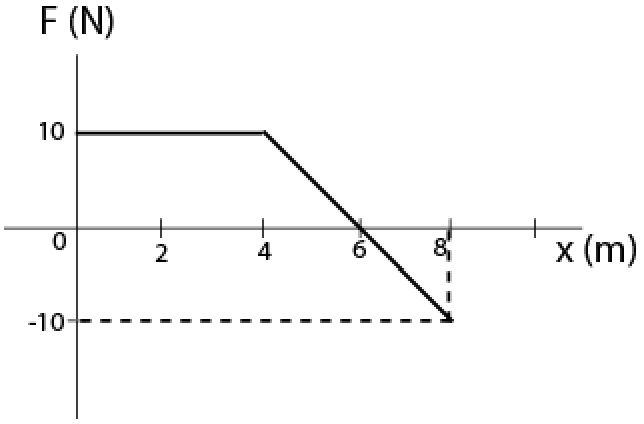

Figure 1

A) 5.0 m/s
B) 7.0 m/s
C) 6.0 m/s
D) 4.0 m/s
E) 3.0 m/s

7. A 0.50 kg block is attached to an ideal spring with a spring constant of 80 N/m rests on a horizontal frictionless surface. The spring is stretched 4.0 cm longer than its equilibrium length and then released. The speed of the block when it passes through the equilibrium point is:
A) 0.71 m/s
B) 1.0 m/s
C) 1.5 m/s
D) 0.33 m/s
E) 0.51 m/s

8. A 0.75-kg block slides on a rough horizontal table top. Just before it hits a horizontal ideal spring its speed is 3.5 m/s. It compresses the spring 5.7 cm before coming to rest. If the spring constant is 2600 N/m, the coefficient of kinetic friction between the block and the table is:
A) 0.52
B) 0.65
C) 1.0
D) 0.88
E) 0.41

9. Sphere A has a mass M and is moving with speed 10 m/s. It makes a head-on elastic collision with a stationary sphere B of mass 3M. After the collision the speed of B is:
   A) 2.0 m/s
   B) 5.0 m/s
   C) 1.0 m/s
   D) 4.0 m/s
   E) 6.0 m/s

10. The two pieces of uniform sheets made of the same metal are placed in the x-y plane as shown in Figure 2. The center of mass (x_{com}, y_{com}) of this arrangement is:

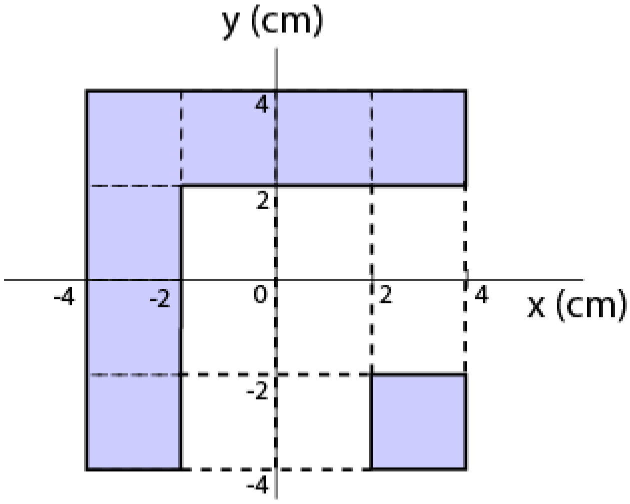

Figure 2

   A) (1.0, -1.0) cm
   B) (-2.0, 2.0) cm
   C) (-0.75, 0.75) cm
   D) (0.50, -0.50) cm
   E) (-0.50, 0.50) cm

11. A 0.50 kg ball moving at 2.0 m/s perpendicular to a wall rebounds from the wall at 1.4 m/s. The impulse on the ball is:
   A) 1.7 N · s away from wall
   B) 0.30 N · s away from wall
   C) 0.30 N · s toward wall
   D) zero
   E) 1.7 N · s towards the wall

12. An object of 12.0 kg at rest explodes into two pieces of masses 4.00 kg and 8.00 kg. The velocity of the 8.00 kg mass is 6.00 m/s in the positive x-direction. The change in the kinetic energy is:
   A) 48.0 J
   B) 54.0 J
   C) 290 J
   D) 432 J
   E) 154 J

13. At t=0, a car engine is idling at ω_o= 500 rev/min at a traffic light. At that moment the light turns green and the crankshaft rotation speeds up at a constant rate to reach ω= 2500 rev/min at t=3.0 s. The number of revolutions the crankshaft makes during this 3.0 s is:
A) 750
B) 7500
C) 75000
D) 500
E) 75

14. Find the moment of inertia of a uniform ring of radius R and mass M about an axis 2R from the center of the ring as shown in the Figure 3.

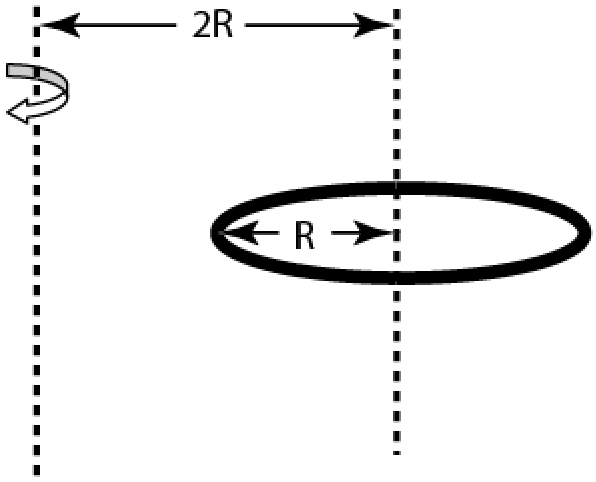

Figure 3

A) $5\,M\,R^2$
B) $4\,M\,R^2$
C) $\frac{1}{2}\,M\,R^2$
D) $\frac{2}{5}\,M\,R^2$
E) $\frac{9}{5}\,M\,R^2$

15. A uniform 2.0 kg cylinder of radius 0.15 m is suspended by two strings wrapped around it, as shown in Figure 4. The cylinder remains horizontal while descending. The magnitude of the acceleration of the center of mass of the cylinder is:

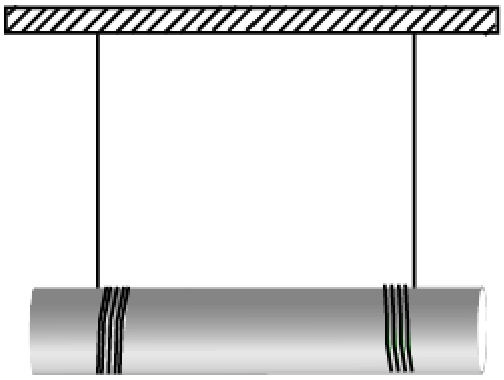

Figure 4

A) 25 m/s^2
B) 1.2 m/s^2
C) 3.5 m/s^2
D) 6.5 m/s^2
E) 12 m/s^2

16. A uniform thin rod of mass M = 3.00 kg and length L = 2.00 m is free to rotate about a horizontal axis at one end O, and is acted upon by an upward vertical force F = 8.00 N at the other end as shown in Figure 5. The angular acceleration of the rod at the moment the rod is in the horizontal position as shown in this figure is:

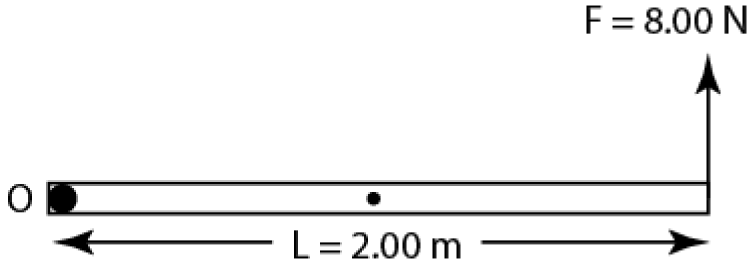

Figure 5

A) 4.00 rad/s^2 counterclockwise
B) 3.35 rad/s^2 clockwise
C) 2.50 rad/s^2 counterclockwise
D) 2.00 rad/s^2 clockwise
E) 1.00 rad/s^2 counterclockwise

17. A wheel is 60 cm in diameter and rolls without slipping on a horizontal floor. The speed of the center of mass of the wheel is 20 m/s. The speed of a point at the top edge of the wheel is:
A) 20 m/s
B) 0 m/s
C) 10 m/s
D) 30 m/s
E) 40 m/s

18. A stone attached to a string is rotating at an angular speed of 3.0 rev/s in a horizontal circle of radius 0.75 m. The mass of the stone is 0.15 kg. The magnitude of the angular momentum of the stone relative to the center of the circle is:
A) 3.2 kg.m^2/s
B) 2.8 kg.m^2/s
C) 1.6 kg.m^2/s
D) 6.4 kg.m^2/s
E) 0.8 kg.m^2/s

19. Force $\vec{F}$ = (-8.0 N) $\hat{i}$ + (6.0 N) $\hat{j}$ acts on a particle at $\vec{r}$ = (3.0 m) $\hat{i}$ + (4.0 m) $\hat{j}$ as shown in Figure 6. The torque on the particle about the point P = (0, 4.0 m) is:

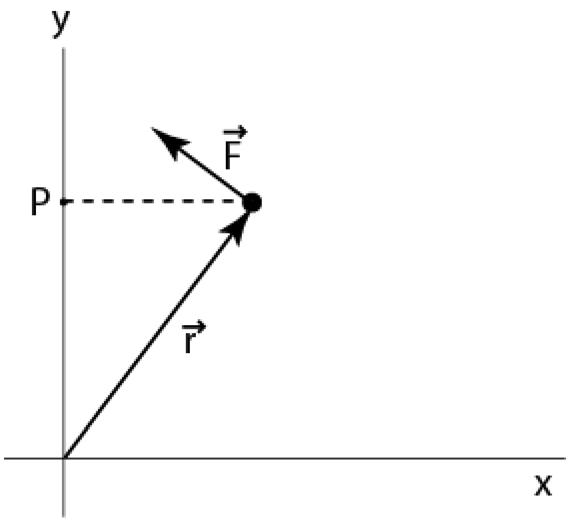

Figure 6

A) $-24\hat{k}$ N.m
B) $50\hat{k}$ N.m
C) zero
D) $18\hat{k}$ N.m
E) $(-24\hat{i} + 18\hat{j})$ N.m

20. A monkey of mass = M stands on the rim of a horizontal disk. The disk has a mass of 4 M and a radius R=2.0 m and is free to rotate about a frictionless vertical axle through its center. Initially the monkey and the disk are at rest. Then the monkey starts running around the rim clockwise at a constant speed of 4.0 m/s relative to the ground. The angular velocity of the disk becomes:

A) 2.0 rad/s counterclockwise
B) 2.0 rad/s clockwise
C) 1.0 rad/s counterclockwise
D) 1.5 rad/s clockwise
E) 4.0 rad/s counterclockwise

PHYS-101 Formula Sheet for the Second Major Exam (051)

$$\vec{r} - \vec{r}_o = \vec{v}_o t + \tfrac{1}{2}\vec{a}t^2$$
$$\vec{v} = \vec{v}_o + \vec{a}t$$
$$v^2 = v_o^2 + 2a(x - x_o)$$
$$x - x_o = \tfrac{1}{2}(v + v_o)t$$

$$\sum \vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}; \qquad \vec{p} = m\vec{v}$$
$$f_k = \mu_k N$$
$$f_s \le \mu_s N$$
$$W = \int \vec{F} \cdot d\vec{r}$$
$$W = \vec{F} \cdot \vec{d} \quad \textit{if } \vec{F} \textit{ is a constant}$$

$$\vec{A} \cdot \vec{B} = A\,B\,\cos\theta$$
$$\left|\vec{A} \times \vec{B}\right| = A\,B\,\sin\theta$$

$$W_{net} = \Delta K = \tfrac{1}{2}mv_f^2 - \tfrac{1}{2}mv_i^2$$
$$P = \frac{dW}{dt} = \vec{F} \cdot \vec{v}$$
$$U_s = \tfrac{1}{2}kx^2, \qquad F_s = -kx$$
$$U_g = mgy$$
$$E_{mech} = K + U$$
$$\Delta U = -W \quad \textit{for a conservative force}$$

$$\Delta K + \Delta U + \Delta E_{th} = W$$
$$\textit{where} \quad \Delta E_{th} = f_k d$$

$$\vec{J} = \int \vec{F}\,dt = \vec{F}_{avg}\Delta t = \Delta\vec{p}$$
$$\vec{p}_{1i} + \vec{p}_{2i} = \vec{p}_{1f} + \vec{p}_{2f}$$

$$\sum \vec{F}_{ext} = M\vec{a}_{com}$$
$$\vec{r}_{com} = \frac{1}{M}\sum_{i=1}^{n} m_i \vec{r}_i = \frac{1}{M}\int \vec{r}\,dm$$

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2}v_{1i} + \frac{2m_2}{m_1 + m_2}v_{2i}$$
$$v_{2f} = \frac{2m_1}{m_1 + m_2}v_{1i} + \frac{m_2 - m_1}{m_1 + m_2}v_{2i}$$

$$\omega = \frac{d\theta}{dt}; \qquad \alpha = \frac{d\omega}{dt}$$
$$s = r\theta, \qquad v = r\omega$$
$$a_t = r\alpha; \quad a_r = \frac{v^2}{r} = r\omega^2$$
$$\vec{a} = \vec{a}_t + \vec{a}_r; \qquad a = \sqrt{a_t^2 + a_r^2}$$

If α is constant:
$$\omega = \omega_o + \alpha t$$
$$\theta - \theta_o = \omega_o t + \tfrac{1}{2}\alpha t^2$$
$$\omega^2 = \omega_o^2 + 2\alpha(\theta - \theta_o)$$

$$I = \sum_i m_i r_i^2 = \int r^2\,dm$$
$$I_p = I_{com} + Mh^2$$
$$\vec{\tau} = \vec{r} \times \vec{F}$$
$$\tau = rF\sin\theta = r_\perp F = rF_t$$
$$W = \int \tau\,d\theta$$
$$= \tau\,\Delta\theta \quad \textit{if } \tau \textit{ is constant}$$
$$\vec{l} = \vec{r} \times \vec{p} = m\vec{r} \times \vec{v}$$
$$l = mr_\perp v = mrv_\perp$$

For a solid rotating about a fixed axis:
$$K_{rot} = \tfrac{1}{2}I\omega^2, \qquad L_z = I\omega$$

$$\Delta K = \frac{1}{2}I(\omega_f^2 - \omega_i^2) = W$$
$$P = \frac{dW}{dt} = \tau\omega$$
$$\vec{\tau} = \frac{d\vec{l}}{dt}$$
$$\sum \vec{\tau}_{ext} = \frac{d\vec{L}}{dt} = I\vec{\alpha}$$

$$\int x^n dx = \frac{x^{n+1}}{n+1}; \qquad \frac{d}{dt}\left(t^n\right) = n\,t^{n-1}$$

$$g = 9.80\ m/s^2$$
$$I_{com}(cylinder) = \tfrac{1}{2}MR^2$$
$$I_{com}(solid\ sphere) = \tfrac{2}{5}MR^2$$
$$I_{com}(thin\ rod) = \tfrac{1}{12}ML^2$$
$$I_{com}(ring,\ about\ central\ axis) = MR^2$$
$$I_{com}(ring,\ about\ diameter) = \tfrac{1}{2}MR^2$$

Answer Key

1. E
2. A
3. B
4. C
5. A
6. B
7. E
8. D
9. B
10. C
11. A
12. D
13. E
14. A
15. D
16. B
17. E
18. C
19. D
20. C