*Comments:* ______________________________________________

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*Closed book. No work needs to be shown for multiple-choice questions.*

**1**. A cheetah can maintain its maximum speed of 100 km/hr for 30.0 seconds. What minimum distance must a gazelle running 80.0 km/hr be ahead of the cheetah to escape?

a. 200 m.
b. 167 m.
c. 100 m.
d. 83 m.
e. 70 m.

**2**. A uniform 1.0-N meter stick is suspended horizontally by vertical strings attached at each end. A 2.0-N weight is suspended from the 10-cm position on the stick, another 2.0-N weight is suspended from the 50 cm position, and a 3.0-N weight is suspended from the 60 cm position. What is the tension is the string attached at the 100-cm end of the stick?

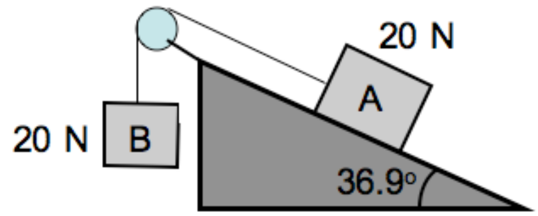
a. 3.5 N
b. 4.0 N
c. 5.0 N
d. 3.0 N
e. 4.5 N

**3 .** A ship sets sail from port and follows a bearing of 30º (i.e., N 30º E) for 15 km and then alters course to a bearing of 90 º (i.e., due E) for 30 km. At this point a crew member has a serious accident and the captain requests a helicopter from the port to fly the person to hospital. He also anchors the ship. What distance and along what bearing must the helicopter fly?

a. 23.4 km at 269 º.
b. 39.7 km at 71 º.
c. 44.8 km at 60 º.
d. 23.4 km at 78 º.
e. 51.0 km at 87 º.

**4**. The system shown to the right remains at rest. Each block weighs 20 N. The force of static friction of the block on the incline is:

a. 4.0 N.
b. 8.0 N.
c. 12 N.
d. 16 N.
e. 20 N.




**5**. A stone is thrown with an initial speed of 15 m/s at an angle of 53° above the horizontal from the top of a 35 m building. If g = 9.8 $m/s^2$ and air resistance is negligible, then what is the speed of the rock as it hits the ground?

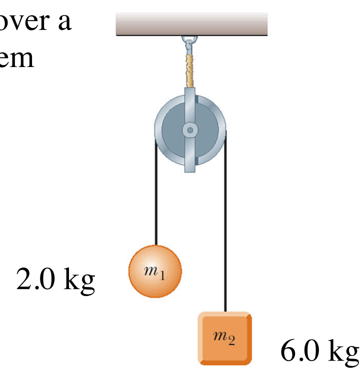
a. 15 m/s
b. 21 m/s
c. 30 m/s
d. 36 m/s
e. 44 m/s

**6**. A Cessna aircraft has a liftoff speed of 120 km/hr. What minimum constant acceleration does this require if the aircraft is to be airborne after a takeoff run of 240 m?

a. 3.63 $m/s^2$.
b. 2.31 $m/s^2$.
c. 5.55 $m/s^2$.
d. 4.63 $m/s^2$.
e. 1.88 $m/s^2$.

**7**. A 6.0-kg mass and a 2.0-kg mass are connected by a light string over a massless, frictionless pulley. What is the acceleration of the system when released?

a. 3.3 $m/s^2$.
b. 7.8 $m/s^2$.
c. 9.8 $m/s^2$.
d. 6.5 $m/s^2$.
e. 4.9 $m/s^2$.



**8**. A ball is launched from ground level at 30 m/s at an angle of 35° above the horizontal. How far does it go before it is at ground level again?

a. 14 m
b. 52 m
c. 86 m
d. 32 m
e. 43 m

**9**. A bicycle wheel undergoes 10 full revolutions in 35 seconds. What is the wheel's angular speed for that time period?

a. 1.8 rad/s.
b. 0.29 rad/s.
c. 0.90 rad/s.
d. 3.5 rad/s.
e. 0.045 rad/s.

**10**. The density of ice is 920 kg/$m^3$, and that of sea water is 1,030 kg/$m^3$. What fraction of the total volume of an iceberg is submerged in seawater?

a. 0.107.
b. 0.120.
c. 0.920.
d. 0.893.
e. 0.0800.

**11**. An object is thrown vertically down with an initial speed of 1.00 m/s. After 5.00 s the object will have traveled:

a. 124 m.
b. 128 m.
c. 245 m.
d. 166 m.
e. 255 m.

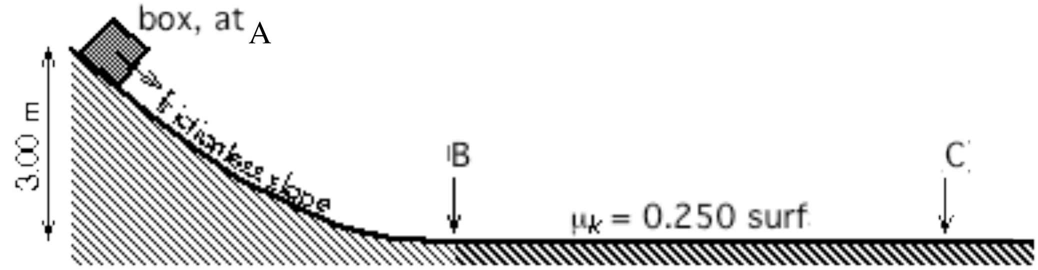
**12.** Use the method of components to add the following vectors. The angles are defined with respect to the X-axis of conventional rectangular axes. **A** = 8 units, 20°**B** = 12 units, 300° and **C** = 5 units, 60°. The resulting vector has a magnitude of

a. 15.3 units
b. 25.0 units
c. 16.0 units
d. 3.3 units
e. 16. 4 units

**13**. A trapeze artist, with swing, weighs 800 N; he is momentarily held to one side by his partner so that the swing ropes make an angle of 30.0° with the vertical. In such a condition of static equilibrium, what is the horizontal force being applied by the partner?

a. 400 N.
b. 924 N.
c. 302 N.
d. 462 N.
e. 196 N.

For questions (14) and (15), consider a 2.00 kg box that slides down a frictionless hill, leaving point [A] with a speed of 1.40 m/s. There is friction on the level ground at bottom of hill, where the kinetic friction coefficient is 0.250. After passing point [B], the box comes to a rest at [C].



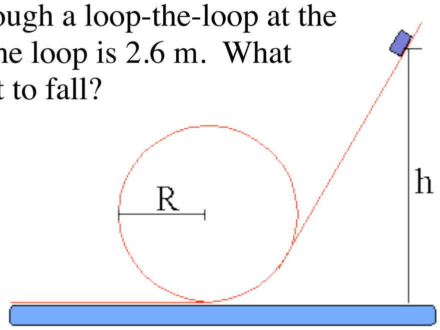

**14**. Which one of the following choices best corresponds to the kinetic energy of the box at point [B]?

a. 1.96 J.
b. 56.8 J.
c. 58.8 J.
d. 60.8 J.
e. 7.84 J.

**15**. Which one of the following choices best corresponds to the total amount of work done by friction for the process [B] →[C]?

a. –60.8 J.
b. –28.8 J.
c. –14.7 J.
d. –0.490 J.
e. –58.8 J.

**16**. A clown rides a small bicycle down an incline and then through a loop-the-loop at the bottom as shown. The radius of the clown's path through the loop is 2.6 m. What minimum speed is required at the top of the loop if he is not to fall?




a. 5.0 m/s.
b. 25 m/s.
c. 13 m/s.
d. 17 m/s
e. 7.1 m/s.

**17**. A 50 kg box is pushed a distance of 13 m at a constant speed along a horizontal floor by an applied force that is parallel to the floor. The coefficient of kinetic friction between the box and floor is 0.63. How much work is done by the applied force?

a. 660 J.
b. 1700 J.
c. 4000 J.
d. 5200 J.
e. 6500 J.

**18**. A 0.10-kg object moving initially with a velocity of + 0.20 m/s makes an elastic head on collision with a 0.15 -kg object initially at rest. What percentage of the original kinetic energy is retained by the 0.10 - kg object?

a. 96%.
b. 4 %.
c. 50 %.
d. 92 %.
e. 38 %.

**19**. A particle experiences a force given by $F = \alpha - \beta x^3$. Find the potential energy the particle is in. (Assume that the zero potential energy is located at $x = 0$.)

a. $\Delta U(x) = 3\beta x^2$.
b. $\Delta U(x) = -\alpha x + \frac{\beta}{4}x^4$.
c. $\Delta U(x) = \alpha x - \frac{\beta}{4}x^4$.
d. $\Delta U(x) = -3\beta x^2$.
e. $\Delta U(x) = -6\beta x$.

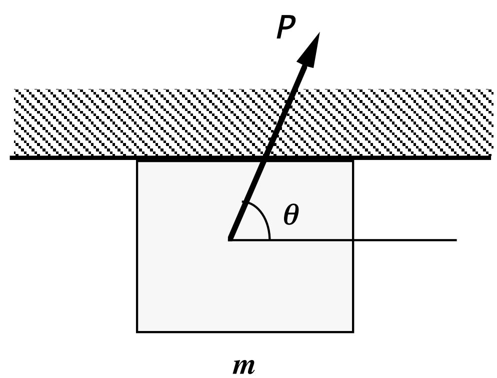
**20**. A 2 500kg truck moving at 10.00 m/s strikes a car waiting at a traffic light, hooking bumpers. The two continue to move together at 7.00 m/s. What was the mass of the struck car?

a. 1550 kg.
b. 1200 kg.
c. 1420 kg.
d. 1730 kg.
e. 1070 kg.

**21**. A 50g ball traveling at 25.0 m/s is bounced off a brick wall and rebounds at 22.0 m/s. A high-speed camera records this event. If the ball is in contact with the wall for 3.50 ms, what is the average acceleration of the ball during this time interval?

a. 6,720 $m/s^2$.
b. 13,400 $m/s^2$.
c. 3,200 $m/s^2$.
d. 857 $m/s^2$.
e. 20 $m/s^2$.

**22**. A Physics 1A student uses a force $\vec{P}$ of magnitude 80 N and angle $\theta = 70^{\circ}$ (with respect to the horizontal) to push a 5.0 kg block horizontally across the ceiling of his room. If the coefficient of kinetic friction between the block and the ceiling is 0.40, what is the magnitude of the block's acceleration?




a. 6.1 $m/s^2$.
b. 4.3 $m/s^2$.
c. 3.9 $m/s^2$.
d. 6.4 $m/s^2$.
e. 3.4 $m/s^2$.

**23**. An ice skater with a moment of inertia of 70.0 $\text{kg} \cdot \text{m}^2$ is spinning at 4.1 rad/s. If the skater pulls in her arms, her rotational inertia decreases to 50.0 $\text{kg} \cdot \text{m}^2$. What is the skater's resulting angular speed?

a. 5.7 rad/s.
b. 2.9 rad/s.
c. 4.9 rad/s.
d. 2.1 rad/s.
e. 8.5 rad/s.

*Equations and constants*

$\begin{Bmatrix} x = r\cos\theta \\ y = r\sin\theta \end{Bmatrix}$; $\begin{Bmatrix} r = \sqrt{x^2+y^2} \\ \theta = \tan^{-1}\left(\frac{y}{x}\right) \end{Bmatrix}$; $\begin{Bmatrix} v_x = v_{ox} + a_x t \\ \Delta x = \frac{1}{2}(v_{ox}+v_x)t \\ \Delta x = v_{ox}t + \frac{1}{2}a_x t^2 \\ v_x^2 = (v_{ox})^2 + 2a_x\Delta x \end{Bmatrix}$; $\begin{Bmatrix} v_y = v_{oy} + a_y t \\ \Delta y = \frac{1}{2}(v_{oy}+v_y)t \\ \Delta y = v_{oy}t + \frac{1}{2}a_y t^2 \\ v_y^2 = (v_{oy})^2 + 2a_y\Delta y \end{Bmatrix}$; $\begin{Bmatrix} \Delta x = x_f - x_i \\ speed_{avg} = \frac{d}{\Delta t} \end{Bmatrix}$;

$\begin{Bmatrix} a_{avg} = \frac{\Delta v}{\Delta t} \\ v_{avg} = \frac{\Delta x}{\Delta t} \end{Bmatrix}$; $\begin{Bmatrix} a = \lim_{\Delta t\to 0}\frac{\Delta v}{\Delta t} \\ v = \lim_{\Delta t\to 0}\frac{\Delta x}{\Delta t} \end{Bmatrix}$; $\begin{Bmatrix} 0 \le f_s \le \mu_s F_N \\ f_k = \mu_k F_N \\ F_g = mg \end{Bmatrix}$; $\begin{Bmatrix} \sum \vec{\mathbf{F}} = 0;\ \vec{\mathbf{a}} = 0 \\ \sum \vec{\mathbf{F}} = m\vec{\mathbf{a}} \\ \vec{\mathbf{F}}_{2on1} = -\vec{\mathbf{F}}_{1on2} \end{Bmatrix}$; $PE_{grav} = mgh$; $KE_{lin} = \frac{1}{2}mv^2$;

$PE_{spring} = \frac{1}{2}k(\Delta x)^2$; $KE_{rot} = \frac{1}{2}I\omega^2$; $\vec{F}_{spring} = -k(\Delta\vec{x})$; $W = |\vec{F}||\Delta\vec{x}|\cos\theta$; $W_{\text{net}} = W_1 + W_2 + W_3 \ldots$;

$W_{\text{nc}} = \Delta E_{mec}$; $E_{total} = PE_{elastic} + PE_{grav} + KE_{lin} + KE_{rot} = \frac{1}{2}kx^2 + mgh + \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$; $\mathcal{P} = \vec{\mathbf{F}}\cdot\vec{\mathbf{v}} = \frac{W}{\Delta t}$;

$\alpha = \frac{\Delta\omega}{\Delta t}$; $\omega = \frac{\Delta\theta}{\Delta t}$; $\Delta\theta = \frac{\Delta s}{r}$; $v_t = r\omega$; $a_t = r\alpha$; $a_C = r\omega^2 = \frac{v_t^2}{r}$; $F_C = m\frac{v^2}{r}$; $\vec{\mathbf{p}} = m\vec{\mathbf{v}}$;

$\vec{\mathbf{I}} = \vec{F}\Delta t = \Delta\vec{\mathbf{p}} = m(\vec{\mathbf{v}}_f - \vec{\mathbf{v}}_i)$; $v_{1i} - v_{2i} = -(v_{1f} - v_{2f})$; $\vec{p}_i = \vec{p}_f$; $m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$;

$\sum \vec{F}_{external} = \frac{\Delta\vec{p}}{\Delta t}$; $\begin{Bmatrix} \omega = \omega_o + \alpha t \\ \Delta\theta = \frac{1}{2}(\omega_o + \omega)t \\ \Delta\theta = \omega_o t + \frac{1}{2}\alpha t^2 \\ \omega^2 = (\omega_o)^2 + 2\alpha\Delta\theta \end{Bmatrix}$; $\begin{Bmatrix} F = G\frac{m_1 m_2}{r^2} \\ G = 6.67\times 10^{-11}\ \text{N}\cdot\text{m}^2/\text{kg}^2 \end{Bmatrix}$; $\begin{Bmatrix} M_{Earth} = 5.98\times 10^{24}\ \text{kg} \\ R_{Earth} = 6.37\times 10^{6}\ \text{m} \end{Bmatrix}$;

$\begin{Bmatrix} \sum\vec{\tau} = 0;\ \vec{\alpha} = 0 \\ \sum\vec{\tau} = I\vec{\alpha} \\ \vec{\tau}_{1on2} = -\vec{\tau}_{2on1} \end{Bmatrix}$; $PE = -G\frac{m_1 m_2}{r}$; $g = 9.80\ \text{m/s}^2$; $g = G\frac{M}{r^2}$; $I = m_1 r_1^2 + m_2 r_2^2 + \ldots = \sum mr^2$;

$I_{disk} = \frac{1}{2}MR^2$; $I_{point\ mass} = I_{hoop} = MR^2$; $I_{solid\ sphere} = \frac{2}{5}MR^2$; $I_{thin\ spherical\ shell} = \frac{2}{3}MR^2$; $L = I\omega$;

$\Delta L = I_f\omega_f - I_i\omega_i$; $\tau = Fr\sin\theta$; $\sum\vec{\tau}_{external} = \frac{\Delta L}{\Delta t}$; $\rho = \frac{m}{V}$; $P = \frac{F_\perp}{A}$; $P_2 = P_1 + \rho gh$;

$F_{Buoyancy} = \rho_{fluid} g V_{displaced}$; $A_1 v_1 = A_2 v_2$; $P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$; $1\ atm = 1.013\times 10^5\ Pa$;

$\rho_{Iron} = 7{,}860\frac{\text{kg}}{\text{m}^3}$; $\rho_{water} = 1.00\ \frac{\text{g}}{\text{cm}^3} = 1.00\times 10^3\ \frac{\text{kg}}{\text{m}^3}$; $\begin{Bmatrix} Volume_{Cylinder} = \pi r^2 h \\ Volume_{Sphere} = \frac{4}{3}\pi r^3 \end{Bmatrix}$;

$\begin{Bmatrix} Area_{Circle} = \pi r^2 \\ Area_{\text{Rect}} = length\times width \end{Bmatrix}$; $\begin{Bmatrix} \text{Circumference}_{Circle} = 2\pi r \\ Perimeter_{\text{Rectangle}} = 2\times length + 2\times width \end{Bmatrix}$; $x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$;

60 s = 1 min; 60 min = 1 hr; 2.54 cm = 1 in; 12 in = 1 ft; 5,280 ft = 1 mi; 1,609 m = 1 mi;

0.3048 m = 1 ft; 1 light year = $5.88\times 10^{12}$ miles; $2\pi$ rad = 1 rev = 360 deg.