1. A uniform rod of length 2 m is bent at its midpoint to form an L-shape. Find the distance of the center of mass from the bent corner.

A) 0.5 m
B) 0.71 m
C) 1.0 m
D) 1.41 m

Answer: B) 0.71 m

Explanation:
Each arm is 1 m long. Center of mass of the horizontal part is at (0.5, 0), and vertical part is at (0, 0.5).
Now take average of positions:
$x_{cm} = (0.5 + 0)/2 = 0.25$ m
$y_{cm} = (0 + 0.5)/2 = 0.25$ m
Distance from corner = $\sqrt{(0.5^2 + 0.5^2)} = \sqrt{0.5} = 0.707 \approx 0.71$ m

2. A disc is rolling without slipping on a horizontal surface with velocity v. The velocity of the topmost point of the disc is:

A) v
B) 2v
C) 0
D) v/2

Answer: B) 2v

Explanation:
The topmost point has both rotational velocity (v) and translational velocity (v), in same direction.
So total = v + v = 2v

3. The moment of inertia of a ring of mass M and radius R about one of its diameters is:

A) MR^2
B) $(1/2)MR^2$
C) $(1/4)MR^2$
D) $2MR^2$

Answer: B) $(1/2)MR^2$

Explanation:
I_diameter = (1/2)MR² (from perpendicular axis theorem for a ring)

4. A solid sphere of mass M and radius R rolls without slipping with velocity v. What is the total kinetic energy?

A) (1/2)Mv²
B) (7/10)Mv²
C) (5/6)Mv²
D) Mv²

Answer: B) (7/10)Mv²

Explanation:
Translational KE = (1/2)Mv²
Rotational KE = (1/2)(2/5)MR² × (v²/R²) = (1/5)Mv²
Total KE = (1/2 + 1/5)Mv² = (7/10)Mv²

5. A flywheel of mass 20 kg and radius 0.5 m rotates at 600 rpm. Calculate its rotational kinetic energy.

A) 395 J
B) 790 J
C) 1580 J
D) 3160 J

Answer: C) 1580 J

Explanation:
ω = 600 × 2π / 60 = 20π rad/s
I = (1/2)MR² = (1/2)(20)(0.5)² = 2.5 kg·m²
KE = (1/2)Iω² = (1/2)(2.5)(20π)² = 1.25 × 400π² = 1.25 × 3947 ≈ 1580 J

6. If net external torque acting on a system is zero, then:

A) Linear momentum is conserved
B) Angular momentum is conserved
C) Kinetic energy is conserved

D) Moment of inertia is conserved

Answer: B) Angular momentum is conserved

Explanation:
If torque $\tau = 0$, then $dL/dt = 0 \Rightarrow$ angular momentum L is conserved.

7. Two particles of masses 2 kg and 3 kg are placed at (2, 0) m and (0, 4) m respectively. Find the coordinates of the center of mass.

A) (1.2, 2.4)
B) (0.8, 2.4)
C) (1.5, 2.0)
D) (2.0, 3.0)

Answer: B) (0.8, 2.4)

Explanation:
$x_{cm} = (2\times2 + 3\times0) / (2 + 3) = 4/5 = 0.8$ m
$y_{cm} = (2\times0 + 3\times4) / 5 = 12/5 = 2.4$ m

8. A ring and a disc of same mass and radius roll without slipping with same speed. Which has more kinetic energy?

A) Ring
B) Disc
C) Both same
D) Depends on material

Answer: A) Ring

Explanation:
Total KE = translational + rotational
For disc: $I = (1/2)MR^2 \Rightarrow KE = (1/2 + 1/4)Mv^2 = (3/4)Mv^2$
For ring: $I = MR^2 \Rightarrow KE = (1/2 + 1/2)Mv^2 = Mv^2$
So ring has more total KE

9. Which of the following has the maximum moment of inertia for same mass and radius?

A) Solid sphere
B) Hollow sphere
C) Solid cylinder
D) Thin ring

Answer: D) Thin ring

Explanation:
I_solid sphere = (2/5)MR²
I_hollow sphere = (2/3)MR²
I_cylinder = (1/2)MR²
I_ring = MR² (maximum)

10. A uniform rod of mass M and length L is hinged at one end and released from horizontal position. Find angular velocity when it becomes vertical.

A) √(3g/L)
B) √(2g/L)
C) √(6g/L)
D) √(g/L)

Answer: A) √(3g/L)

Explanation:
Initial PE = MgL/2
Final KE = (1/2)Iω² = (1/2)(1/3)ML²ω² = (1/6)ML²ω²
So MgL/2 = (1/6)ML²ω² ⇒ ω² = 3g/L ⇒ ω = √(3g/L)

11. A particle of mass 2 kg is moving in a circle of radius 1 m with an angular speed of 4 rad/s. What is its angular momentum about the center?

A) 2 kg·m²/s
B) 4 kg·m²/s
C) 8 kg·m²/s
D) 16 kg·m²/s

Answer: C) 8 kg·m²/s

Explanation:
$L = mvr = m(r\omega)r = mr^2\omega$
$= 2 \times (1)^2 \times 4 = 8\ kg \cdot m^2/s$

12. The moment of inertia of a solid cylinder of mass M and radius R about its axis is:

A) MR^2
B) $(1/2)MR^2$
C) $(1/3)MR^2$
D) $(2/5)MR^2$

Answer: B) $(1/2)MR^2$

Explanation:
Standard formula for solid cylinder about its own axis: $I = (1/2)MR^2$

13. A uniform disc is rotated about its diameter. What is its moment of inertia about that diameter?

A) $(1/2)MR^2$
B) $(1/4)MR^2$
C) $(1/8)MR^2$
D) $(3/8)MR^2$

Answer: B) $(1/4)MR^2$

Explanation:
I_z (about axis perpendicular to plane) $= (1/2)MR^2$
By perpendicular axis theorem:
$I_x + I_y = I_z \Rightarrow I_{diameter} = (1/4)MR^2$

14. A solid sphere rolls down an inclined plane without slipping. What is its acceleration along the incline?

A) $(2/3)g \sin\theta$
B) $(5/7)g \sin\theta$
C) $g \sin\theta$
D) $(1/2)g \sin\theta$

Answer: B) $(5/7)g \sin\theta$

Explanation:
For rolling object:
$a = [g \sin\theta] / [1 + (I/mR^2)]$
For solid sphere: $I = (2/5)MR^2$
So $a = g \sin\theta / (1 + 2/5) = g \sin\theta / (7/5) = (5/7)g \sin\theta$

15. If a torque of 6 N·m acts on a body for 4 seconds, and its initial angular momentum was 8 kg·m²/s, what is its final angular momentum?

A) 8 kg·m²/s
B) 14 kg·m²/s
C) 24 kg·m²/s
D) 32 kg·m²/s

Answer: C) 24 kg·m²/s

Explanation:
$\tau = dL/dt \Rightarrow \Delta L = \tau \times t = 6 \times 4 = 24$
Final L = Initial + ΔL = 8 + 16 = 24 kg·m²/s

16. A disc rotates at 120 rpm. What is its angular speed in rad/s?

A) 2π rad/s
B) 4π rad/s
C) 8π rad/s
D) 6π rad/s

Answer: D) 4π rad/s

Explanation:
$\omega = (2\pi \times N)/60 = (2\pi \times 120)/60 = 4\pi$ rad/s

17. Two discs of same mass and radius roll without slipping. One is hollow and the other is solid. Which reaches the bottom of incline first?

A) Both together
B) Solid disc

C) Hollow disc
D) Cannot be determined

Answer: B) Solid disc

Explanation:
$a = g \sin\theta / [1 + (I/mR^2)]$
For solid disc: $I = (1/2)MR^2 \Rightarrow a = (2/3)g \sin\theta$
For hollow disc: $I = MR^2 \Rightarrow a = (1/2)g \sin\theta$
Solid disc has higher acceleration ⇒ reaches first

18. The torque required to produce an angular acceleration of 4 rad/s² in a disc of mass 2 kg and radius 0.5 m is:

A) 0.5 N·m
B) 1 N·m
C) 2 N·m
D) 4 N·m

Answer: B) 1 N·m

Explanation:
$I = (1/2)MR^2 = (1/2)(2)(0.5)^2 = 0.25$
$\tau = I \times \alpha = 0.25 \times 4 = 1$ N·m

19. A particle of mass 1 kg is moving with speed 3 m/s at a distance 2 m from a point. What is the magnitude of its angular momentum about that point? (Motion is perpendicular)

A) 3 kg·m²/s
B) 6 kg·m²/s
C) 9 kg·m²/s
D) 12 kg·m²/s

Answer: C) 6 kg·m²/s

Explanation:
$L = mvr \sin\theta = 1 \times 3 \times 2 \times 1 = 6$ kg·m²/s (since $\theta = 90° \Rightarrow \sin\theta = 1$)

20. A disc of radius R is rolling without slipping. What is the velocity of the point of contact with the ground?

A) v
B) 0
C) v/2
D) 2v

Answer: B) 0

Explanation:
At the point of contact, rotational velocity is equal and opposite to translational velocity ⇒ Net velocity = 0

21. A body of moment of inertia 4 kg·m² is rotating with angular velocity 2 rad/s. What is its rotational kinetic energy?

A) 4 J
B) 8 J
C) 12 J
D) 16 J

Answer: B) 8J

Explanation:
Rotational KE = (1/2) I ω²
= (1/2) × 4 × (2)² = 0.5 × 4 × 4 = 8 J
Correct Answer: B) 8 J

22. A uniform rod of length L is rotated about an axis perpendicular to its length and passing through one end. What is its moment of inertia?

A) (1/2)ML²
B) (1/3)ML²
C) (1/4)ML²
D) (1/12)ML²

Answer: B) (1/3)ML²

Explanation:
For a uniform rod about one end:

$I = (1/3)ML^2$

23. A torque of 5 N·m is applied to a wheel of moment of inertia 2 kg·m². What is the angular acceleration produced?

A) 10 rad/s²
B) 5 rad/s²
C) 2.5 rad/s²
D) 0.4 rad/s²

Answer: C) 2.5 rad/s²

Explanation:
$\alpha = \tau / I = 5 / 2 = 2.5$ rad/s²

24. A disc rotates freely about its axis. A boy moves from the rim to the center. What happens to the angular velocity? (Assume no external torque)

A) Increases
B) Decreases
C) Remains the same
D) Becomes zero

Answer: A) Increases

Explanation:
Angular momentum is conserved: $I_1\omega_1 = I_2\omega_2$
Since moment of inertia decreases when boy moves inward, ω must increase.

25. A disc is rotating with angular velocity ω. If its radius is doubled keeping mass the same, how does the moment of inertia change?

A) Becomes twice
B) Becomes four times
C) Becomes half
D) Remains same

Answer: B) Becomes four times

Explanation:
Moment of inertia for disc: $I = (1/2)MR^2$
If $R \rightarrow 2R$, then $I \propto R^2 \Rightarrow$ New $I = (1/2)M(2R)^2 = 4 \times$ old I

26. A rod of length 2 m lies along the x-axis with one end at the origin. What is the x-coordinate of its center of mass?

A) 0 m
B) 1 m
C) 2 m
D) 0.5 m

Answer: B) 1 m

Explanation:
$x_{cm} = (0 + 2)/2 = 1$ m

27. A wheel of radius 0.5 m is rotating such that a point on its rim has a linear speed of 2 m/s. What is its angular speed?

A) 1 rad/s
B) 2 rad/s
C) 3 rad/s
D) 4 rad/s

Answer: D) 4 rad/s

Explanation:
$v = r\omega \Rightarrow \omega = v / r = 2 / 0.5 = 4$ rad/s

28. A circular ring has moment of inertia MR^2 about its axis. What is its moment of inertia about a diameter?

A) MR^2
B) $(1/2)MR^2$
C) $(1/4)MR^2$
D) $2MR^2$

Answer: B) $(1/2)MR^2$

Explanation:
Using perpendicular axis theorem:
$I_x + I_y = I_z \Rightarrow 2I_{diameter} = MR^2 \Rightarrow I_{diameter} = (1/2)MR^2$

29. A disc rotates at 300 rpm. How many radians does it rotate in 2 seconds?

A) 20π rad
B) 40π rad
C) 60π rad
D) 100π rad

Answer: B) 40π rad

Explanation:
$\omega = 2\pi \times (300/60) = 10\pi$ rad/s
$\theta = \omega \times t = 10\pi \times 2 = 20\pi$ rad
Correct Answer: A) 20π rad
(Previous options mismatched — corrected here.)

30. A wheel starts from rest and has angular acceleration of 2 rad/s². What is its angular velocity after 5 seconds?

A) 2 rad/s
B) 5 rad/s
C) 10 rad/s
D) 20 rad/s

Answer: C) 10 rad/s

Explanation:
$\omega = \omega_0 + \alpha t = 0 + 2 \times 5 = 10$ rad/s

31. A disc and a ring, both of same mass and radius, are released from the top of an inclined plane. Which one reaches the bottom first?

A) Ring

B) Disc
C) Both reach together
D) Cannot be determined

Answer: B) Disc

Explanation:
Acceleration $a = g \sin\theta / (1 + I/mR^2)$
For disc: $I = (1/2)MR^2 \rightarrow a = g \sin\theta / (3/2)$
For ring: $I = MR^2 \rightarrow a = g \sin\theta / 2$
Since disc has higher acceleration, it reaches first.

32. A non-uniform rod of length L has mass per unit length $\lambda = \lambda_o x$, where x is measured from one end. What is the center of mass from that end?

A) L/2
B) 2L/3
C) L/3
D) 3L/4

Answer: B) 2L/3

Explanation:
$x_{cm} = \int x \lambda(x)\, dx / \int \lambda(x)\, dx = \int_o^L x(\lambda_o x)\, dx / \int_o^L \lambda_o x\, dx = \lambda_o \int_o^L x^2\, dx / \lambda_o \int_o^L x\, dx$
$= [x^3/3] / [x^2/2] = (L^3/3)/(L^2/2) = 2L/3$

33. A force F acts tangentially on the rim of a disc of radius R. What is the torque about its center?

A) FR
B) F/R
C) F + R
D) Zero

Answer: A) FR

Explanation:
Torque $\tau = r \times F = FR$ (since angle = 90°)

34. If the net external force on a system is zero, what quantity remains conserved?

A) Angular velocity
B) Angular momentum
C) Linear momentum
D) Kinetic energy

Answer: C) Linear momentum

Explanation:
When net force = 0 → linear momentum is conserved
Net torque = 0 → angular momentum is conserved

35. A rod is pivoted at its center and a force F is applied at one end perpendicular to its length. What is the torque about the center? (Rod length = L)

A) FL
B) FL/2
C) 2FL
D) F/L

Answer: B) FL/2

Explanation:
Torque = force × perpendicular distance = F × (L/2)

36. A body is rotating with angular velocity ω. Its angular momentum is halved without external torque. What happens to its moment of inertia?

A) Doubled
B) Remains same
C) Halved
D) Becomes zero

Answer: C) Halved

Explanation:
L = Iω. If L is halved and ω is constant, I must be halved.

37. A wheel of moment of inertia I is rotating with angular velocity ω. If a constant torque τ is applied, what is the angular acceleration?

A) τ/I
B) I/τ
C) τ/ω
D) ω/τ

Answer: A) τ/I

Explanation:
α = τ/I by definition of torque

38. A solid sphere and a hollow sphere are allowed to roll down the same incline. Which one reaches the bottom first and why?

A) Solid sphere, due to lower moment of inertia
B) Hollow sphere, due to higher inertia
C) Both together
D) Cannot be said

Answer: A) Solid sphere, due to lower moment of inertia

Explanation:
Solid sphere: $I = (2/5)MR^2$
Hollow sphere: $I = (2/3)MR^2$
Higher I ⇒ lower acceleration ⇒ takes longer time
So solid sphere reaches first.

39. A uniform disc of radius R is rolling without slipping with velocity v. What is the angular velocity?

A) v/R
B) R/v
C) v × R
D) v^2/R

Answer: A) v/R

Explanation:
For pure rolling: $v = R\omega \Rightarrow \omega = v/R$

40. A constant torque is applied to a rotating body. What happens to its angular velocity with time?

A) Remains constant
B) Increases linearly
C) Decreases
D) Becomes zero

Answer: B) Increases linearly

Explanation:
$\tau = I\alpha \Rightarrow$ constant α
$\omega = \omega_0 + \alpha t \Rightarrow$ angular velocity increases linearly

41. A hoop and a disc are released simultaneously from the top of a smooth incline. Which will have more rotational kinetic energy at the bottom?

A) Hoop
B) Disc
C) Both equal
D) Depends on mass

Answer: A) Hoop

Explanation:
Total KE = Translational + Rotational
Hoop has greater moment of inertia, so more rotational KE and less translational
But question asks about rotational KE $\Rightarrow$ hoop has more

42. A particle moves in a circle with constant speed. Which quantity is not constant?

A) Angular speed
B) Linear speed
C) Angular momentum
D) Centripetal force

Answer: D) Centripetal force

Explanation:
Centripetal force direction changes continuously ⇒ not constant

43. A disc rotating with angular speed ω has kinetic energy K. What is its moment of inertia?

A) $2K/\omega^2$
B) K/ω^2
C) $K/2\omega^2$
D) $\sqrt{(K/\omega^2)}$

Answer: A) $2K/\omega^2$

Explanation:
$K = (1/2)I\omega^2 \Rightarrow I = 2K/\omega^2$

44. A bullet hits and gets embedded in a stationary wooden disc at the edge. What is conserved in the system?

A) Angular momentum
B) Linear momentum
C) Kinetic energy
D) All three

Answer: A) Angular momentum

Explanation:
Collision is inelastic ⇒ KE not conserved
Force is internal ⇒ angular momentum is conserved about center

45. A uniform rod is placed horizontally and is free to rotate about one end. It is released from rest. What is its angular acceleration initially? (Rod length = L)

A) g/L
B) 2g/L
C) 3g/2L
D) 3g/L

Answer: C) 3g/2L

Explanation:
Torque $\tau = MgL/2$ (weight acts at center)
$I = (1/3)ML^2$
$\alpha = \tau/I = (MgL/2) / (1/3)ML^2 = (3g)/(2L)$