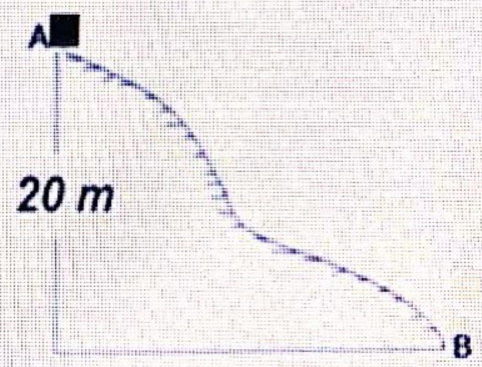
A 50-kg object slides from rest from point A on the rough track (المسار الخشن) shown in the adjacent figure. If the speed of the particle at point B is 6 m/s. The work (in Joules) done by frictional forces is:

A. −7300
B. +7300
C. −8200
D. +8200
E. −8900



*Take $g = 9.8\ m/s^2$

A

$\boxed{1})$

$$E_1 + W_{fk} = E_2$$

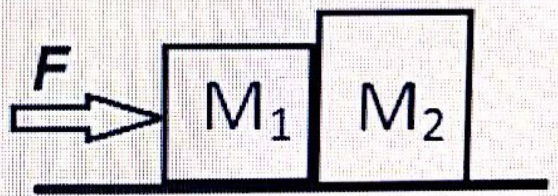
$$mgh + W_{fk} = \frac{1}{2}mv^2$$

$$W_{fk} = \frac{1}{2}(50)(6)^2 - 50(9.8)(20)$$

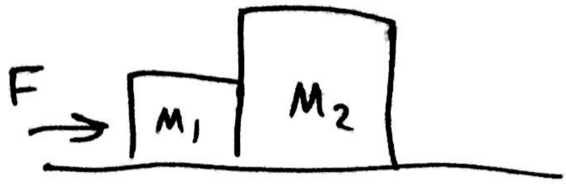
$$= -8900 \rightarrow E$$

Two blocks $M_1 = 3$ kg and $M_2 = 5$ kg are in contact with each other on a frictionless, horizontal surface, as shown in the adjacent figure. If a horizontal force $F = 20$ N is applied to M_1, the magnitude (in N) of the contact force between the two blocks is:

A. Zero
B. 2
C. 4
D. 10
E. 12.5



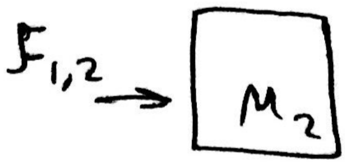
2



$$\Sigma F = ma$$

$$F = (M_1 + M_2)a$$

$$20 = 8a \Rightarrow a = 2.5 \, m/s^2$$



$$F_{1,2} = M_2 a$$

$$= 5(2.5) = \boxed{12.5 N} \rightarrow E$$

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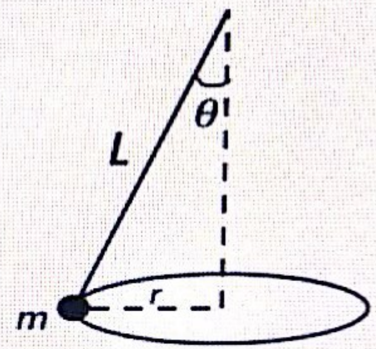
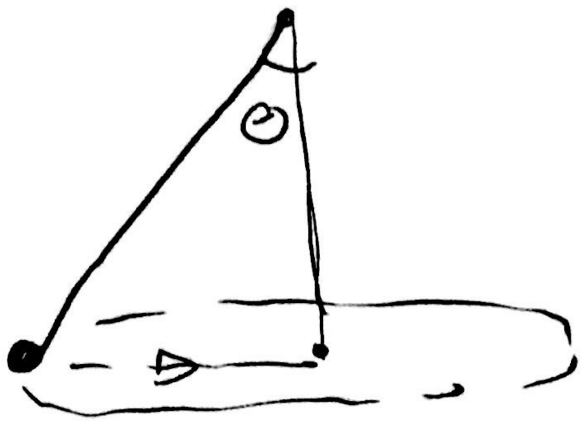
A small ball of mass m is suspended from a string (خيط) of length L. The ball revolves (تدور) with constant speed v in the horizontal circle of radius r as shown in the adjacent figure. If the string makes an angle $\theta = 10^0$ with the vertical direction, the magnitude of the centripetal acceleration of the ball (in m/s^2) is:

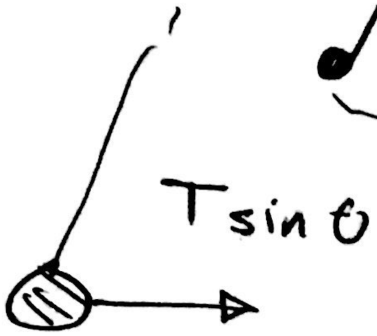
A. 1.73
B. 3.57
C. 4.06
D. 5.66
E. 9.80



*Take g= 9.8 m/s²

A
B
C





$$T = \frac{mg}{\cos\theta}$$

$$T\sin\theta = m a_r$$

$$\frac{mg\sin\theta}{\cos\theta} = m a_r$$

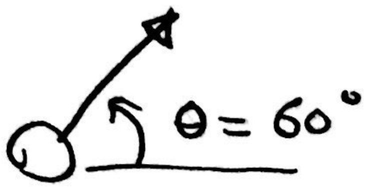
$$\cancel{m}g\tan\theta = \cancel{m}a_r \Rightarrow a_r = g\tan\theta$$
$$= 9.8\tan(10)$$
$$= \underline{\underline{1.73}}\ \text{m/s}^2 - \text{A}$$

A ball is fired (أطلقت) with an initial velocity of 30 m/s that makes an angle of 60^0 above the horizontal direction. The speed (in m/s) of the ball after 1 sec of its launch is:

A. 16.3
B. 18.8
C. 26.3
D. 22.1
E. Zero

③

$v_i = 30 m/s$



$V_x = 30 \cos 60 = 15 m/s$

$V_{y1} = 30 \sin 60 = 26 m/s$

$V_{y_2} = V_{y_1} + gt$

$= 26 - 9.8(1) = 16.2 m/s$

$V_x = 15 m/s$

$V_2 = \sqrt{(16.2)^2 + (15)^2} = 22 m/s \longrightarrow$ D

9

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In a collision, a 1200 kg car initially moving at 30 m/s comes to a stop in 0.5 second. The magnitude of the average force (in kN) on the car during the crash is:

A. 72
B. 80
C. 90
D. 94
E. 102

(5) $I = \Delta P = m(v_2 - v_1) = 1200(30-0)$

$= 36000 \ kg.m/s$

$F_{avg} = \frac{I}{\Delta t} = \frac{36000}{0.5} = 72 \ kN \rightarrow$ (a) t of

A 2 kg particle moves in a circle of radius 3 m. Its angular momentum relative to the circle's center depends on time (t) as L(t) = 4t, where t is measured in sec and L is measured in kg.m^2/s. The magnitude of the particle's angular acceleration (measured in rad/s^2) at t = 1 sec is:

A. 0.31
B. 0.22
C. 0.65
D. 0.11
E. 0.17

A

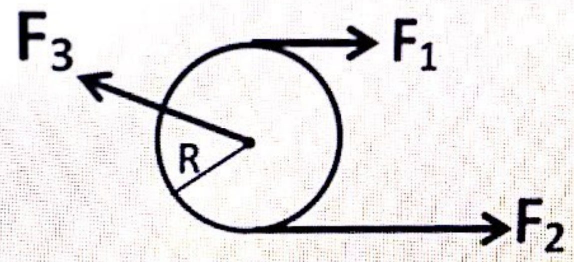
(6) $\tau = \frac{dL}{dt} = \frac{d}{dt}(4t) = 4 \text{ N.m}$

$I = mr^2 = 2(3)^2 = 18 \text{ kg.m}$

$\tau = I\alpha \Rightarrow \alpha = \frac{4}{18} = 0.22 \rightarrow$ (B)

A <u>wheel</u> (عجلة) of radius $R = 1.5$ m is acted upon by three forces $F_1 = 10$ N, $F_2 = 20$ N, and $F_3 = 15$ N as shown in the adjacent figure. If F_1 and F_2 act <u>tangentially</u> (بشكل مماسي), the <u>*magnitude*</u> of the net torque (in N.m) acting on the wheel about an axis that is <u>perpendicular</u> (عمودي) on the plane of the wheel and passes through its center is:

A. Zero
B. 10
C. 15
D. 20
E. 25



(7) $\tau_1 = F_1 r \sin\theta$

$= 10(1.5)\sin(-90)$

$= -15$ N.m

$\tau_2 = F_2 r \sin\theta$

$= 20(1.5)\sin(90)$

$= 30$ N.m

$\tau_3 = 0$

$\tau = \tau_1 + \tau_2 + \tau_3$

$= 15$ N.m $\rightarrow$ (C)

6

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A 0.004 kg bullet moving with a speed V strikes a 0.6-kg block initially at rest. The bullet rests in the block and then the block, with the bullet inside, moves on a rough (خشن) horizontal surface (coefficient of kinetic friction = 0.4) a distance of 6 m before it comes to a stop. The bullet's initial speed V (in m/s) is:

A. 96
B. 1196
C. 286
D. 1036
E. 846

A

(3)

1|

2|

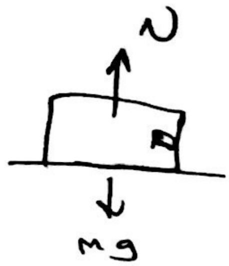
بعد التصادم

$E_1 = E_2$

$\frac{1}{2}MV_2^2 + W_{f_k} = 0$

$W_{f_k} = f_k d$

$f_k = N\mu_k$



$N = (m+M)g$

$= 0.604(9.8) = \underline{\underline{5.9\ N}}$

$f_k = 5.9(0.4) = 2.36\ N$

$W_{f_k} = -(2.36)(6) = -14.16\ J$

$\frac{1}{2}MV_2^2 = -W_{f_k}$

$(V_2) = \sqrt{\frac{2 * -(-14.16)}{0.604}} = 6.84\ m/s$

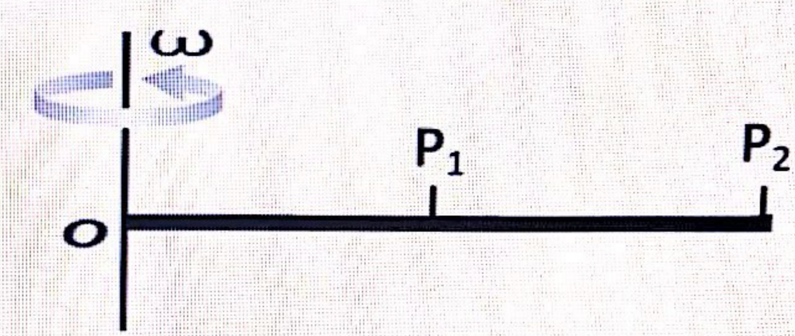
$P_1 = P_2$

$0.004V + (0.6)(0) = 0.604(6.84)$

$V = 1032\ m/s \rightarrow$ D

A rod of length L= 2 m rotates counterclockwise around an axis that is perpendicular to the rod and passes through its end, as shown in the figure below. Two points P_1 and P_2 lie at L/2 and at L, respectively, from the axis of rotation. If the angular speed of the rod is ω = 5 rad/sec, the ratio (V_2/V_1) of the linear speeds of points P_2 and point P_1 is:

A. 1.5
B. 2.0
C. 0.3
D. 0.5
E. 0.75



A

B

9 $\omega = \frac{v}{r} = \frac{v_1}{L/2} = \frac{v_2}{L}$

$$\frac{2v_1}{\cancel{L}} = \frac{v_2}{\cancel{L}} \Rightarrow \boxed{\frac{v_2}{v_1} = 2} \text{ --- } B$$

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The angular speed of a rotating disk increases from 4 rad/s to 12 rad/s in 6 sec. If the angular acceleration is kept constant, then the angular displacement of the disk (in radians) during this time interval is:

A. 48
B. 12
C. 16
D. 32
E. 64

13 $\omega_2 = \omega_1 + \alpha t$

$12 = 4 + \alpha(6)$

$\alpha = 1.33 \text{ rad/s}^2$

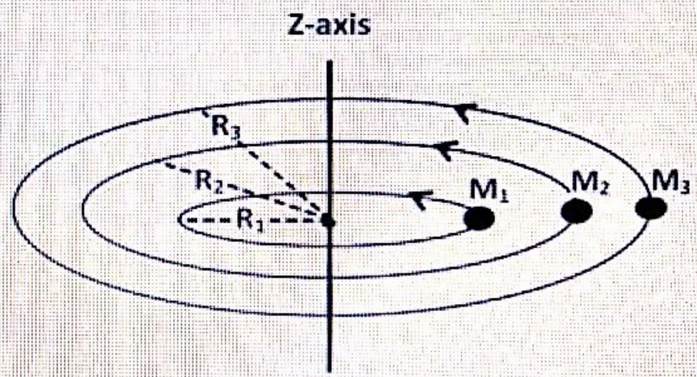
$\Delta\theta = \omega_1 t + \frac{1}{2}\alpha t^2$

$= 4(6) + \frac{1}{2}(1.33)(6)^2$

$= \underline{48 \text{ rad}} \rightarrow$ a

Three masses $M_1 = M_2 = M_3 = 2$ kg rotate counterclockwise (عكس عقارب الساعة) in the XY plane around the Z-axis with the same angular speed $\omega = 5$ rad/sec, as shown in the figure below. If $R_1 = 1$ m, $R_2 = 2$ m, and $R_3 = 3$m, the rotational kinetic energy (in Joules) of the previous setup is:

A. 126
B. 170
C. 224
D. 275
E. 350



(10) $I = I_1 + I_2 + I_3$

$= (2)(1)^2 + (2)(2)^2 + (2)(3)^2$

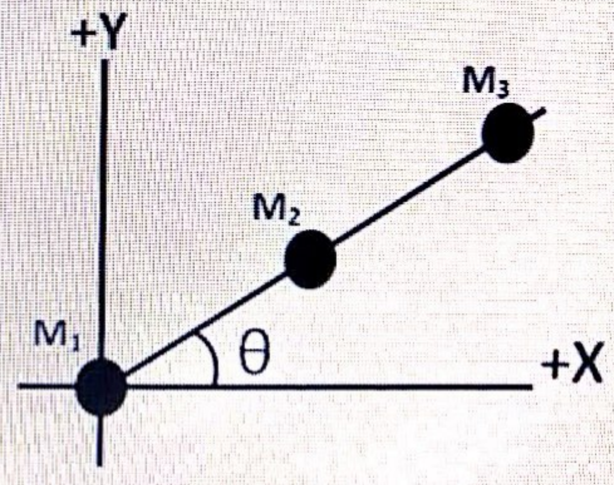
$= 28\ \text{kg-m}^2$

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

$= \frac{1}{2}(28)(5)^2 = 350\ \text{J} \rightarrow$ (E)

Three equal masses ($M_1 = M_2 = M_3 = 10$ kg) are placed on a rigid rod of negligible mass. The distance between two successive (متعاقبتين) masses is d = 1 m. If the rod lies in the XY plane and makes an angle $\theta = 30^0$ with the positive X-axis, as shown in the figure below, the X-coordinate (in meters) of the center of mass is:

A. Zero
B. 0.87
C. 0.50
D. 0.44
E. 0.25



$$X_{cm} = \frac{\Sigma mx}{\Sigma m} = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$$

$$= \frac{10(0) + 10(1\cos 30) + 10(2)\cos 30}{30}$$

$$= 0.87 \rightarrow a$$

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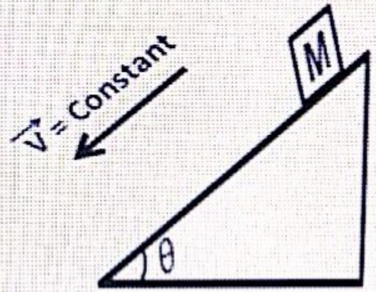
on

A block of mass M slides (تنزلق) along a rough (خشن) inclined surface (سطح مائل) with a constant velocity. If the inclination angle (زاوية ميلان) of the surface is $\theta = 25^0$ as shown in the adjacent figure (الشكل المجاور). The coefficient (معامل) of kinetic friction (μ_k) of the inclined surface is:

A. 0.17
B. 0.26
C. 0.36
D. 0.47
E. 0.57

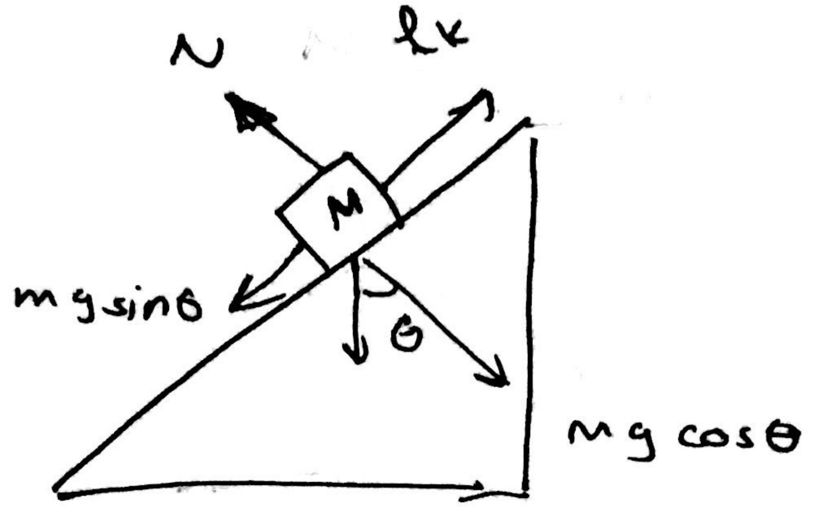


*Take g= 9.8 m/s²

A

B

(12)



$\Sigma F_y = 0$

$N = mg\cos\theta$

$\Sigma F_x = 0$ (v constant, a = 0)

$mg\sin\theta - f_k = 0$

$mg\sin\theta - N\mu_k = 0$ $(N = mg\cos\theta)$

$\cancel{mg}\sin\theta = \cancel{mg}\cos\theta\,\mu_k$

$\mu_k = \tan\theta = \tan 25$

$= 0.4663 \rightarrow$ D

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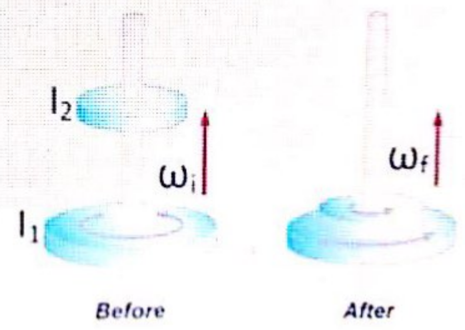
A cylindrical disk (قرص اسطواني) with moment of inertia I_1= 100 kg.m^2 rotates about a vertical, frictionless axle (محور) with angular speed ω_i = 10 rad/sec. A second cylindrical disk of moment of inertia I_2= 50 kg.m^2 and <u>initially not rotating</u> drops (سقط) onto the first disk as shown in the adjacent figure where they eventually (بالنهاية) have the same angular speed ω_f. The magnitude (in rad/sec) of the final angular speed of the two disks is:

A. 6.67
B. 10.0
C. 13.3
D. 22.7
E. 33.2



A

(14)

$$L_1 = L_2$$

$$I_1\omega_1 + I_2\omega_2 = (I_1 + I_2)\,\omega_f$$

$$100(10) + 50(0) = 150\,\omega_f$$

$$\omega_f = 6.67 \text{ rad/s} \longrightarrow (a)$$