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

1. A cheetah can run at approximately 100 km/hr and a gazelle at 80.0 km/hr. If both animals are running at full speed, with the gazelle 70.0 m ahead, how long before the cheetah catches its prey?

a. 12.6 s
b. 25.2 s
c. 6.30 s
d. 10.7 s

2. 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. 500 N
d. 2 900 N

3. 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. 1.9 m/s
c. 3.2 m/s
d. 4.7 m/s

4. Mitch throws a 100-g lump of clay at a 500-g target, which is at rest on a horizontal surface. After impact, the target, including the attached clay, slides 2.1 m before stopping. If the coefficient of friction is $\mu = 0.50$, find the speed of the clay before impact.

a. 4.5 m/s
b. 12 m/s
c. 27 m/s
d. 36 m/s

5. A 40 kg box sits on a horizontal surface. If the coefficient of kinetic friction between the box and the surface is 0.34, what horizontal force must be applied to give the box an acceleration of 2.0 m/s^2?

a. 213 N
b. 134 N
c. 80 N
d. 186 N

6. Object A is projected horizontally at 10 m/s from the top of a building at the same moment that object B is dropped from the same point. Assume air resistance is negligible. If the ground around the building is level:

a. object A will strike the ground first.
b. object B will strike the ground first.
c. both objects will strike the ground at the same time.
d. since the height of the building was not given, the correct answer cannot be determined.

7. A boy whirls a ball on a string 1.0 m long in a horizontal circle at 5.23 rad/sec. If the mass of the ball is 0.22 kg, what is the tension in the string?

a. 13.2 N
b. 8.7 N
c. 6.0 N
d. 550 N

8. A car rounds a curve at constant speed. Which of the following statements is correct?

a. The velocity of the car is constant.
b. The car has an acceleration directed outward from the center of the curve.
c. The car has an acceleration directed inward toward the center of the curve.
d. The car has zero acceleration.

9. In a perfectly inelastic collision:

a. total kinetic energy is constant.
b. momentum is never conserved.
c. the final momentum is always zero.
d. the colliding objects stick together.

10. A uniform circular solid disk with a mass of 6.0 kg and a radius of 40 cm is released at the top of an incline that is 10 m long and makes an angle of 25º above the horizontal. What is its speed at the bottom of the incline? Assume it rolls without slipping.

a. 3.8 m/s.
b. 5.0 m/s.
c. 7.4 m/s.
d. 11 m/s.

11. The vector $-\vec{A}$ is:

a. greater than $\vec{A}$ in magnitude.
b. less than $\vec{A}$ in magnitude.
c. in the same direction as $\vec{A}$.
d. in the direction opposite to $\vec{A}$.

12. The inertia of a body tends to cause the body to:

a. speed up.
b. slow down.
c. resist any change in motion.
d. fall toward Earth.

13. A 25 kg crate is pushed across a frictionless horizontal floor with a force of 20 N. The force is directed 20° below the horizontal. The acceleration of the crate is:

a. 0.27 m/s^2.
b. 0.75 m/s^2.
c. 0.80 m/s^2.
d. 170 m/s^2.

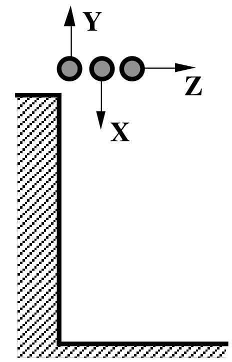
14. An ice skater spins at 2.5 rev/s when his arms are extended. He draws his arms in and spins at 6.0 rev/s. By what factor does his moment of inertia change in the process?

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

15. 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.

16. Three rocks of equal mass are thrown with identical speeds from the top of the same building. Rock X is thrown vertically downward, rock Y is thrown vertically upward, and rock Z is thrown horizontally. Which ball has the greatest speed just before it hits the ground? Assume air resistance is negligible.



a. Rock X.
b. Rock Y.
c. Rock Z.
d. All rocks hit the ground with the same speed.

17. 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.

18. A ball is thrown vertically upward and reaches a maximum height of 20.0 m. What is the total time the ball is in the air? Assume the ball was released from ground level.

a. 1.01 s.
b. 2.02 s.
c. 4.04 s.
d. 6.06 s.

19. A bullet is fired horizontally from a handgun at a target 20 m away. If the initial velocity of the bullet as it leaves the gun is 100 m/s, how much will the bullet drop as it hits the target?

a. 0.10 m.
b. 0.20 m.
c. 0.30 m.
d. 0.40 m.

20. 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. 1740 J.
c. 4000 J.
d. 6500 J.

21. A billiard ball moving to the right collides with a stationary, much less massive ping-pong ball. Which one of the following statements best describes what will happen after the collision? Neglect the effects of frictional forces.

a. The billiard ball will move to the *right*, and the ping-pong ball will move to the *right*.
b. The billiard ball will move to the *right*, and the ping-pong ball will move to the *left*.
c. The billiard ball will move to the *left*, and the ping-pong ball will move to the *right*.
d. The billiard ball will move to the *left*, and the ping-pong ball will move to the *left*.

22. 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. 32 kg-m^2.
c. 54 kg-m^2.
d. 108 kg-m^2.

23. A wheel initially has an angular velocity of 18 rad/s but it is slowing down at a rate of 2.0 rad/s^2. By the time it stops it will have turned through:

a. 81 rad.
b. 160 rad.
c. 245 rad.
d. 330 rad.

24. A liquid flows through two horizontal sections of tubing joined end to end. In the first section the cross-sectional area is 10.0 cm^2, and the flow speed is 275 cm/s. In the second section, the cross-sectional area is 2.50 cm^2. The smaller section's flow speed is:

a. 0.688 m/s.
b. 0.100 m/s.
c. 11.0 m/s.
d. 44.0 m/s.

25. 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. 250 kg/m^3.

26. An object with an initial velocity of 12 m/s in the positive direction experiences a constant acceleration of 4.0 m/s^2 in the positive direction for 3.0 seconds. During this time the object travels a distance of:

a. 24 m.
b. 36 m.
c. 54 m.
d. 144 m.

27. A boy on the edge of a vertical cliff 20 m high throws a stone horizontally outward with a speed of 20 m/s. It strikes the ground at what horizontal distance from the foot of the cliff?

a. 10 m.
b. 40 m.
c. 50 m.
d. 110 m.

28. A block of wood has a density of 0.50 g/cm^3 and a mass of 1500 g. It floats in a container of oil (the oil's density is 0.75 g/cm^3). What volume of oil does the wood displace?

a. 3000 cm^3.
b. 2000 cm^3
c. 1500 cm^3.
d. 1000 cm^3.

29. A 0.40 kg pendulum bob passes through the lowest point of its path at a speed of 3.0 m/s. The pendulum is 80 cm long. When if the pendulum reaches its highest point, what angle does the cable make with the vertical?

a. 55°.
b. 45°.
c. 25°.
d. 65°.

30. Two identical billiard balls have velocities of 2.0 m/s and –1.0 m/s when they meet in an elastic head-on collision. What is the final velocity of the first ball after the collision?

a. –2.0 m/s.
b. –1.0 m/s.
c. –0.50 m/s.
d. +1.0 m/s.

Equations and constants:

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

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

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

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

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

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

$\sum\vec{F}_{external} = \frac{\Delta\vec{p}}{\Delta t}$; $\left\{\begin{matrix} \omega = \omega_o + \alpha t \\ \Delta\theta = \frac{1}{2}(\omega_o + \omega)t \\ \Delta\theta = \omega_o t + \frac{1}{2}\alpha t^2 \\ \omega^2 = (\omega_o)^2 + 2\alpha\Delta\theta \end{matrix}\right\}$; $\left\{\begin{matrix} F = G\frac{m_1 m_2}{r^2} \\ G = 6.67\times10^{-11}\ \text{N}\cdot\text{m}^2/\text{kg}^2 \end{matrix}\right\}$; $\left\{\begin{matrix} M_{Earth} = 5.98\times10^{24}\ \text{kg} \\ R_{Earth} = 6.37\times10^{6}\ \text{m} \end{matrix}\right\}$;

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

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

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

$F_{Buoyancy} = \rho_{fluid} g V_{displaced}$; $A_1 v_1 = A_2 v_2$; $P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$; $1\ atm = 1.013\times10^5\ Pa$;

$\rho_{Iron} = 7{,}860\frac{\text{kg}}{\text{m}^3}$; $\rho_{water} = 1.00\ \frac{\text{g}}{\text{cm}^3} = 1.00\times10^3\ \frac{\text{kg}}{\text{m}^3}$; $\left\{\begin{matrix} Volume_{Cylinder} = \pi r^2 h \\ Volume_{Sphere} = \frac{4}{3}\pi r^3 \end{matrix}\right\}$;

$\left\{\begin{matrix} Area_{Circle} = \pi r^2 \\ Area_{\text{Rect}} = length \times width \end{matrix}\right\}$; 100 cm = 1 m; 1,000 m = 1 km; 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;
2π rad = 1 rev = 360 deg.