Physics 2311. Mechanics of Solids

Ch. 9-11 Exam-like questions Name:_____

Use to practice for exam.

1. **A bullet feels an average force of 280 N for 0.02 seconds as it travels down the barrell of a gun. What is the change in momentum of the bullet?**

   (a) 0 (b) 5.6 kg m s^{-1} (c) 11.2 kg m s^{-1} (d) 96 kg m s^{-1} (e) 14000 kg m s^{-1}

2. **Two bodies, A and B, have equal momenta. The mass of A is nine times that of B. The ratio of the kinetic energy of B to that of A (K_B/K_A) is:**

   (a) 1/9 (b) 1/3 (c) 1/1 (d) 3/1 (e) 9/1

3. **A "closed system" consists of a 2 kg ball moving at 12 m/s, and a 4 kg ball at rest.**
   I. What is the total *kinetic energy* after an elastic, head-on collision between the balls?

   (a) 0 J (b) 24 J (c) 48 J (d) 96 J (e) 144 J

   II. What is the total *kinetic energy* after a perfectly inelastic, head-on collision?

   (a) 0 J (b) 24 J (c) 48 J (d) 96 J (e) 144 J

   III. What is the total *momentum*, in kg m s^{-1}, after either type of collision between the balls?

   (a) 0 (b) 6 (c) 12 (d) 24 (e) 72

4. **At 0.1 kg ball is flying directly towards a wall in outer space with v=20 m/s. After 0.02 seconds of contact, the ball rebounds straight away from the wall with the speed v=15 m/s. What was the average force exerted on the ball by the wall (magnitude only) during the time of contact?**

   (a) 0.5 N (b) 3.5 (c) 35 N (d) 175 N (e) 880 N

5. **Find the center of mass (X_{CM},Y_{CM}) of this system of three discrete masses: 1 kg at (-10,-10), 1 kg at (0,0), and 5 kg at (20,20).**

   (a) (-5,-5) (b) (-10.3,20.2) (c) (90,90) (d) (12.9,12.9) (e) (3.3,3.3)

6. A rod has a mass per length given by $\lambda = 0.20 + 0.50x$ kg/m and a length of 0.5 m. What is the total mass of the rod if it extends from the origin to x=0.5m?

(a) 0.16 kg (b) 0.21 kg (c) 0.31 kg (d) 0.50 kg (e) 0.70 kg

7. A rod has a mass per length given by $\lambda = 0.20 + 0.50x$ kg/m and a length of 0.5 m. What is the center of mass of the rod if it extends from the origin to x=0.5m?

(a) 0.015 m (b) 0.111 m (c) 0.237 m (d) 0.283 m (e) 0.331 m

8. (1pt) Using symbols like ω, α, θ (with appropriate subscripts), write the equation which is the rotational equivalent to $v_f^2 - v_i^2 = 2a(x_f - x_i)$.

(a) $\omega_f = \omega_i + \alpha t$

(b) $x = \frac{1}{2}at^2 + v_0 t + x_0$

(c) $\theta = \frac{1}{2}\alpha t^2 + \omega_0 t + \theta_0$

(d) $\omega_f^2 - \omega_i^2 = 2\alpha(\theta_f - \theta_i)$

(e) $\omega_f^2 - \omega_i^2 = 2a(\theta_f - \theta_i)$

9. A wheel initially has an angular velocity of 18 rad/s but it is *slowing* at a rate of 4.0 rad/s^2. By the time it stops it will have turned through _____. (Note: not radians!)

(a) 3.2 rev (b) 6.4 rev (c) 16 rev (d) 36 rev (e) 45 rev

10. A barbell has a small, 2 kg weight on each end of a 2-m long massless bar. What is the rotational inertia relative to a spin axis running perpendicular to the bar and through the center of the bar?

(a) 2 kg m^2 (b) 3 kg m^2 (c) 4 kg m^2 (d) 8.0 kg m^2 (e) 9 kg m^2

11. A flywheel (hoop shaped) with radius of 0.2 m starts from rest and spins up with a constant angular acceleration of 3.0 rad/s^2. What is the tangential acceleration of the flywheel at r=0.2 m?

(a) 0.3 m s^{-2} (b) 0.49 m s^{-2} (c) 0.55 m s^{-2} (d) 0.60 m s^{-2} (e) 3.0 m s^{-2}

12. A flywheel (hoop shaped) with radius of 0.2 m starts from rest and spins up with a constant angular acceleration of 3.0 rad/s^2. What is the centripetal acceleration at r=0.2 m after 6 seconds?

(a) 0.6 m s^{-2}

(b) 9.2 m s^{-2}

(c) 38.1 m s^{-2}

(d) 60.0 m s^{-2}

(e) 64.8 m s^{-2}

13. The rotational inertia of a solid uniform sphere about a diameter is (2/5)MR^2, where M is its mass and R is its radius. If the sphere is pivoted about an axis that is tangent to its surface, its rotational inertia is:

(a) MR^2 (b) (2/5)MR^2 (c) (3/5)MR^2 (d) (5/2)MR^2 (e) (7/5)MR^2

14. What is the total kinetic energy of a 0.2 kg baseball with I =0.002 kg m^2, thrown at 10 m/s with a spin of 60 rad/s?

(a) 1.5 J (b) 13.6 J (c) 22.0 J (d) 23.5 J (e) 32.5 J

15. A cylinder is 0.10 m in radius and its rotational inertia about the axis of symmetry, is 0.020 kg m^2. A string is wound around the cylinder and pulled with a force of 1.0 N. The angular acceleration of the cylinder is:

(a) 2.5 rad/s^2 (b) 5.0 rad/s^2 (c) 10 rad/s^2 (d) 15 rad/s^2 (e) 20 rad/s^2

16. A 1.5 kg particle moves with a velocity of 6 m/s $\hat{j}$ at the instant when its position vector is 3.0 m $\hat{i}$ + 2.0 m $\hat{j}$. What are the magnitude and direction of the angular momentum about the origin (0,0,0)?

(a) 27 $\hat{k}$ kgm^2s^{-1}

(b) 3 $\hat{i}$ + 2 $\hat{j}$ kgm^2s^{-1}

(c) 45 $\hat{k}$ kgm^2s^{-1}

(d) 9 $\hat{i}$ + 27 $\hat{j}$ kgm^2s^{-1}

(e) 9 $\hat{j}$ + 33 $\hat{k}$ kgm^2s^{-1}

17. (1pt) A solid cylinder, hoop, and two solid spheres roll (without slipping) down an incline starting from rest at the same height. Sphere 1 has the same mass and radius as the cylinder and hoop. Sphere 2 has twice the mass and the same radius of sphere 1. What is the order in which they reach the bottom, first to last?

(a) sphere 2, sphere 1, cylinder, hoop

(b) hoop, cylinder, sphere 2 and sphere 1 tie

(c) cylinder, sphere 1, sphere 2, hoop

(d) sphere 1 and sphere 2 tie, cylinder, hoop

(e) sphere 1, cylinder, hoop, sphere 2

18. (1pt) An ice skater spinning at 5 rad/s has a rotational inertia of 4.0 kg m^2 with her arms out. After pulling her arms in, her rotational inertia is 1.5 kg m^2 and her angular speed becomes _____

(a) 5.0 rad/s (b) 9.0 rad/s (c) 13.3 rad/s (d) 16. rad/s (e) 18.3 rad/s

19. (2pts) A solid disk with $I_1 = 6$ kg m^2 and $\omega_1 = 4$ rad s^{-1}, is spinning about its axis of symmetry, which is oriented vertically. A second solid disk, oriented in the same way, has $I_2 = 12$ kg m^2 and $\omega_2 = 0$ and it falls straight down on disk 1. What final spin, ω_f, do the two disks have after friction brings their ***relative*** motion to a stop.

(a) 1.33 rad s^{-1} (b) 1.5 rad s^{-1} (c) 2.7 rad s^{-1} (d) 24 rad s^{-1} (e) 32 rad s^{-1}