Name or Initials: *Course 3-digit Code*

Comments: ____

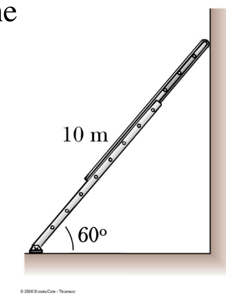
____

____

____

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

1. An 80 kg man is one fourth of the way up a 10 m ladder that is resting against a smooth, frictionless wall. If the ladder has a mass of 20 kg and it makes an angle of 60° with the ground, find the force of friction of the ground on the foot of the ladder.



a. 780 N.
b. 200 N.
c. 50 N.
d. 170 N.
e. 340 N.

2. A piece of wood is floating in a lake. 35% of its volume is immersed in the water. What is the density of the ball?

a. 350 kg/m^3.
b. 500 kg/m^3.
c. 1000 kg/m^3.
d. 650 kg/m^3.
e. 250 kg/m^3.

3. At the top of a cliff 100 m high, Raoul throws a rock upward with velocity 15.0 m/s. How much later should he drop a second rock from rest so both rocks arrive simultaneously at the bottom of the cliff?

a. 5.1s.
b. 3.8 s.
c. 2.7 s.
d. 2.2 s.
e. 1.8 s.

4. A rifle is aimed horizontally toward the center of a target 100 m away. If the bullet strikes 10 cm below the center, what was the velocity of the bullet? (Ignore air friction.) (hint: remember to consider the horizontal and vertical components)

a. 300 m/s
b. 333 m/s
c. 500 m/s
d. 700 m/s
e. 833 m/s

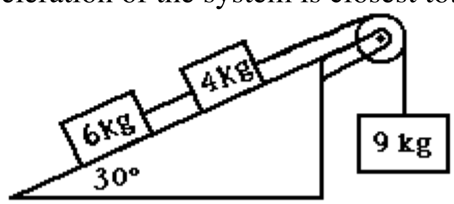
5. A torque of 42 N-m gives a large wheel an angular acceleration of 0.78 rad/s^2. What is the moment of inertia of the wheel?

a. 12 kg-m^2.
b. 33 kg-m^2.
c. 54 kg-m^2.
d. 108 kg-m^2.
e. 19 kg-m^2.

6. A ball is launched from ground level at a speed 37.0 m/s at an angle of 53.1° above the horizontal. How high will the ball go? Assume air resistance is negligible.

a. 134 m.
b. 67.1 m.
c. 25.2 m.
d. 69.8 m.
e. 44.7 m.

7. A system comprising blocks, a light frictionless pulley, a frictionless incline, and connecting ropes is shown in the figure. The 9 kg block accelerates downward when the system is released from rest. The acceleration of the system is closest to:



a. 1.7 m/s^2
b. 2.3 m/s^2
c. 1.5 m/s^2
d. 2.1 m/s^2
e. 1.9 m/s^2

8. A 2 000-kg sailboat experiences an eastward force of 3 000 N by the ocean tide and a wind force against its sails with magnitude of 6 000 N directed toward the northwest (45° N of W). What is the magnitude of the resultant acceleration?

a. 1.5 m/s^2
b. 1.9 m/s^2
c. 2.1 m/s^2
d. 2.2 m/s^2
e. 3.0 m/s^2

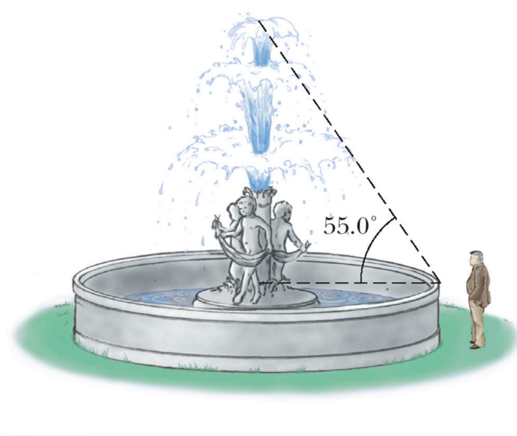
9. A designer of airplane runways needs to make a runway that supports a plane that must reach a speed of 27.8 m/s before it can lift-off and can accelerate at 2.00 m/s^2. At the very least, how long of a runway must she make for an airplane starting from rest?

a. 384 m.
b. 111 m.
c. 272 m.
d. 223 m.
e. 193 m.

10. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 11 s. What is the final velocity of the bird after 11s?

a. 1.7 m/s.
b. 3.2 m/s.
c. 5.1 m/s.
d. 2.5 m/s.
e. 0.46 m/s.

11. A high fountain of water is in the center of a circular pool of water. You walk the circumference of the pool and measure it to be 150 meters. You then stand at the edge of the pool and use a protractor to gauge the angle of elevation of the top of the fountain. It is 55°. How high is the fountain?



a. 17 m.
b. 23 m.
c. 29 m.
d. 34 m.
e. 120 m.

12. A 5 000-N weight is suspended in equilibrium by two cables. Cable 1 applies a horizontal force to the right of the object and has a tension, T_1. Cable 2 applies a force upward and to the left at an angle of 37° to the negative x axis and has a tension, T_2. Find T_1.

a. 4000 N.
b. 6640 N.
c. 7220 N.
d. 8310 N.
e. 3340 N.

13. A 10 kg mass sits at the top of an incline that makes an angle of 37º with respect to the horizontal. When released it slides down at constant speed. What is the coefficient of kinetic friction between the mass and the plane?

a. 0.81
b. 0.75
c. 0.60
d. 0.48
e. 0.32

14. A force given by $F = a\sqrt{x}$ acts in the x direction, where $a = 9.50\ \mathrm{N \cdot m^{-1/2}}$. Calculate the work done by this force acting on the object as it moves from $x = +3.00$ m to $x = +6.00$ m.

a. 32.9 J.
b. 60.2 J.
c. 77.9 J.
d. 49.4 J.
e. 85.5 J.

15. A girl and her bicycle have a total mass of 40 kg. At the top of the hill her speed is 5.0 m/s. The hill is 10 m high and 100 m long. If the coeffcient of friction as she rides down the hill is 0.0513, what is her speed at the bottom?

a. 5 m/s.
b. She stops before she reaches the bottom.
c. 9 m/s.
d. 11 m/s.
e. 13 m/s.

16. 4.00 x 10^5 J of total work are done on a 1416 kg car while it accelerates from 10.0 m/s to some final velocity. Find this final velocity.

a. 20.6 m/s.
b. 21.6 m/s.
c. 23.8 m/s.
d. 28.4 m/s.
e. 25.8 m/s.

17. A roller coaster, loaded with passengers, has a mass of 2 000 kg; the radius of curvature of the track at the bottom point of the dip is 24 m. If the vehicle has a speed of 18 m/s at this point, what force is exerted on the vehicle by the track?

a. 2.3×10^4 N.
b. 7.4×10^3 N.
c. 4.7×10^4 N.
d. 1.0×10^4 N.
e. 2.7×10^4 N.

18. A 50 N block, on a 30° incline, is being held motionless by friction. The coefficient of static friction between the block and the plane is 0.83. The force due to static friction acting on the block in this case is:

a. 0 N.
b. 13 N.
c. 43 N.
d. 36 N.
e. 25 N.

19. A 3.0 kg block, moving on as frictionless surface with a speed of 1.2 m/s, makes a perfectly elastic collision with a block of mass M at rest. After the collision, the 3.0 kg block recoils with a speed of 0.3 m/s. The mass M is:

a. 6 kg.
b. 3 kg.
c. 7.5 kg.
d. 4 kg.
e. 5 kg.

20. A railroad freight car, mass 15 000 kg, is allowed to coast along a level track at a speed of 2.0 m/s. It collides and couples with a 50 000-kg loaded second car, initially at rest and with brakes released. What percentage of the initial kinetic energy of the 15 000-kg car is preserved in the two coupled cars after collision?

a. 14 %.
b. 100 %.
c. 23 %.
d. 48 %.
e. 86 %.

21. An Olympic skier moving at 20.0 m/s down a 30º slope encounters a region of wet snow, of coefficient of friction of 0.740. How far down the slope does she go before stopping?

a. 119 m.
b. 145 m.
c. 170 m.
d. 199 m.
e. 205 m.

22. A bowling ball of mass 5.0 kg initially moves with a speed of 3.0 m/s in the +*x* direction. It then hits the wall and bounces back with the same speed in the in the –*x* direction. What was the change in momentum of the ball?

a. –30 kg(m/s).
b. –15 kg(m/s).
c. 0 kg(m/s).
d. +15 kg(m/s).
e. +30 kg(m/s).

23. An ice skater spins at 2.5 rev/s when his arms are extended. He draws his arms in and spins at 6.0 rev/s. By what factor does his moment of inertia change in the process?

a. 2.4
b. 1.0
c. 0.42
d. 8.3
e. 0.12

Equations and constants

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

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

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

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

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

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

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

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

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

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

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

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

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

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 = 5.88×10^{12} miles; 2π rad = 1 rev = 360 deg.