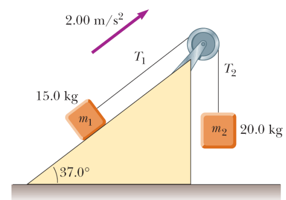
University of Ottawa PHY1124B Dr. Czajkowski, Winter 2017 Assignment 4
Assigned Feb24 Due March 15

STUDENT LAST NAME:_______________ STUDENT NUMBER: ___________________

1 Two blocks are connected by a string of negligible mass passing over a pulley of radius 0.250 m and moment of inertia *I*. The block on the frictionless incline is moving up with a constant acceleration of 2.00 m/s^2. (a) Determine T_1 and T_2, the tensions in the two parts of the string. (b) Find the moment of inertia of the pulley.



SOLVED DURING THE LECTURE

2 A man of mass m=80kg runs at speed u=4m/s along the tangent to a disk-shaped platform of mass M=160kg and radius R=2m. The platform is initially at rest but can rotate freely about the axis through its center. Find the new angular velocity after the man step on the platform.
(HINT: Treat the man as point particle)

SOLVED DURING THE LECTURE

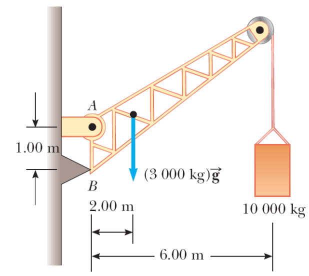
3 A uniform rod of length L and mass M is pivoted freely at one end. What is the angular acceleration of the rod when it is at the angle θ to the vertical? What is the tangential linear acceleration of the free and when the rod is horizontal? The moment of inertia of the rod about one end is $1/3ML^2$

SOLVED DURING LECTURE

4 A 60.0-kg woman stands at the rim of a horizontal turntable having a moment of inertia of 500 kg · m^2 and a radius of 2.00 m. The turntable is initially at rest and is free to rotate about a frictionless, vertical axle through its center. The woman then starts walking around the rim clockwise (as viewed from above the system) at a constant speed of 1.50 m/s relative to the Earth.
(a) In what direction and with what angular speed does the turntable rotate?
(b) How much work does the woman do to set herself and the turntable into motion?

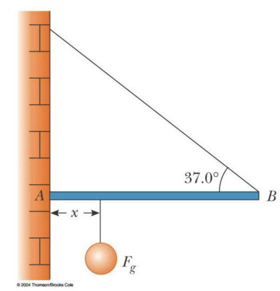
SOLUTION ON NEXT PAGE

5 A crane of mass 3 000 kg supports a load of 10 000 kg as shown. The crane is pivoted with a frictionless pin at *A* and rests against a smooth support at *B*. Find the reaction forces at *A* and *B*.



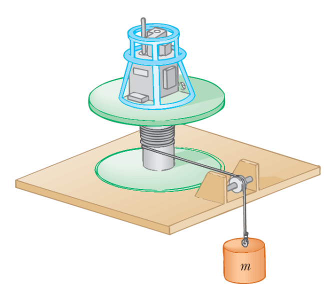
SOLUTION ON NEXT PAGE

6 One end of a uniform 4.00-m-long rod of weight F_g is supported by a cable. The other end rests against the wall, where it is held by friction, as shown The coefficient of static friction between the wall and the rod is $\mu_s = 0.500$. Determine the minimum distance *x* from point *A* at which an additional weight F_g (the same as the weight of the rod) can be hung without causing the rod to slip at point *A*.



SOLUTION ON NEXT PAGE

7 This problem describes one experimental method for determining the moment of inertia of an irregularly shaped object such as the payload for a satellite. Figure below shows a counterweight of mass *m* suspended by a cord wound around a spool of radius *r*, forming part of a turntable supporting the object. The turntable can rotate without friction. When the counterweight is released from rest, it descends through a distance *h*, acquiring a speed *v*. Show that the moment of inertia *I* of the rotating apparatus (including the turntable) is $mr^2(2gh/v^2 - 1)$.



SOLVED DURING THE LECTURE

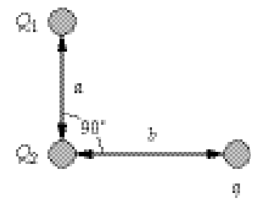
For multiple choice questions below – circle your answer and provide your solution on the opposite page.

8 A particle (charge = +40 μC) is located on the *x* axis at the point *x* = –20 cm, and a second particle (charge = –50 μC) is placed on the *x* axis at *x* = +30 cm. What is the magnitude of the total electrostatic force on a third particle (charge = –4.0 μC) placed at the origin (*x* = 0)?

a. 41 N b.16 N c. 56 N d.35 N e. 72 N

9 If *a* = 3.0 mm, *b* = 4.0 mm, *Q*1 = 60 nC, *Q*2 = 80 nC, and *q* = 24 nC in the figure, what is the magnitude of the total electric force on *q*?

a. 2.7 N b. 1.9 N c. 2.3 N d. 1.5 N e. 0.52 N



10 A uniform linear charge of 2.0 nC/m is distributed along the *x* axis from *x* = 0 to *x* = 3 m. Which of the following integrals is correct for the *y* component of the electric field at *y* = 4 m on the *y* axis?

a. $\int_0^3 \frac{72dx}{(16+x^2)^{3/2}}$ b. $\int_0^3 \frac{18dx}{(16+x^2)^{3/2}}$ c. $\int_0^3 \frac{72dx}{16+x^2}$

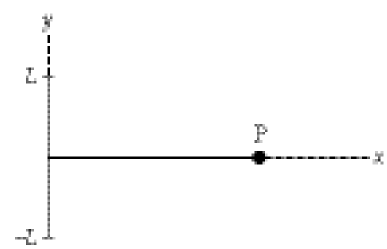
d. $\int_3^0 \frac{18dx}{16+x^2}$ e. none of these

11 Charge *Q* is uniformly distributed over a line segment of length 2*L*, as shown below. When the *x*-coordinate of point P is *x*, the magnitude of the *y*-component of the electric field at point P is

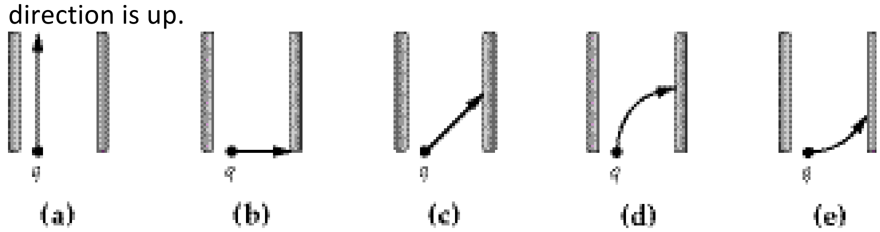
a. 0. b. $\frac{1}{4\pi\varepsilon_0}\frac{Q}{2\sqrt{L^2+x^2}}$.

c. $\frac{1}{4\pi\varepsilon_0}\frac{Q}{\sqrt{L^2+x^2}}$. d. $\frac{1}{4\pi\varepsilon_0}\frac{Q}{x\sqrt{L^2+x^2}}$.

e. $\frac{1}{4\pi\varepsilon_0}\frac{Q}{2x\sqrt{L^2+x^2}}$



12 A positively charged particle is moving in the +*y*-direction when it enters a region with a uniform electric field pointing in the +*x*-direction. Which of the diagrams below shows its path while it is in the region where the electric field exists. The region with the field is the region between the plates bounding each figure. The field lines always point to the right. The *x*-direction is to the right; the *y*-direction is up.



ANS: D

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4(a) The table turns opposite to the way the woman walks, so its angular momentumcancels that of the woman. From conservation of angular momentum for the system of the woman and the turntable, we have $L_f = L_i = 0$

so, $L_f = I_{\text{woman}}\omega_{\text{woman}} + I_{\text{table}}\omega_{\text{table}} = 0$

and $\omega_{\text{table}} = \left(-\frac{I_{\text{woman}}}{I_{\text{table}}}\right)\omega_{\text{woman}} = \left(-\frac{m_{\text{woman}}r^2}{I_{\text{table}}}\right)\left(\frac{v_{\text{woman}}}{r}\right) = -\frac{m_{\text{woman}}rv_{\text{woman}}}{I_{\text{table}}}$

$$\omega_{\text{table}} = -\frac{60.0\text{ kg}(2.00\text{ m})(1.50\text{ m/s})}{500\text{ kg}\cdot\text{m}^2} = -0.360\text{ rad/s}$$

or $\omega_{\text{table}} = \boxed{0.360\text{ rad/s (counterclockwise)}}$

(b) work done $= \Delta K = K_f - 0 = \frac{1}{2}m_{\text{woman}}v_{\text{woman}}^2 + \frac{1}{2}I\omega_{\text{table}}^2$

$$W = \frac{1}{2}(60\text{ kg})(1.50\text{ m/s})^2 + \frac{1}{2}(500\text{ kg}\cdot\text{m}^2)(0.360\text{ rad/s})^2 = \boxed{99.9\text{ J}}$$

5

We interpret the problem to mean that the support at point B is frictionless. Then the support exerts a force in the *x* direction and

$\boxed{F_{By} = 0}$

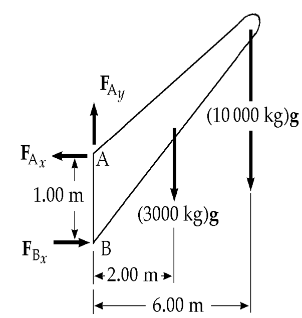
$\sum F_x = F_{Bx} - F_{Ax} = 0$ and $\sum\tau = -(3\,000g)(2.00) - (10\,000g)(6.00) + F_{Bx}(1.00) = 0$.

$F_{Ay} - (3\,000 + 10\,000)g = 0$

These equations combine to give

$F_{Ax} = F_{Bx} = \boxed{6.47\times10^5\text{ N}}$

$F_{Ay} = \boxed{1.27\times10^5\text{ N}}$



SOLUTION

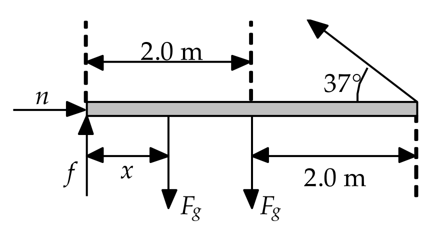
When $x = x_{\text{min}}$, the rod is on the verge of slipping, so

$$f = (f_s)_{\text{max}} = \mu_s n = 0.50n.$$

From $\sum F_x = 0$, $n - T\cos 37° = 0$, or $n = 0.799T$.

Thus, $f = 0.50(0.799T) = 0.399T$

From $\sum F_y = 0$, $f + T\sin 37° - 2F_g = 0$, or $0.399T - 0.602T - 2F_g = 0$, giving $T = 2.00F_g$.



Using $\sum\tau = 0$ for an axis perpendicular to the page and through the left end of the beam gives $-F_g\cdot x_{\text{min}} - F_g(2.0\text{ m}) + \left[(2F_g)\sin 37°\right](4.0\text{ m}) = 0$, which reduces to $x_{\text{min}} = \boxed{2.82\text{ m}}$.