Name or Initials: *Course 3-digit Code*

Comments: ____

____

____

____

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

1. A helicopter is traveling at 60 m/s at a constant altitude of 140 m over a level field. If a wheel falls off the helicopter, with what speed will it hit the ground? (g = 9.8 m/s^2 and air resistance negligible) (hint: remember to consider the horizontal and vertical components)

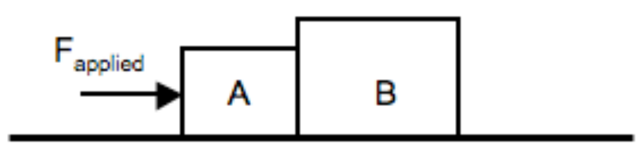
a. 40 m/s.
b. 60 m/s.
c. 80 m/s.
d. 90 m/s.
e. 100 m/s.

2. A ventilation fan with a rotational inertia of 0.0340 $kg{\cdot}m^2$ has a net torque of 0.110 N·m applied to it. If it starts from rest, what angular momentum will it have 8.00 s later?

a. 0.880 $kg{\cdot}m^2/s$.
b. 0.970 $kg{\cdot}m^2/s$.
c. 2.00 $kg{\cdot}m^2/s$.
d. 3.25 $kg{\cdot}m^2/s$.
e. 0.299 $kg{\cdot}m^2/s$.

3. Two blocks (***A*** and ***B***) are in contact on a horizontal frictionless surface. A 36 N constant horizontal force is applied to ***A***. The mass of ***A*** is 4.0 kg and the mass of ***B*** is 20 kg. The magnitude of the force of ***A*** on ***B*** is:

a. 1.5 N.
b. 6.0 N.
c. 26 N.
d. 36 N.
e. 30 N.



4. A baseball leaves the bat with a speed of 44.0 m/s and an angle of 30° above the horizontal. A 5.0 m-high fence is located at a horizontal distance of 132 m from the point where the ball is struck. Assuming the ball leaves the bat 1.0 m above ground level, by how much does the ball clear the fence?

a. 4.4 m
b. 8.8 m
c. 13.4 m
d. 17.9 m
e. 22.4 m

5. An 800-N billboard worker stands on a 4.0-m scaffold supported by vertical ropes at each end. If the scaffold weighs 500 N and the worker stands 1.0 m from one end, what is the tension in the rope nearest the worker?

a. 450 N
b. 500 N
c. 600 N
d. 800 N
e. 850 N

6. Norma releases a bowling ball from rest; it rolls down a ramp with constant acceleration. After half a second it has traveled 0.75 m. How far has it traveled after two seconds?

a. 1.2 m
b. 4.7 m
c. 9.0 m
d. 12 m
e. 15 m

7. An airplane flies from Denver to Chicago (1770 km) in 4.4 hrs when no wind blows. On a day with a tailwind, the plane makes the trip in 4.0 hrs. What is the magnitude of the wind speed?

a. 44 km/hr.
b. 40 km/hr.
c. 42 km/hr.
d. 200 km/hr.
e. 20 km/hr.

8. A cheetah can run at approximately 120 km/hr and a gazelle at 90.0 km/hr. If both animals are running at full speed, with the gazelle 75.0 m ahead, how long before the cheetah catches its prey?

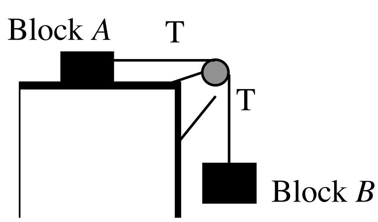
a. 3.3 s.
b. 7.8 s.
c. 12 s.
d. 23 s.
e. 9.0 s.

9. A wood board floats in fresh water with 60% of its volume under water. The density of the wood is:

a. 400 kg/m^3.
b. 500 kg/m^3.
c. 600 kg/m^3.
d. less than 350 kg/m^3.
e. more than 650 kg/m^3.

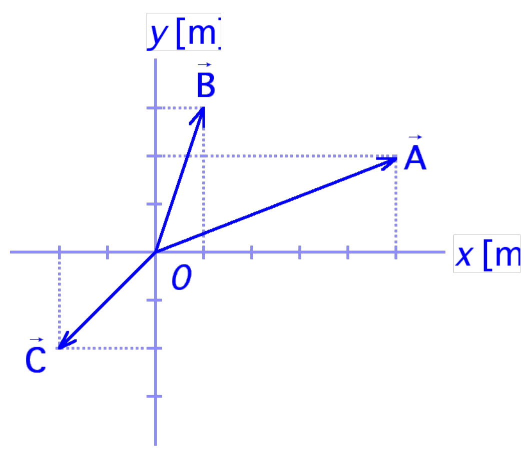
10. Block *A* (mass = 2.25 kg) rests on a level tabletop. It is connected by a horizontal cord passing over a light, frictionless pulley to a hanging block *B* (mass = 1.30 kg). The coefficient of kinetic friction between block *A* and the table is 0.450. After the blocks are released from rest, what is the speed of block *B* after it has fallen 3.00 cm?

a. 0.619 m/s.
b. 0.767 m/s.
c. 0.445 m/s.
d. 0.569 m/s.
e. 0.218 m/s.



11. Consider the three displacement vectors $\vec{\mathbf{A}}$, $\vec{\mathbf{B}}$, and $\vec{\mathbf{C}}$ shown at right. Each tick mark on the *x*-*y* axes represents 1.00 m. Which one of the following choices best describes the magnitude of the resultant vector $\vec{\mathbf{A}} + 2\vec{\mathbf{B}} + \vec{\mathbf{C}}$?

a. 1.70 m.
b. 7.81 m.
c. 14.2 m.
d. 14.5 m.
e. 5.00 m.



12. A 500-N tightrope walker stands at the center of the rope such that each half of the rope makes an angle of 10.0° with the horizontal. What is the tension in the rope?

a. 1,440 N
b. 1,000 N
c. 820 N
d. 500 N
e. 2,900 N

13. A person throws a ball vertically upward into the air with an initial velocity of 17.0 m/s. Calculate the distance the ball travels between t = 1.00 s and t = 2.00s.

a. 0.30 m.
b. 2.9 m.
c. 2.3 m.
d. 12.1 m.
e. 4.6 m.

14. A 5.0 kg cart is moving horizontally at 6.0 m/s. In order to change its speed to 10.0 m/s, the net work down on the cart must be:

a. 40 J.
b. 90 J.
c. 160 J.
d. 400 J.
e. 550 J.

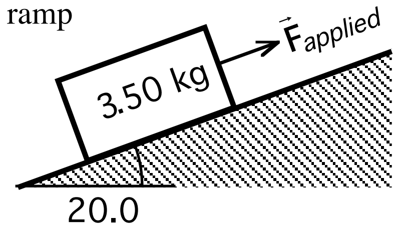
15. A 20-N crate starting at rest slides down a rough 5.0-m long ramp, inclined at 25° with the horizontal. 20 J of energy is lost to friction. What will be the speed of the crate at the bottom of the incline?

a. 0.98 m/s
b. 1.5 m/s
c. 2.4 m/s
d. 3.2 m/s
e. 4.7 m/s

16. A force $\vec{F} = \left(12\hat{i} - 10\hat{j}\right)$N acts on an object. How much work does this force perform as the object moves from the origin to the point $\vec{r} = \left(12\hat{i} + 11\hat{j}\right)$m?

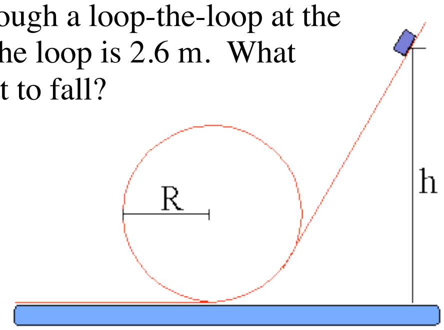
a. 46 J.
b. 130 J.
c. 27 J.
d. 34 J.
e. 250 J.

17. Consider an applied force exerted on a box with mass 3.50 kg, on a ramp with a friction coefficient of 0.13 and that makes an angle of 20.0º with respect to the horizontal, as shown to the right. Which one of the following choices best corresponds to the magnitude of the applied force, if the box slides up the ramp at a constant speed of 0.500 m/s?



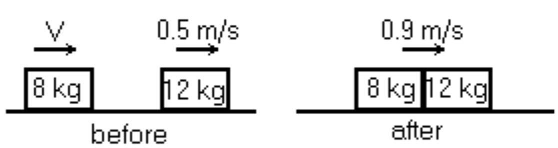
a. 11.7 N.
b. 15.9 N.
c. 38.5 N.
d. 34.3 N.
e. 4.2 N.

18. 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.

19. An 8 kg block has a speed n and is behind a 12 kg block that has a speed of 0.5 m/s. The surface is frictionless. The blocks collide and couple. After the collision, the blocks have a common speed of 0.9 m/s. The loss of kinetic energy of the blocks due to the collision is closest to:



a. 1.5 J.
b. 1.8 J.
c. 2.7 J.
d. 2.4 J.
e. 2.1 J.

20. In problem 19, the impulse on the 12 kg block due to the collision is closest to:

a. 6.0 N.s.
b. 7.2 N.s.
c. 4.8 N.s.
d. 8.4 N.s.
e. 3.6 N.s.

21. A 20-kg object moving at -3.0 m/s is struck elastically in a head-on collision with a 10-kg object initially moving at +3.0 m/s. Find the final velocity of the 20-kg object after the collision.

a. – 2 m/s.
b. – 1 m/s.
c. + 1 m/s.
d. + 2 m/s.
e. + 3 m/s.

22. A 2 000-kg ore car rolls 50.0 m down a frictionless 10° incline. If there is a horizontal spring at the end of the incline, what spring constant is required to stop the ore car in a distance of 1.00 m?

a. 1320 kN/m.
b. 681 kN/m.
c. 1960 kN/m.
d. 980 kN/m.
e. 340 kN/m.

23. A potter's wheel, with rotational inertia 31 kg·m^2, is spinning at 40 rev/min. The potter drops a lump of clay onto the wheel, where it sticks a distance 1.2 m from the rotational axis. If the subsequent angular speed of the wheel and clay is 32 rev/min, what is the mass of the clay (ignore torques that arise from frictional effects)?

a. 7.8 kg.
b. 4.7 kg.
c. 3.6 kg.
d. 5.4 kg.
e. 5.9 kg.

Equations and constants

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

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

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

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

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

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

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

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

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

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

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

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

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

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.