socrative by MasteryConnect

AP Physics 1 - Test 09 - Rotational Dynamics

Score:

1. One revolution is the same as

- (A) 1 rad
- (B) 57 rad
- (C) pi/2 rad
- (D) pi rad
- (E) 2*pi rad

2. One revolution per minute is about

- (A) 0.0524 rad/s
- (B) 0.105 rad/s
- (C) 0.95 rad/s
- (D) 1.57 rad/s
- (E) 6.28 rad/s

1 rev = 2π rad

1 min = 60 sec

$\frac{1\ rev}{1\ min} \cdot \frac{2\pi\ rad}{1\ rev} \cdot \frac{1\ min}{60\ sec}$

$1\ \frac{rev}{min} = 0.104\ \frac{rad}{sec}$

3. If a wheel turns with constant angular speed then

- (A) each point on its rim moves with constant velocity
- (B) each point on its rim moves with constant acceleration
- (C) the wheel turns through equal angles in equal times
- (D) the angle through which the wheel turns in each second increases as time goes on
- (E) the angle through which the wheel turns in each second decreases as time goes on

4. The angular speed of the second hand of a watch is

- (A) (π/1800) rad/s
- (B) (π/60) rad/s
- (C) (π/30) rad/s
- (D) (2π) rad/s
- (E) (60) rad/s

the second hand make 1 revolution every minute

$\frac{1\ rev}{1\ min} \cdot \frac{2\pi\ rad}{1\ rev} \cdot \frac{1\ min}{60\ sec} = \frac{\pi}{30} = 0.104$

5. Ten seconds after an electric fan is turned on, the fan rotates at 300 rev/min. Its average angular acceleration is

- (A) 3.14 rad/s^2
- (B) 30 rad/s^2
- (C) 30 rev/s^2
- (D) 50 rev/min^2
- (E) 1800 rev/s^2

$\to \times \frac{2\pi}{60} = 31.4\ \frac{rad}{s}$

$\alpha = \frac{\Delta\omega}{t} = \frac{31.4}{10} = 3.14\ rad/s^2$

6. Three identical balls are tied by light strings to the same rod and rotate around it, as shown above. Rank the balls according to their rotational inertia, least to greatest.

(A) 1, 2, 3

(B) 3, 2, 1

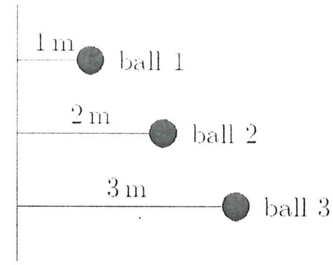
(C) 3, then 1 and 2 tie

(D) 1, 3, 2

(E) All are the same

$I = \Sigma M R^2$

bigger radius → bigger inertia



7. The rotational inertia of a wheel about its axle does not depend upon its

(A) diameter

(B) mass

(C) distribution of mass

(D) speed of rotation

$I = \Sigma M R^2$

no "ω" in the equation

8. To increase the rotational inertia of a solid disk about its axis without changing its mass

(A) drill holes near the rim and put the material near the axis

(B) drill holes near the axis and put the material near the rim

(C) drill holes at points on a circle near the rim and put the material at points between the holes

(D) drill holes at points on a circle near the axis and put the material at points between the holes

(E) do none of the above (the rotational inertia cannot be changed without changing the mass)

Moving the mass outward increases inertia ; $I = \Sigma M R^2$ ↑ becomes bigger

9. The rotational inertia of a disk about its axis is 0.70 kg $\cdot m^2$. When a 2.0 kg weight is added to its rim, 0.40 m from the axis, the rotational inertia becomes:

(A) 0.38 kg $\cdot$ m^2

(B) 0.54 kg $\cdot$ m^2

(C) 0.70 kg $\cdot$ m^2

(D) 0.86 kg $\cdot$ m^2

(E) 1.00 kg $\cdot$ m^2

$I_{disk} = 0.7$

$I_{mass} = MR^2 = (2)(0.4)^2 = 0.32$

$I_{total} = I_{disk} + I_{mass} = 1.02$

10. A rod is pivoted about its center. A 5-N force is applied 4m from the pivot and another 5-N force is applied 2m from the pivot, as shown. The magnitude of the total torque about the pivot (in N·m) is:

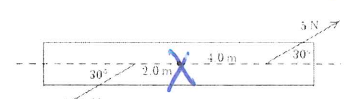
(A) 0

(B) 5

(C) 8.7

(D) 15

(E) 26



$\tau_1 = -(4)(5)\sin 30 = -10$

$\tau_2 = -(2)(5)\sin 30 = -5$

Clockwise & Clockwise

total = -15

11. A disk is free to rotate on a fixed axis. A force of given magnitude F, in the plane of the disk, is to be applied. Of the following alternatives the greatest angular acceleration is obtained if the force is:

(A) applied tangentially halfway between the axis and the rim

(B) applied tangentially at the rim

(C) applied radially halfway between the axis and the rim

(D) applied radially at the rim

(E) applied at the rim but neither radially nor tangentially

12. A cylinder is 0.10m in radius and 0.20m in length. Its rotational inertia, about the cylinder axis on which it is mounted, is 0.020 kg ·m^2. A string is wound around the cylinder and pulled with a force of 1.0N. 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

$\Sigma \tau = r F \sin\theta = I\alpha$

$(0.1)(1)(1) = (0.02)\alpha$

$\alpha = \frac{0.1}{0.02} = 5$

13. A 16-kg block is attached to a cord that is wrapped around the rim of a flywheel of diameter 0.40m and hangs vertically, as shown. The rotational inertia of the flywheel is 0.50 kg · m^2. When the block is released and the cord unwinds, the acceleration of the block (in multiples of g) is:

(A) 0.15g

(B) 0.56g

(C) 0.84g

(D) g

(E) 1.3g

$\Sigma \tau = r F_T \sin(90) = I\alpha$, $\frac{a}{r} = \alpha$

$F_T = \frac{I\alpha}{r} = \frac{Ia}{r^2} = \frac{(0.5)a}{0.2^2} = 12.5a$

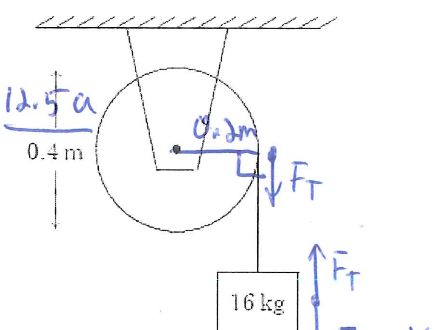
$\Sigma F = mg - F_T = ma$

$F_T = mg - ma = 160 - 16a$

Set equal: $160 - 16a = 12.5a$

$160 = 28.5a$

$a = 5.61\ m/s^2 = 0.561g$



14. A wheel of radius 0.5m rolls without sliding on a horizontal surface as shown. Starting from rest, the wheel moves with constant angular acceleration 6 rad/s^2. The distance traveled by the center of the wheel from t = 0 to t = 3 s is: NOTE: Convert angular acceleration to linear acceleration first

(A) zero

(B) 27 m

(C) 13.5 m

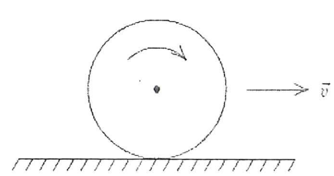
(D) 18 m

(E) none of these

$\omega_0 = 0$, $\alpha = 6$, $t = 3$, $\Delta\theta = ?$

$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2 = \frac{1}{2}(6)(3)^2$

$\Delta\theta = 27$ rads



$S = \theta \cdot r$

$S = (27)(0.5)$

$S = 13.5$ m

15. A net torque applied to a rigid object always tends to produce

- (A) linear acceleration
- (B) rotational equilibrium
- (C) angular acceleration
- (D) rotational inertia
- (E) none of these

just like a net Force makes something accelerate

16. The conditions that the net force and the net torque both vanish:

- (A) hold for every body in static equilibrium
- (B) hold only for elastic bodies in equilibrium
- (C) hold for every body
- (D) are always sufficient to calculate the forces on a solid object in equilibrium
- (E) are sufficient to calculate the forces on a solid object in equilibrium only if the object is elastic

$\Sigma F = 0$

$\Sigma \tau = 0$

equilibrium

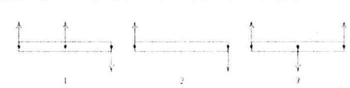
17. For a body to be in equilibrium under the combined action of several forces:

- (A) all the forces must be applied at the same point
- (B) all of the forces form pairs of equal and opposite forces
- (C) the sum of the components of all the forces in any direction must equal zero
- (D) any two of these forces must be balanced by a third force
- (E) the lines of action of all the forces must pass through the center of gravity of the body

18. For a body to be in equilibrium under the combined action of several forces

- (A) all the forces must be applied at the same point
- (B) all of the forces form pairs of equal and opposite forces
- (C) any two of these forces must be balanced by a third force
- (D) the sum of the torques about any point must equal zero
- (E) the lines of action of all the forces must pass through the center of gravity of the body

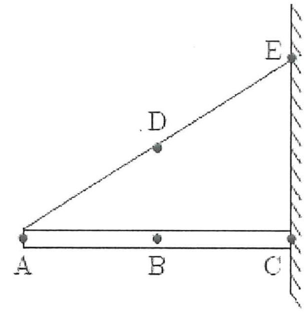
19. Three identical uniform rods are each acted on by two or more forces, all perpendicular to the rods and all equal in magnitude. Which of the rods could be in static equilibrium if an additional force is applied at the center of mass of the rod?



- (A) Only 1
- (B) Only 2
- (C) Only 3
- (D) Only 1 and 2
- (E) All three

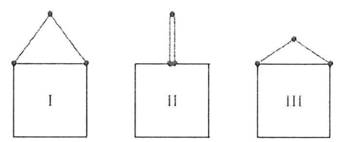
20. Which Point would be best in designating as the point of rotation?

- (A) A
- (B) B
- (C) C
- (D) D
- (E) E



21. A picture can be hung on a wall with string in three different ways, as shown. The magnitude of the tension force of the string is:

- (A) least in I
- (B) greatest in I
- (C) greatest in II
- (D) least in III
- (E) greatest in III

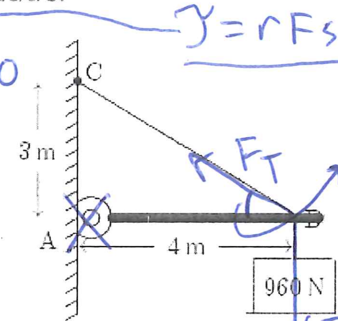


22. A 960-N block is suspended as shown. The beam AB is weightless and is hinged to the wall at A. The tension force of the cable BC has magnitude:

- (A) 720 N
- (B) 1200 N
- (C) 1280 N
- (D) 1600 N
- (E) None of these

$\Sigma \tau = (4) F_T \sin(36.9) - (4)(960) = 0$ $\quad \tau = rF\sin\theta$

$F_T = 1600 N$



$\theta = \tan^{-1}(\frac{3}{4}) = 36.9°$

$F_y = 960$

23. A thin-walled hollow tube rolls without sliding along the floor. The ratio of its translational kinetic energy to its rotational kinetic energy (about an axis through its center of mass) is:

- (A) 1
- (B) 2
- (C) 3
- (D) 1/2
- (E) 1/3

Hollow tube: $I = MR^2$ $\quad \omega = \frac{v}{r}$

rotational energy: $K = \frac{1}{2}I\omega^2 = \frac{1}{2}(MR^2)(\frac{v}{R})^2 = \frac{1}{2}Mv^2$

translational energy: $K = \frac{1}{2}mv^2$

same energy

this would be different for a solid cylinder, since $I = \frac{1}{2}MR^2$ for that

24. A sphere and a cylinder of equal mass and radius are simultaneously released from rest on the same inclined plane and roll without sliding down the incline. Then:

(A) the sphere reaches the bottom first because it has the greater inertia

(B) the cylinder reaches the bottom first because it picks up more rotational energy

(C) the sphere reaches the bottom first because it picks up more rotational energy

(D) they reach the bottom together

(E) none of the above are true

25. A hoop, a uniform disk, and a uniform sphere, all with the same mass and outer radius, start with the same speed and roll without sliding up identical inclines. Rank the objects according to how high they go, least to greatest.

$K = \frac{1}{2} I \omega^2$

(A) hoop, disk, sphere

(B) disk, hoop, sphere

(C) sphere, hoop, disk

(D) sphere, disk, hoop

(E) hoop, sphere, disk

$I_{hoop} = MR^2$ → most inertia so most energy → greater final height

$I_{disk} = \frac{1}{2} MR^2$

$I_{sphere} = \frac{2}{5} MR^2$ → least inertia → least energy → smallest height.

26. A hoop rolls with constant velocity and without sliding along level ground. Its rotational kinetic energy is:

Look at # 23

(A) half its translational kinetic energy

(B) the same as its translational kinetic energy

(C) twice its translational kinetic energy

(D) four times its translational kinetic energy

(E) one-third its translational kinetic energy

27. The fundamental dimensions of angular momentum are:

(A) mass·length·time^−1

(B) mass·length^−2·time^−2

(C) mass^2·time^−1

(D) mass·length^2·time^−2

(E) none of these

$L = I \omega$; I: $kg \cdot m^2$, ω: $\frac{rad}{s}$ → $\frac{kg \cdot m^2}{s}$

28. Possible units of angular momentum are:

(A) kg·m/s

(B) kg·m2/s2

(C) kg·m/s2

(D) kg·m2/s

(E) none of these

29. The newton·second is a unit of:

(A) work

(B) angular momentum

(C) power

(D) linear momentum

(E) none of these

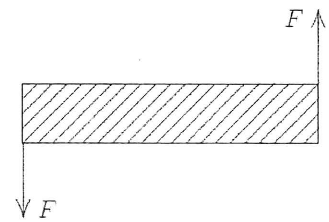
$\Delta P = F \Delta t$

30. A rod rests on frictionless ice. Forces that are equal in magnitude and opposite in direction are then simultaneously applied to its ends as shown. The quantity that is zero is its:

$\Delta P = F \Delta t$

net force is zero

but torque is Clockwise.



(A) angular momentum

(B) angular acceleration

(C) total linear momentum

(D) kinetic energy

(E) rotational inertia

31. A 2.0-kg stone is tied to a 0.50-m long string and swung around a circle at a constant angular velocity of 12 rad/s. The net torque on the stone about the center of the circle is:

(A) 0

(B) $6.0 N \cdot m$

(C) $12 N \cdot m$

(D) $72 N \cdot m$

(E) $140 N \cdot m$

Constant velocity means no acceleration and thus no net torquy

32. A man, with his arms at his sides, is spinning on a light frictionless turntable. When he extends his arms:

(A) his angular velocity increases

(B) his angular velocity remains the same

(C) his rotational inertia decreases

(D) his rotational kinetic energy increases

(E) his angular momentum remains the same

Inertia increases

speed decreases

momentum constant

33. A machine part is made up of two pieces, with centers of gravity shown in the Figure. Which point could the center of gravity of the entire part?

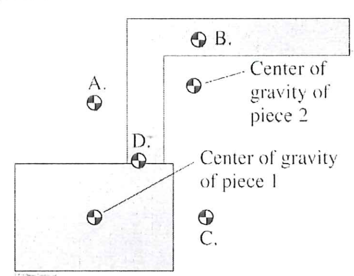
(A) A

(B) B

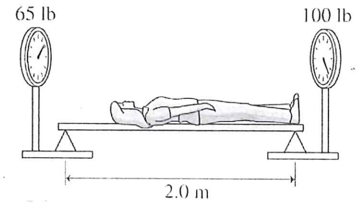
(C) C

(D) D

between the other two centers of gravity.



34. A student lies on a weightless board atop two scales as shown in the figure. What is the student's weight?



- (A) 65 lbs
- (B) 75 lbs
- (C) 100 lbs
- (D) 165 lbs

35. A father (mass 2□) and his son (mass □) begin walking towards opposite ends of a balanced see-saw. As they walk, the see-saw stays exactly horizontal. How do their speeds compare?

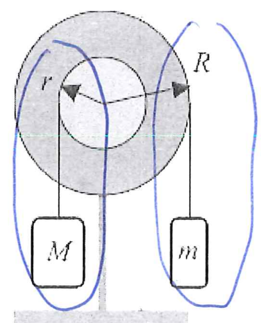
- (A) $v_{son} = 2v_{father}$
- (B) $v_{son} = 4v_{father}$
- (C) $v_{son} = 2v_{father}$
- (D) $2v_{son} = v_{father}$

36. Due to Mr. Hart's teacher salary, he is required to obtain a job over the summer pushing children on a merry-go round. In order to make the job easier, Mr. Hart should

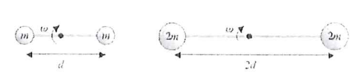
- (A) Place all the children on the outer edge of the circle, spread out evenly
- (B) Place all the children on the outer edge, concentrated on one side
- (C) Place all the children in a line going through the diameter of the circle.
- (D) Place the children in the center of the circle.

37. The pulley system consists of two solid disks of different radii fastened together coaxially, with two different masses connected to the pulleys as shown. Under what condition will this pulley system be in static equilibrium?

- (A) $rm=RM$
- (B) $r^2m=R^2M$
- (C) $rM=Rm$
- (D) $r^2M=R^2m$

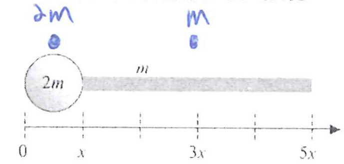


38. A dumbbell consists of two masses m connected by a rigid rod of negligible mass and length d. A physics student takes the dumbbell and rotated it about its center of mass with an angular velocity ω, giving it an angular momentum L_1. The student then takes a second dumbbell, with masses 2m and length 2d, and rotates them with the same angular velocity ω. What is the angular momentum L_2 of this second dumbbell?



- (A) $2L_1$
- (B) $4L_1$
- (C) $6L_1$
- (D) $8L_1$

39. A solid sphere of diameter x and mass 2m is fastened to a long thin rod of length 4x and mass m as shown. Where is the location of the center of mass of this system?



- (A) x
- (B) 4x/3
- (C) 3x/2
- (D) 5x/3

$$x_{cg} = \frac{2m(\frac{1}{2}x) + m(3x)}{2m + m}$$

$$= \frac{mx + 3mx}{3m}$$

$$= \frac{4mx}{3m} = \frac{4}{3}x$$