Exam 4--PHYS 201--F14

Multiple Choice (each is $\frac{1}{3}$ points, 20 points total)

Identify the choice that best completes the statement or answers the question.

1. Which of these is a measure of angular displacement?
   I. radians
   II. degrees
   III. revolutions
   IV. arcs
   a. I alone
   b. I, II, and III
   c. I & II
   d. III & IV

2. One revolution is the same as
   a. $1 \text{ rad}$
   b. $2\pi \text{ rad}$
   c. $\pi \text{ rad}$
   d. $57 \text{ rad}$
   e. $\frac{\pi}{2} \text{ rad}$

3. What is the angular velocity of the second hand of a clock?
   a. $1 \text{ rad/s}$
   b. $2 \text{ rad/s}$
   c. $0.1 \text{ rad/s}$
   d. $0.5 \text{ rad/s}$

4. If a wheel turns with constant angular speed then:
   a. the wheel turns through equal angles in equal times
   b. the angle through which the wheel turns in each second decreases as time goes on
   c. the angle through which the wheel turns in each second increases as time goes on
   d. each point on its rim moves with constant velocity
   e. each point on its rim moves with constant acceleration

5. An object at rest begins to rotate with a constant angular acceleration. If this object has an angular velocity of $\omega$ in time $t$, what is its angular velocity after time $\frac{1}{2} t$?
   a. $\omega/2$
   b. $4\omega$
   c. $0$
   d. $2\omega$
   e. $\omega/4$

6. Consider this bar that can rotate about points A, B, and C. About which point, does the bar exhibit the greater moment of inertia?
   a. A
   b. B
   c. C
   d. A & C
   e. they are all the same moment of inertia
7. The following figure shows a configuration of particles arranged on an equilateral triangle, whose sides are all 4.0 m. The rotation axis is the dashed line in this figure. What is the moment of inertia for this configuration of particles?

![Diagram of particles on an equilateral triangle]

a. 96 kg m²  
b. 48 kg m²  
c. 24 kg m²  
d. 72 kg m²

8. A figure skater is rotating at 5 rev/s. Then, she moves her arms in and is then rotating at 10 rev/s. Which of these statements is true?

   a. she has increased her moment of inertia by a factor of 2  
   b. she has decreased her moment of inertia by a factor of 2  
   c. her moment of inertia is the same; she has just sped up  
   d. she has increased her moment of inertia by a factor of 4  
   e. she has decreased her moment of inertia by a factor of 4

9. This figure shows 3 levers of the same length. Each holds up a block of mass m. List the 3 levers in order of the force required to hold up the block, from greatest F to least F.

   ![Diagrams of levers with forces F]  

   a. 2, 1, 3  
   b. 1, 3, 2  
   c. 3, 1, 2  
   d. 1, 2, 3

10. Buckets are spinning horizontally on frictionless bearings. Suddenly, it starts raining. Which of these statements is true:

   ![Diagram of buckets spinning]  

   a. the buckets’ angular speed will decrease because their moment of inertia is increasing  
   b. the buckets’ moment of inertia will increase, causing the buckets angular momentum to increase  
   c. the buckets will spin at the same angular speed because there is no torque acting on this  
   d. None of these are true
11. Which of these are the basic SI units for torque?

a. \( \text{kg m} \, \text{s}^{-2} \)

b. \( \frac{\text{N}}{\text{m}} \)

c. \( \text{kg m} \, \text{s}^{-2} \)

d. \( \text{kg m} \, \text{s}^{-1} \)

12. Two spheres have the same mass. One sphere is made of aluminum, while the other sphere is made of gold. Both are solid. Because gold is more dense, the radius of the gold sphere is smaller than the aluminum sphere. Which has the larger moment of inertia?

a. aluminum sphere

b. gold sphere

c. both the same

d. not enough information
Problem

13. (15 pts) A hoop that can rotate about its central point. The hoop has a radius of 2 m and a mass of 30 kilograms and is initially at rest. Starting at time $t=0$, a force of $12\hat{i} + 5\hat{j}$ Newtons is applied at the top of the hoop (i.e. at the point $x=0, y=2$).

a) What is the torque applied to the hoop?

b) After 3 seconds, what is the kinetic energy of the sphere?
14. (10 pts) A man has a moment of inertia of 100 kg m². He stands on a rotating platform (with negligible moment of inertia) and is initially at rest. The man has a 1.0 kg mass attached to a rope of length 2.0 m. He swings the mass on a rope at a rate of 1.2 rev/s in the clockwise direction. What is the magnitude and direction of the man’s angular speed when he swings the mass? [Hint: The angular momentum is the same (i.e., zero) before and after he swings the mass.]

15. (10 pts) A propeller (arm length 1.2 m) starts from rest and begins to rotate counterclockwise with a constant angular acceleration of size 2 rad/s².

   a. How long does it take for the propeller's angular speed to reach 8 rad/s?

   b. How many revolutions does it take for the propeller's angular speed to reach 8 rad/s?

   c. What is the linear speed of the tip of the propeller at 8 rad/s?

   d. What is the linear acceleration of the tip of the propeller when it rotates at 8 rad/s?

   e. What is the centripetal acceleration of the tip of the propeller when it rotates at 8 rad/s?
16. (5 pts) A boy swings a 20 kg stone in a horizontal circle with a radius of 2 m. The string breaks under 200 N of tension.

a) What is the maximum speed (in m/s) the stone can have?

b) What is the maximum angular speed (in rad/s) the stone can have without breaking the string?
Exam 4--PHYS 201--F14
Answer Section

MULTIPLE CHOICE

1. ANS: B  PTS:  1
2. ANS: B  PTS:  1
3. ANS: C  PTS:  1
4. ANS: A  PTS:  1
5. ANS: A  PTS:  1
6. ANS: A  PTS:  1
7. ANS: A  PTS:  1
8. ANS: B  PTS:  1
9. ANS: A  PTS:  1
10. ANS: A  PTS:  1
11. ANS: C  PTS:  1
12. ANS: A  PTS:  1

PROBLEM

13. ANS: 
   
   PTS:  1
14. ANS: 
   
   PTS:  1
15. ANS: 
   
   PTS:  1
16. ANS: 
   
   PTS:  1