Name Key Date

AP Physics

Rotational Motion Review

1. If radius of solid sphere is doubled by keeping its mass constant, then

$I = \frac{2}{5}mR^2$
$= (1)(1)(2)^2$
$= 4$

(a) $\frac{I_1}{I_2} = \frac{1}{4}$ (b) $\frac{I_1}{I_2} = \frac{4}{1}$
(c) $\frac{I_1}{I_2} = \frac{3}{2}$ (d) $\frac{I_1}{I_2} = \frac{2}{3}$

2. A constant torque of 31.4 N-m (τ) is applied to a pivoted wheel. If the angular acceleration of the wheel is 4π rad/s² (α), then the moment of inertia of the wheel is

$I = \tau/\alpha$
$= \frac{31.4 \text{ N}\ldots}{4\pi \text{ rad/s}\ldots}$

(a) 1.5 kg m² (b) 2.5 kg m²
(c) 3.5 kg m² (d) 4.5 kg m²

3. By keeping moment of inertia of a body constant, if we double the time period, then angular momentum of body

to cover same θ

$L = I\omega$
$= I\frac{\theta}{t}$
$= \frac{(1)(1)}{2}$

(a) Remains constant (b) Becomes half
(c) Doubles (d) Quadruples

4. A rope is wound round a hollow cylinder of mass 5 kg (m) and radius 0.5 m (r). what is the angular acceleration of the cylinder if the rope is pulled with a force of 20 N? (F)

$\tau = I\alpha$
$\tau = Fr$
$Fr = I\alpha$
$\alpha = \frac{Fr}{I} = \frac{Fr}{mr^2} = \ldots$

(a) 4 rad/s² (b) 5 rad/s²
(c) 6 rad/s² (d) 8 rad/s²

5. The torque acting is 2000Nm with an angular acceleration of 2 rad/s². the moment of inertia of body is

$\tau = I\alpha$
$I = \tau/\alpha$
$= \frac{2000 \text{ Nm}}{2 \text{ rad/s}^2}$

(a) 1200 kgm² (b) 900 kgm²
(c) 1000 kgm² (d) Can't say

6. A wheel rotates with a constant angular acceleration of 2 rad/s². if the wheel start from rest the number of revolutions it makes in the first ten second will be approximately

① $\theta = \cancel{\omega_0 t} + \frac{1}{2}\alpha t^2$
$\frac{1}{2}(2)(10)^2 = 100$ rad
② $100 \text{ rad}\left(\frac{1 \text{ rev}}{2\pi \text{ rad}}\right) = \ldots$

(a) 8 (b) 16
(c) 24 (d) 32

7. A body of M.I. of 5 kg m², rotating with an angular velocity of 6 rad/s, has the same kinetic energy as a mass of 20 kg, moving with a velocity of

(a) 3 m/s (b) 2 m/s
(c) 4 m/s (d) 5 m/s

① $K_R = \frac{1}{2}I\omega^2 = \frac{1}{2}(5)(6)^2 = 90$ J
② $v = \sqrt{\frac{2K}{m}} = \sqrt{\frac{2(90)}{20}} = 3$

8. If a gymnast, sitting on a rotating stool, with his arms outstretched, suddenly lowers his arms

(a) The angular velocity ~~decreases~~ ↓R ↑v
(b) His moment of inertia decreases ↓R ↓I
(c) The angular velocity ~~remains constant~~ angular momentum is con…
(d) The angular momentum increases $L_b = L_a$

9. The M.I. of a body does not depends upon

(a) Angular velocity of a body L
(b) Axis of rotation of the body
(c) The mass of the body
(d) The distribution of the body

10. If I, α and τ are the moment of inertia, angular acceleration and torque respectively of a body rotating about any axis with angular velocity ω, then

(a) $\tau = I\alpha$ (b) $\tau = I\omega$
(c) $I = \tau\omega$ (d) $\alpha = I\omega$

11. Which is the wrong relation from the following?

(a) $\tau = I\,\alpha$ ✓ correct way (b) $F = ma$ ✓
(c) $L = I\,\omega$ ✓ (d) $I = \tau\,\alpha$

12. Constant torque acting on a uniform circular wheel changes it angular momentum from A to 4 A in 4 seconds. The magnitude of this torque is

$\Delta L = \tau\Delta t$
$\tau = \frac{\Delta L}{\Delta t} = \frac{4A - A}{4s}$
$= \frac{3}{4}A$

(a) $\frac{3}{4}$A (b) A
(c) 4 A (d) 12 A

13. The moment of inertia (I) of a body about a given axis is 1.2 kg × metre². Initially, the body is at rest. In order to produce a rotating kinetic energy of 1500 joules, an angular acceleration of 25 (α) radian/sec² must be applied about that axis for a duration of

$\omega_0 = 0$
K_R

(a) 4 sec (b) 2 sec
(c) 8 sec (d) 10 sec

① $\omega = \sqrt{\frac{2K}{I}} = \sqrt{\frac{2(1500)}{1.2}} = 50$ rad/s

② $t = \frac{\Delta\omega}{\alpha} = \frac{50 \text{ rad/s}}{25 \text{ rad/s}^2} = 2$ s

14. A disc of moment of inertia I_1 is rotating with angular velocity ω_1 about an axis perpendicular to its plane and passing through its centre. If another disc of moment of inertia I_2 about the same axis is gently placed over it, then the new angular velocity of the combined disc will be

(a) $\frac{(I_1 + I_2)\omega_1}{I_1}$ (b) $\frac{I_1\omega_1}{I_1 + I_2}$
(c) ω_1 (d) $\frac{I_2\omega_1}{I_1 + I_2}$

$L_0 = L_f$
$I_1\omega_1 = I_f\omega_f$
$I_1\omega_1 = (I_1 + I_2)\omega_f$
$\omega_f = \frac{I_1\omega_1}{I_1 + I_2}$

A solid disk w/ radius R rotates at a constant rate ω. Which of the following points has greater angular displacement?

15. ~~When a torque acting upon a system is zero then the quantity which remains constant is~~
   (a) Force (b) Linear impulse
   (c) Linear momentum (d) Angular momentum

(d) All points have same θ

16. When a steady torque is acting on a body, the body
   (a) Continues in its state of rest or uniform motion along a straight line — no τ_{net} or F_{net}
   (b) ~~Gets linear acceleration~~
   (c) Gets angular acceleration
   (d) Rotates at a ~~constant~~ increasing angular speed

$\tau = I\alpha$ (constant, same, steady)

17. The moment of inertia of a body comes into play
   (a) In motion along a curved path
   (b) In linear motion
   (c) In rotational motion
   (d) None of the above

18. The speed of a homogeneous, solid sphere after rolling down in the inclined plane of vertical height h, from rest without sliding is
   (a) $\sqrt{\left(\frac{10}{7}gh\right)}$ (b) $\sqrt{gh}$
   (c) $\sqrt{\left(\frac{6}{3}gh\right)}$ (d) $\sqrt{\left(\frac{4}{3}gh\right)}$

$E_o = E_f$
$U_g = K + K_r$
$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$
$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{5}mr^2\right)$
$\omega = \frac{v}{r}$ $I = \frac{2}{5}mr^2$
$gh = \frac{7}{10}v^2$
$v = \sqrt{\frac{10}{7}gh}$

19. Two disc with same mass but different radii are moving with same K.E. one of them rolls and other slides without friction. Then
   (a) Rolling disc has greater velocity
   (b) Sliding disc has greater velocity
   (c) Both have same velocity
   (d) The disc with greater radius will have greater velocity.

roll: $K = K_e + K_r = \frac{1}{2}I\omega^2 + \frac{1}{2}mv^2$

slide: $K = K_r = \frac{1}{2}mv^2$ no energy lost to roll

20. A thin circular ring of mass M and radius R is rotating about an axis passing through its centre and perpendicular to its plane with a constant angular velocity ω_1. Two small bodies each of mass m are attached gently to the opposite ends of a diameter of ring. The new angular velocity ω_2 of the ring will be
   (a) $\frac{M + 2m}{M\omega_1}$ (b) $\frac{M\omega_1}{M + 2m}$
   (c) $\frac{\omega_1(M + 2m)}{M}$ (d) $\frac{\omega_1(m + 2M)}{2m}$

$L_o = L_f$
$I\omega = I\omega$
$MR^2\omega = (Mr^2 + mr^2 + mr^2)\omega$
$\frac{M\omega}{M+2m}$

21. A solid sphere, a hollow sphere and a disc are released from the top of a frictionless inclined plane so that they slide down the inclined plane (without rolling). The maximum acceleration down the plane is
   (a) For the solid sphere
   (b) For the hollow sphere
   (c) For the disc
   (d) The same for all bodies

w/o rolling
$\Sigma F = ma$
$F_{g\parallel} = ma$
$\cancel{m}g\sin\theta = \cancel{m}a$

22. The kinetic energy of a body is 4 joule and its moment of inertia is 2 kg m^2 then angular momentum is
   (a) 4 kg m^2/sec (b) 5 kg m^2 /sec
   (c) 6 kg m^2/sec (d) 7 kg m^2/sec

① $\omega = \sqrt{\frac{2K}{I}} = \sqrt{\frac{2(4)}{2}} = 2$

② $L = I\omega = (2)(2) = 4$

23. A disc of radius R rotating about its axis has a moment of inertia I about that axis. When it is rotating about that axis at a constant angular velocity ω a heavy particle of mass m is placed gently at the rim of the disc. The resulting angular velocity of the system is
   (a) ω (b) $I\omega\,(I + mR)$
   (c) $(I + mR)/I\omega$ (d) $I\omega/(I + mR^2)$

$L_o = L_f$
$I\omega = I_{Total}\,\omega_f$
$I\omega = (I + mr^2)\omega_f$
$\omega_f = \frac{I\omega}{I + mr^2}$

24. A sphere (solid) of mass 0.5 kg and diameter 1 m ($r = .5$ m) rolls without sliding with a constant velocity of5 m/s. what is the ratio of the rotational K.E. to the total kinetic energy of the sphere?
   (a) $\frac{7}{10}$ (b) $\frac{5}{7}$
   (c) $\frac{2}{7}$ (d) $\frac{1}{2}$

① $K_r = \frac{1}{2}I\omega^2 = \frac{1}{2}\left(\frac{2}{5}mr^2\right)\omega^2 = \frac{1}{5}mr^2\frac{v^2}{r^2} = \frac{(.5)(5)^2}{5} =$

② $K = \frac{1}{2}mv^2 = \frac{1}{2}(.5)(5)^2 = 6.25$

③ $K_{Tot} = 8.75$ ④ $\frac{K_R}{K_{Tot}} = \frac{2.5}{8.75} = 2/7$

1. A 2. B 3. B 4. D 5. C 6. B 7. A 8. B 9. A 10. A 11. D 12. A 13. B 14. B 15. A 16. C D 17. C 18. A 19. B 20. B 21. D 22. A 23. D 24. C