Physics 111, Spring 2014, Common Exam 3

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

ysics 111 Common Exam 3: Spring 2014

Name (Pri[redacted] **4 Digit ID:________ Section: ______** **A**

Honors ([redacted]asons all students are pledged to comply with the provisions [redacted]st answer the exam questions entirely by yourself. **Turn off a**[redacted]**nication devices**. Use only your own calculator.

Instructi[redacted]

- First, v[redacted]e Scantron card and this exam sheet.
- Use th[redacted]) other materials.
- Budge[redacted]
- Use th[redacted]l, of the multiple choice problems, it will be difficult to arrive at the [redacted]ever, while partial credit will be awarded for the long workout proble[redacted]tiple choice problems.
- Answe[redacted]encil. Also circle your answers on question papers.
- Do not[redacted]stion, if needed, from your proctor or Professor.

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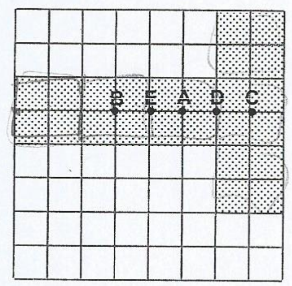
1. A uniform T-shaped piece, represented by the shaded area on the figure, is cut from a metal plate of uniform thickness. The point that is **closest** to the center of mass of the T-shaped piece is

A) A
B) B
C) C
D) D
E) E



2. A **300 g** hockey puck moving with a horizontal speed of **60 m/s** collides with and becomes embedded in a **90 kg** hockey player (tending the goal) who is initially at rest on an icy horizontal, frictionless surface. The speed of the hockey player and puck moving together after the collision is about:

.300 kg $\quad V_I = 60$

$.3(60) = 90.3(x)$

A) 0.5 m/s
B) 2.4 m/s
C) 5 m/s
D) 0.2 m/s
E) 1.2 m/s

3. A 7.5-gram bullet with unknown speed passes through a wooden block with mass 1.5 kg, initially at rest. The bullet emerges on the other side of the block with speed of 200 m/s, while the block gains the speed of 2 m/s. Find the original speed of the bullet

$(.0075)x + 0 = (1.5)2\,m/s + (200).0075$

A) 300 m/s
B) 600 m/s
C) 900 m/s
D) 1200 m/s
E) 1500 m/s

. A rocket with mass M=2 kg is moving with velocity v=100 m/s in positive x-direction. At some point, the rocket explodes breaking into two equal parts, the first one moving with velocity V=282 m/s oriented 45 degrees to the direction of original motion. Find the angle with the x-axis (in degrees) for the directions of motion of the 2nd part. (Hint: use vector form of momentum conservation).

A) 0 (the 2nd part moves in the original direction)
B) 180
C) -60
D) -120
E) -90

2kg 100 m/s 45°

200 = (282) 1 · Cos 45° + 1·282 cos θ

5. A football player is about to try for a field goal by kicking a 0.5 kg ball which is at rest on the field. He needs to give the ball a velocity of at least 30 m/s to have a chance of scoring a goal. He can kick with an average force of 400 N. How long must the players' foot must be in contact with the ball during the kick?

A) 0.2 s
B) 0.1 s
C) 0.02 s
D) 0.04 s
E) 0.01 s

400 ΔT = 15

J = ΔP

Fne ΔT = m vf − m vi
− 0

50 N

6. A **50 N** force is the only force on a **2 kg** box that starts from the rest. At the instant the object has gone **2 m** the power due to this force is:

A) 2.5 W
B) 25 W
C) 75 W
D) 100 W
E) 500 W

2 m

50 · 2
100 N

50 = 2a
50 = 2a
100 =

Vi = 0
Δd = 2
a = 25
ΔT =

2 = ½ 25 T²
4 = 25
2 = ½ 25 T²

7. A fan blade of length 1.5 m rotates with angular velocity given by: $\omega(t) = [-5.00 + 0.80\, t^2](\frac{rad}{s})$. Calculate the magnitude of the total linear acceleration of a point at the tip of the blade (furthest point from the center of rotation) at t = 3 seconds (in m/s²).
Hint: total linear acceleration have both tangential and radial components.

A) 2.40
B) 7.26
C) 8.05
D) 7.65
E) 10.2

2.2 = ω
2.2 · r
3.63

v = ωr
1.65
3.63² +

$\frac{v^2}{R}$
1.6T = α
1.6T = α

8. A wheel rotating about a fixed axis with a constant angular acceleration of 2.0 rad/s² turns through 2.4 revolutions during a 2.0-s time interval. What is the angular velocity at the end of this time interval (in rad/s)?

A) 9.5
B) 9.7
C) 9.3
D) 9.1
E) 8.8

Vf² = Vi² + αT
+ 4

α = 2
2.4 = Δω
2 = ΔT

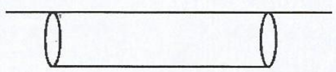
(2.4) 2π = Vi(2) + ½ · 2 · 2²
Vi = 5.53

9. A uniform cylinder of radius R, mass M, and length L rotates freely about a horizontal axis parallel and tangent to the cylinder, as shown below. The moment of inertia of the cylinder about this axis is (the moment of inertia of the cylinder about its central axis is $I_{cylinder} = MR^2/2$).

A) 1/2 M R^2
B) 2/3 M R^2
C) 7/5 M R^2
D) 5/7 M R^2
E) 3/2 M R^2

$\frac{1}{2}MR^2 + \frac{2}{2}MR^2$

$\frac{3}{2}MR^2$



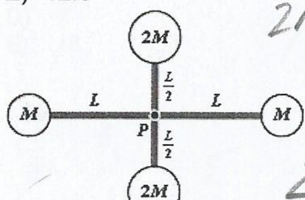
10. The rigid object shown rotates about an axis perpendicular to the paper and through point P. The rigid object is also moving in the +x directions (to right) with a velocity of 5 m/s. The total kinetic energy of the object as it rotates and moves along the x axis is equal to ~~80~~ 330 J. If M = 4 kg and L = 0.50 m, what is the angular velocity of the object? Neglect the mass of the connecting rods and treat the masses as particles (rad/s).

A) 1.7
B) 6.5
C) 2.4
D) 4.5
E) 12.8

$330 = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$2M + 2M + 2m$

$30 = \frac{1}{2}I\omega^2$



$60 = I\omega^2$

$2(2m(\frac{L}{2})^2) + 2(ML^2)$

$60 = 3\omega^2$

$1 + 2$

$= .1406$

11. A computer disk drive is turned on starting from rest and has constant angular acceleration. If it took 0.750 s for the drive to make its *second* complete revolution, (a) how long did it take to make the first complete revolution (in seconds)

$\omega_I = 0$

$\alpha t_1 = 2\pi$

$\alpha t_{2+1} = 4\pi$

$\alpha = \text{constant}$

$\Delta T = .750$

$4\pi = 0$

$t_2 = t_{2+1} - t_1$

$.75 = T_{2+1} - T_1$

$4\pi = \frac{1}{2}\alpha(.75)^2$

$\alpha = 44.68$

$2\pi = \frac{1}{2}(44.68)t^2$

A) 1.30
B) 2.50
C) 1.81
D) 0.95
E) 5.30

12. A coin ($I = \frac{1}{2}MR^2$) is rolling without slipping along a table top. The ratio of its translational kinetic energy to its rotational kinetic energy (about an axis through its center of mass) is:

A) 1
B) 2
C) 3
D) 1/2
E) 1/3

$KE = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$\omega r = v$

$\omega = \frac{v}{r}$

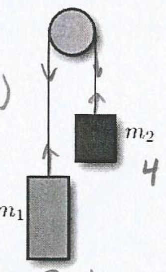
$\frac{1}{2}MR^2\frac{v^2}{r^2}$

$\frac{1}{2}Mv^2$

$mg - ma = T_2$

. The figure below shows a pulley (R=3.0 cm and I= 0.0045 $\text{kg}\cdot\text{m}^2$) suspended from the ceiling. A rope passes over it with a m_1=2.0 kg block attached to one end and a m_2=4.0 kg block attached to the other. If the system is initially at rest, what will be the speed of block 2 (in m/s) after it has descended by 1 m:

A) 4.55
B) 1.34
C) 5.8
D) 1.89
E) 3.25



4 kg

2 kg

$M_2 \ \Sigma F_y = mg - T_2 = m_2 a$

$T_2 = m(g-a)$

$m_1 \ \Sigma F_y = T_1 - mg = ma$

$T_1 = m_1(g+a)$

$m_1 g - m_2 g = m_1 \alpha r m_2 \alpha r + I\alpha$

$(m_1 r + m_2 r + I)\alpha$

$\tau = I\alpha$

$\frac{m_1 g - m_2 g}{m_1 r + m_2 r + I}$

$F l = I\alpha$

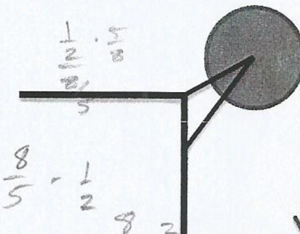
$(T_1 - T_2)R = I\alpha$

$m_1(g+\alpha r) - m_2(g - \alpha r) = I\alpha$

$m_1 g + m_1 \alpha r - m_2 g + m_2 \alpha r = I\alpha$

14. A uniform disk of radius 50 cm and mass 4 kg is mounted on a frictionless axle, as shown in the Figure. A light cord is wrapped around the rim of the disk and a steady downward pull of 10 N is exerted on the cord. Find the angular acceleration of a point on the rim of the disk (in rad/s^2). (the moment of inertia of the disk about its center of mass is $I_{disk}=MR^2/2$).

A) 23
B) 10
C) 5
D) 7
E) 18



$F L = I\alpha$

$10(.5) = 4 \cdot .5^2 \ \alpha$

$5 = 1 \ \alpha$

$\frac{5}{8} \cdot \frac{4}{1}$

$\frac{5}{8} : \frac{4}{8}$

$\frac{5}{8} \cdot \frac{4}{8}$ $\frac{1}{2}$ $\frac{8}{5}$

$\frac{1}{2} \cdot \frac{5}{8}$

$\frac{8}{5} \cdot \frac{1}{2}$

$\frac{8}{5} \cdot \frac{2}{1}$

$\frac{5}{2} \cdot \frac{2}{1}$

$\frac{5}{4}$

$\frac{5}{8} - \frac{9}{4}$

$\frac{5}{8}$

$\frac{9}{8}$

$\cancel{2} \ \frac{5}{8} MR^2 \omega_f^2$

$KE = \cancel{2}\left(\frac{1}{2}MR^2\right)\omega_I^2$

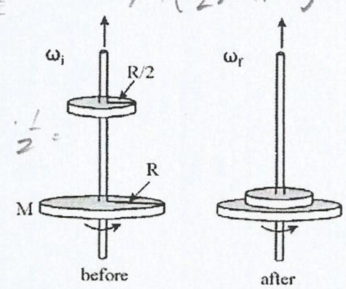
15. A solid disc of mass M and radius R rotates about a frictionless vertical axle with angular speed ω_i. A second solid disc of the **same** mass M but of radius R/2, initially not rotating, drops onto the first disc, as shown in the figure. Because of friction between the surfaces, the two eventually reach the same angular speed, ω_f. The ration between ω_f and ω_i is:

$\frac{1}{2}$ $\frac{5}{8}$

$\frac{8}{5} \cdot \frac{1}{2}$

$\frac{1}{2} MR^2$

A) 4/5 B) 2/3 C) 3/4
D) 8/10 E) 3/5



$V = \omega_I R$

$\omega_I =$

$\frac{1}{2}MR^2 + \frac{1}{2}M\left(\frac{R}{2}\right)^2$

$\frac{1}{8}MR^2$

$\Delta KE = \frac{1}{2} MR^2 \omega_F^2 +$

$\Delta KE = \frac{1}{2} I \omega^2$

$\Delta KE = \frac{1}{16} MR^2$

$\frac{1}{4} MR^2 \omega_I^2$

$\frac{4}{8} + \frac{1}{8} = \frac{5}{8}$

$\frac{1}{16} \ \frac{4}{1}$

$\frac{1}{12}ML^2 + mr^2$

$.004$

16. The figure shows an object of mass m=0.1 kg and velocity=V_o is fired onto one end of a uniform thin rod (L is the length of the road and L=0.4 m, M = 1.0 kg) initially at rest. The rod can rotate freely about an axis through its center (O). The object sticks to the rod after collision. The angular velocity of the system (rod + object) is 10 rad/s immediately after the collision. Calculate V_o (in m/s). (*the moment of inertia of the rod about its center of mass is* $I_{rod}=ML^2/12$)

$\omega_F = 10$

$K_1 = K_2$

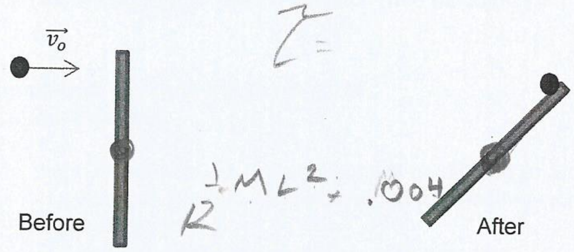
$\frac{1}{2}mv^2 = \frac{1}{2}I\omega^2$

$\frac{1}{2}mv^2 = .8667$

$\tau =$

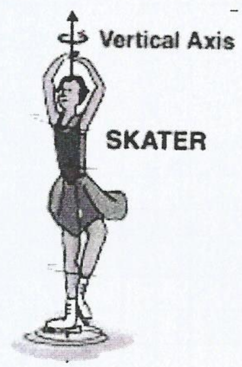
$\frac{1}{12}ML^2 + .004$

A) 12.0
B) 15.3
C) 8.7
D) 10.5
E) 3.5



17. A figure skater goes into a spin, keeping her arms up and close to her body as shown. When she extends her arms horizontally:

A) her angular velocity increases.
B) her angular velocity remains the same.
C) her angular momentum remains the same. ✓
D) her rotational inertia decreases. X
E) her rotational kinetic energy increases.



18. A single particle is located somewhere on the **negative z** axis. A net force acting on this particle points in the **positive y** direction. The vector representing the resulting torque points in the:

A) positive x direction
B) positive y direction
C) positive z direction
D) negative y direction
E) negative z direction

$\tau = F \times L$