Name: _____PID _____ _____ Sec. _____

Useful constants:
$\rho_{water}$=1000 kg/m$^3$, g=9.8 m/s$^2$, 1 hp = 746 W, R$_{earth}$ = 6.38x10$^6$ m,
G=6.67x10$^{11}$ Nm$^2$/kg$^2$, g=9.81 m/s$^2$, k$_B$=1.38x10$^{-23}$ J/degK,
Absolute Zero = -273.15 degC. 1 cal = 4.186 J.
P$_{atm}$=1.013x10$^5$ Pa.

For each problem, choose the most nearly correct answer.

1. (1) One Joule is equivalent to one:
   a) $kg \cdot m^2 / s^2$
   b) $N \cdot m$
   c) $W \cdot s$
   d) all of the above
   e) none of the above

2. (2) A baseball is thrown upwards with a velocity of 30 m/s. How much time will pass before it returns to its original height? Neglect air resistance.
   a)      5.01 m/s
   b)      9.81 s
   c)      2.05 s
   d)      6.11 s
   e)      1.34 s

3. (3) An airplane is rated at an air speed of 320 mph. After accounting for the wind, a pilot flies the plane due directly south from Detroit to Cincinnati despite a strong west wind of 80 mph. What is the ground speed of the airplane during this trip?

   a) 400 mph
   b) 489.9 mph
   c) 320.0 mph
   d) 309.8 mph
   e) 240 mph

4. (4) A child and a sled have a mass of 45 kg. If the coefficient of friction between the snow and the sled is 0.23, what horizontal force must be applied to move the sled?
   a) 101.6 N
   b) 30.5 N
   c) 68.0 N
   d) 435.0 N
   e) 5.4 N

5. (4) Consider the picture below where the M=150 kg mass is held in place by the cable. What is the tension in the cable? Assume the pulley is frictionless.
   a) 1471.5 N
   b) 1040.5 N
   c) 2081 N
   d) 735.8 N
   e) 2943 N
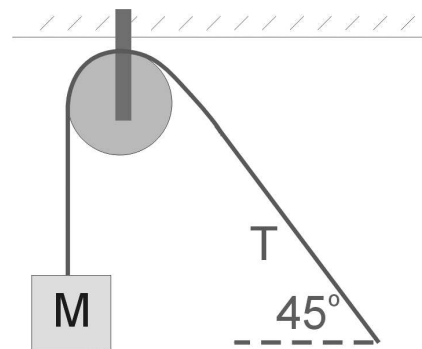
6. (4,5) After sliding down a frictionless slope of height h=200 m, a skier reaches a horizontal section where the coefficient of friction is 0.25. What distance $x$ will the skier slide along the horizontal section before coming to a stop?

   a) 800 m
   b) 50 m
   c) 275.4 m
   d) 480.6 m
   e) 6534 m
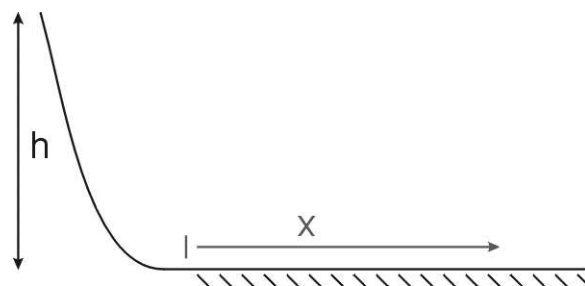
7. (5,6) Two blocks of mass 5 kg each, initially connected by a compressed spring, move together on a smooth surface with velocity 4 m/s. When the spring is suddenly released, the two blocks recoil from each other. One of the blocks comes to a stop; the other moves forward with increased speed. What is the kinetic energy gained or lost by this system in this process?

   a) 0 ( kinetic energy is conserved)
   b) 80 J
   c) 120 J
   d) 160 J
   e) not enough information to answer this question

8. (6) Hockey puck '1' which is initially at rest is struck head-on by an identical puck '2' which has an initial velocity $v_0$. The collision is perfectly elastic and puck '1' leaves with a velocity $v_1$ and puck '2' leaves with velocity $v_2$. Which of the following statements are true?

   a) $|v_1| < |v_0|$
   b) $|v_1| = |v_2|$
   c) $|v_1| > |v_0|$
   d) $v_2 = -v_0$
   e) $v_2 = 0$



9. (6) A child practices her skateboarding skill at a ramp as shown in the accompanying figure. She approaches the ramp with (horizontal) velocity of $v_i = 7$ m/s; and leaves the ramp with (vertical) velocity of $v_f = 3$ m/s. Assuming friction is negligible, the height of the ramp, $h$, is closest to:

   a)  1 m
   b)  1.5 m
   c)  2 m
   d)  2.5 m
   e)  4 m
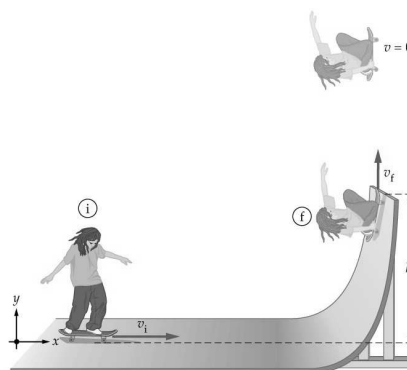
10. (7) A carnival ride is based on a rotating cylinder as illustrated in the picture. If the cylinder rotates once every 2 seconds, what radius is necessary for the normal force between the rider and the wall to equal 5 times the rider's weight?

a) 4.01 m
b) 4.97 m
c) 5.67 m
d) 8.86 m
e) 11.2 m
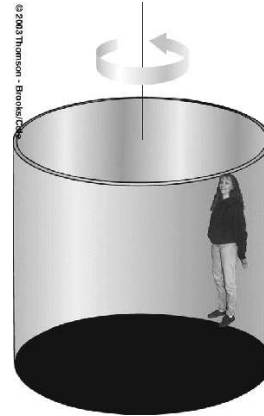
11. (8) Consider a light beam hung by two cables as shown above. A weight, Mg = 9000 N is hung as shown. What is the tension $T_L$ in the **left-side** cable?
a) 30,000 N
b) 12,857 N
c) 9000 N
d) 4500 N
e) 2700 N
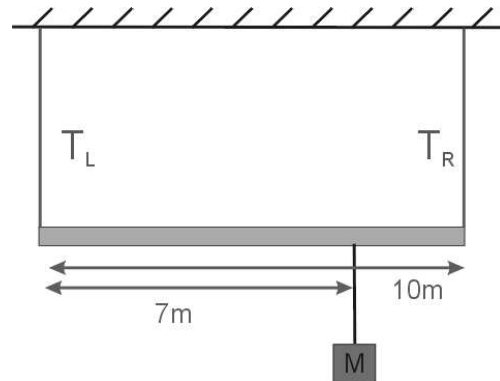
12. (9) An incompressible fluid moves through a pipe that has a radius of 30 cm at point 'A' and then narrows to a radius of 20 cm at point 'B'. Which of the following is true? (Assume non-viscous laminar flow).
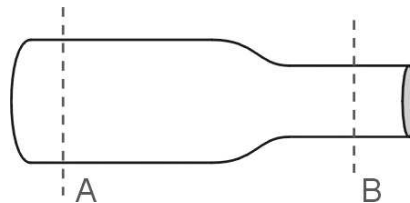
a) The amount of mass that passes 'A' in one second equals the amount of mass that passes 'B' in the same time.
b) The density of the fluid at 'A' equals the density of the fluid at 'B'.
c) The pressure of the fluid at 'A' is higher than the pressure at point 'B'.
d) The velocity of the fluid at 'A' is lower than the velocity at point 'B'.
e) All of the above.

13. (9) A rectangular raft has a uniform thickness of 15 cm and an area of 4.0 m². The mass of the raft is 240 kg. If the raft is floating on Lake Michigan, what percentage of the raft is below the water line?

   a) 20%

   b) 33.3%

   c) 40%

   d) 50%

   e) 63.3%

14. (9) A metal wire of length 2 m and thickness 1 mm expands by 1 mm in length when heated from 10 °C to 30 °C.   Another wire is made of the same material but length 1 m, and thickness 2 mm. By how much will the length of this wire expand when it is heated from 0 °C to 40 °C?

   a) 1 mm

   b) 2 mm

   c) 3 mm

   d) 4 mm

   e) 5 mm

15. (11) A 30-g lead bullet at 0°C is fired at a speed of 240 m/s into a large block of ice at 0°C, in which it embeds itself. What mass of ice melts?

DATA: $c_{lead} = 0.0305$ cal/(g·°C) , $L_{H20\ fusion} = 79.7$ cal/g

   a) 12.0 g

   b) 13.4 g

   c) 97.6 g

   d) 103.3 g

   e) 2.58 g

16. (11)  In an effort to reduce heating costs in his bunker, Dictator Dan doubles the thickness of his concrete walls. Which of the following is true?

   a) The conductivity of the concrete is doubled.

   b) The R-value of the wall is doubled.

   c) The conductivity of the concrete is halved.

   d) The R-value of the wall is halved.

   e) None of the above

17. (12) A massive piston traps an amount of Helium gas as shown. The piston freely slides up and down. The system initially equilibrates at room temperature (a). Weight is slowly added to the piston, ***adiabatically*** compressing the gas to half its original volume (b).

Which statement(s) are true?
   a) $P_b > P_a$
   b) $T_b > T_a$
   c) $U_b > U_a$
   d) All of the above
   e) None of the above
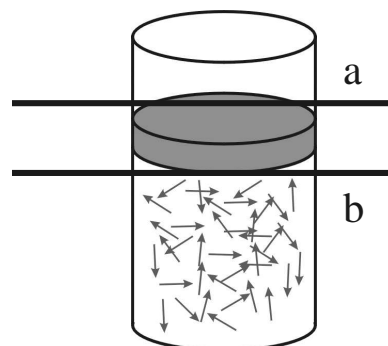
18. (13) If the amplitude $A$ of a system in simple harmonic motion (SHM) is doubled, which of the following statements is true?

   (a) total energy $E$ doubles,
   (b) maximum speed $v_{max}$ stays the same,
   (c) maximum acceleration $a_{max}$ stays the same,
   (d) period $T$ doubles,
   (e) maximum speed $v_{max}$ doubles.

19. (13) A simple pendulum has a period of $T_0$ at rest on earth.  It is put inside the space capsule mounted on a rocket. When the rocket accelerates upward with acceleration $a = 8\ g$ (g is the usual gravitational acceleration).  What is the period of the pendulum during this phase of the lift?

   (a) $T_0 / 8$
   (b) $T_0 / 3$
   (c) $2T_0$
   (d) $4\ T_0$
   (e) none of above

20. (13,14) A simple harmonic wave is given by the formula: $y(x,t) = (8\ cm)\ cos\ 2\pi(0.5\ x - 2\ t)$, where $x$ is in meters and $t$ in seconds. The wavelength $\lambda$ and velocity $v$ of this wave are, respectively:
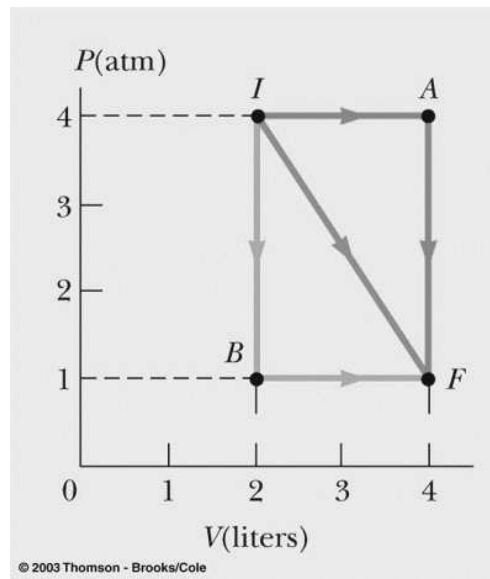
   (a) 1 m, 1 m/s ;
   (b) 0.5 m, 2 m/s ;
   (c) 1 m, 2 m/s ;
   (d) 2 m, 1 m/s ;
   (e) 2.0 m, 4 m/s

21. (13,14) A violinist is trying to tune her instrument to 550 Hz, but it is at 500 Hz. By what percent must she change the tension to tune the violin?
    a) 10%
    b) 21%
    c) 33.3%
    d) 50%
    e) 100%

22. (12) What amount of work is done by the gas in the cycle I→A→F→I shown below? ($P_{atm}=1.013\times10^5$ Pa)

    a) 0.5 J
    b) 304 J
    c) 681 J
    d) −681 J
    e) 16 J



23. (10) An ideal gas is kept at a constant pressure while being heated from room temperature (20 °C) to the temperature where water boils (100 °C). If the initial volume of the gas is 5.0 liters, what is the volume of the gas after being heated?
    a) 1.0 liters
    b) 3.14 liters
    c) 5 liters
    d) 6.36 liters
    e) 100.0 liters

24. (14) Two speakers separated by $x$ emit sound at 200 Hz in phase. An observer directly approaches speaker 'A' from far away and observes a first destructive interference minimum at distance $y$. If the distance of this furthest minimum is $y = 200$ m, what is $x$? (The speed of sound is 343 m/s)

    a)  52.4 m
    b)  1.42 m
    c)  32.6 m
    d)  0.45 m
    e)  18.5 m
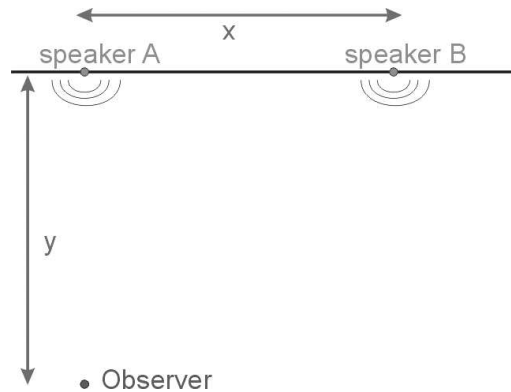


25. (14) A stationary whistle emits sound at 200 Hz. If a car hears the whistle with a frequency of 230 Hz, how fast is the car moving? (The speed of sound is 343 m/s)

    a)  51.5 m/s
    b)  43.9 m/s
    c)  29.8 m/s
    d)  17.4 m/s
    e)  13.2 m/s