1. A solid sphere has a mass of 10.0 kg and a radius of 2.0 m. It rolls and has a linear velocity of 2.0 m/s. What is the rotational kinetic energy of the sphere?

   a. 2.0 J  
   b. 40.0 J  
   c. 8.0 J  
   d. 20.0 J

2. A figure skater pulls her arms in to decrease her moment of inertia by a factor of two. As a result, she spins twice as fast. What has happened to her rotational energy?

   a. it has increased by a factor of 4  
   b. it has increased by a factor of 2  
   c. it remains the same  
   d. it has decreased by a factor of 2  
   e. it has decreased by a factor of 4

3. A solid sphere, hoop, and cylinder all have the same mass and radius. Which is the most difficult to spin?

   a. hoop  
   b. cylinder  
   c. sphere  
   d. all are the same difficulty to spin

4. Consider this object. It consists of two equal length and mass bars. Each dashed line shows an axis of rotation. Which of these describe the moments of inertia for the object?

   a. $I_A > I_B > I_D > I_C$  
   b. $I_A > I_B > I_C > I_D$  
   c. $I_A > I_B > I_C = I_D$  
   d. $I_D > I_C > I_B > I_A$

5. This figure shows a bar 4.0 meters long; the bar has a mass of 3.0 kg. A mass is attached at one end of the bar. This mass is 2.0 kg. The system rotates at the pivot point as shown. What is the moment of inertia for this system?

   a. 32 kg m²  
   b. 9.0 kg m²  
   c. 8.0 kg m²  
   d. 12 kg m²  
   e. 4.0 kg m²
6. A bar has a moment of inertia of 4 kg m$^2$ and is rotating at 3 rev/s. It engages with a flywheel, which is stationary and has a moment of inertia of 8 kg m$^2$. After they engage, both move at the same speed. What is this new speed?

a. 4.5 rev/s  
b. 1.5 rev/s  
c. 9 rev/s  
d. 3 rev/s  
e. 1 rev/s

7. Consider this figure of a hoop rotating about the axis labeled “C.” What is the net torque?

a. 40 Nm counter clockwise  
b. 0 Nm  
c. 50 Nm clockwise  
d. 20 Nm counter clockwise

8. Consider the hoop in the previous problem. After 2 seconds of the net torque acting on the rod, what is the rod’s angular velocity?

a. 30 rad/s  
b. 40 rad/s  
c. 10 rad/s  
d. 20 rad/s

9. Consider this figure of a rod rotating about the axis labeled “C.” The mass of the rod is 3.0 kg. What is the net torque?

![Image of a rod with forces and moment of inertia](image)

a. 36 Nm clockwise  
b. 80 Nm clockwise  
c. 40 Nm clockwise  
d. 10 Nm counterclockwise

10. This figure shows wrenches and an applied force, which is represented by the arrow. Rank the torques provided by the wrenches from greatest to least torque.

![Image of wrenches and force](image)

a. d>b>c>a  
b. d≈c>b>a  
c. b≈c>a>d  
d. c>d>a>b
11. A rectangular boat is 2.0 m by 1.0 m. To what depth is the boat submerged if it has a mass of 500.0 kg?

   a. 2.0 m  
   b. 1.0 m  
   c. 0.25 m  
   d. 0.5 m

12. A boat carrying a large chunk of steel is floating on a lake. The chunk is then thrown overboard and sinks. What happens to the water level in the lake (with respect to the shore)?

   a. rises  
   b. drops  
   c. remains the same  
   d. depends on the mass of the steel

13. A swift wind blows across the top of a chimney. What happens to the smoke rising inside of the chimney?

   a. the smoke rises more quickly  
   b. the smoke is pushed down the chimney  
   c. the smoke is unaffected by the wind

14. Bernoulli’s principle says:

   a. a change in pressure at one point in an incompressible fluid is felt at every other point in the fluid  
   b. the buoyant force equals the weight of the displaced fluid  
   c. a small input force always causes a large output force  
   d. energy is conserved in a flowing ideal fluid  
   e. matter must be conserved in a flowing ideal fluid

15. Water flows through a pipe. The pressure is 2000 Pa, and the water flows at 1.0 m/s. The water enters a narrower pipe, and the speed is 2.0 m/s. What is the pressure in this second section of pipe?

   a. 2500 Pa  
   b. 8000 Pa  
   c. 500 Pa  
   d. 5000 Pa

16. Which fills a larger volume: 100 kg of gold or 100 kg of lead?

   a. gold  
   b. lead  
   c. both have the same volume  
   d. there is not enough information

17. The following is a diagram for a hydraulic jack. The area of the piston on the left is $A_1=0.008 \text{ m}^2$; the area of the right piston is $A_2=0.024 \text{ m}^2$. If the input force is $F_i=25 \text{ N}$, what force is exerted by the right piston?

   a. 25 N  
   b. 50 N  
   c. 75 N  
   d. 100 N
18. This manometer is measuring the pressure, $P$. The known pressure, $P_0$, is 1.0 atm. The height of the column, $h$, is 0.5 m. The liquid in the manometer is mercury (Hg). What is the pressure $P$?

![Manometer Diagram]

a. 0.32 atm
b. 1.7 atm
c. 68,000 atm
d. 0.45 atm

19. You put a straw into a glass of water, place your finger over the top so no air can get in or out, and then lift the straw from the liquid. You find that the straw retains some liquid. How does the air pressure $P$ in the upper part compare to atmospheric pressure $P_A$?

![Straw Diagram]

a. $P > P_A$
b. $P = P_A$
c. $P < P_A$
d. it depends on the density of the liquid

20. Which of these is considered a fluid:
I. Solid
II. Liquid
III. Gas

a. III only
b. I, II, and III
c. II only
d. II & III

21. A person’s femur is about 0.50 meters and has a cross-sectional area of about $6.2 \times 10^{-4}$ m$^2$. A femur can supposedly support about 30 times the typical human weight. By how much will the femur change its length if it is supporting 2000 N (about 30 times the weight of a human)?

![Femur Diagram]

a. 0.0032 m
b. 9.0 $\times 10^{-5}$ m
c. 8.2 $\times 10^{-3}$ m
d. 0.010 m

22. An ideal gas is confined to a container with constant volume. The number of moles is constant. By what factor will the pressure change if the absolute temperature triples?

a. 9.0
b. 3.0
c. 1/3
d. 1/9

23. A 2.00-L container holds half a mole of an ideal gas at a pressure of 12.5 atm. What is the gas temperature? (1 liter = 0.001 m$^3$)

a. 1190 K
b. 601 K
c. 1980 K
d. 965 K
24. A long steel beam has a length of twenty-five meters on a cold day when the temperature is 0°C. What is the length of the beam on a hot day when \( T = 40°C \)?

a. 25.044 m  
b. 25.011 m  
c. 25.00044 m  
d. 25.0044 m

25. What happens to its moment of inertia when a steel disk is heated?
   a. It decreases.  
   b. It increases.  
   c. It increases for half the temperature increase and then decreases for the rest of the temperature increase.  
   d. It stays the same.

26. Which best describes the relationship between two systems in thermal equilibrium?
   a. masses are equal  
   b. no net energy is exchanged  
   c. volumes are equal  
   d. zero velocity

27. 88°F is how many degrees Celsius?
   a. 31  
   b. 49  
   c. 56  
   d. 158

28. Which of the following properties can be used to measure temperature?
   a. the length of a solid  
   b. the volume of gas held at constant pressure  
   c. the color of a glowing object  
   d. all of the above
Exam 4--PHYS 101--F15
Answer Section

MULTIPLE CHOICE

1. ANS: C  PTS: 1  REF: F15
2. ANS: B  PTS: 1  REF: F15
3. ANS: A  PTS: 1  REF: F15
4. ANS: B  PTS: 1  REF: F15
5. ANS: D  PTS: 1  REF: F15
6. ANS: E  PTS: 1  REF: F15
7. ANS: D  PTS: 1  REF: F15
8. ANS: D  PTS: 1  REF: F15
9. ANS: C  PTS: 1  REF: F15
10. ANS: B  PTS: 1  REF: F15
11. ANS: C  PTS: 1  REF: F15
12. ANS: B  PTS: 1  REF: F15
13. ANS: A  PTS: 1  REF: F15
14. ANS: D  PTS: 1  REF: F15
15. ANS: C  PTS: 1  REF: F15
16. ANS: B  PTS: 1  REF: F15
17. ANS: C  PTS: 1  REF: F15
18. ANS: A  PTS: 1  REF: F15
19. ANS: C  PTS: 1  REF: F15
20. ANS: D  PTS: 1  REF: F15
21. ANS: B  PTS: 1  REF: F15
22. ANS: B  PTS: 1  REF: F15
23. ANS: B  PTS: 1  REF: F15
24. ANS: B  PTS: 1  REF: F15
25. ANS: B  PTS: 1  REF: F15
26. ANS: B  PTS: 1  REF: F15
27. ANS: A  PTS: 1  REF: F15
28. ANS: D  PTS: 1  REF: F15