1. (1 pt) How must the intensity of a sound be changed to cut the loudness in half?
   a. 1/100
   b. 1/10
   c. 1/2
   d. 1/\sqrt{2}

2. (1 pt) What is the change in internal energy for an adiabatic process?
   a. -Q
   b. -Q
   c. +W
   d. -W
   e. 0

3. (2 pt) A uniform beam 10.0m long, weighing 400N rests symmetrically on two supports, A and B, 4.0m apart.
   Todd weighs 800N and walks along the beam from A to B. How far beyond B can he walk before the beam begins to tip?
   a. 1m
   b. 2m
   c. 3m
   d. 4m

4. (6 pts) A bracket hangs from a wall and is loaded as shown. Calculate the magnitude of the force supported by the pin at A. Neglect the weight of the bracket. A separate, complete FBD is required for full credit.

5. (6 pts) Josh is on the International Space Station making 0.652 revolutions per hour in its orbit around the earth. Assuming a circular orbit, how high is this satellite above the surface of the earth?

\[ h = \frac{374000 \text{ m}}{\sqrt{\frac{GM_e}{r}}} \]

6. (6 pts) A proposed elevator in Estabrook is suspended by a steel cable with cross-sectional area 3\times10^{-4} \text{m}^2 and an ultimate strength of 9.25 \times 10^8 \text{ Pa}. If the elevator weighs 10KN, how many 70kg students can the elevator hold for a minimum factor of safety of 18?

\[ SF = \frac{UTS}{\sigma} \]

7. (6 pts) A styrofoam buoy is held completely submerged in water by a rope. The volume of the buoy is 0.045 m³. What is the tension in the rope? \( \rho_{\text{water}} = 1000 \text{ kg/m}^3 \)
   A separate, complete FBD is required for full credit.
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8. (6 pts) Megan is using a sewing machine and notices that the point of the needle moves in simple harmonic motion with a frequency of 8.5 Hz. At t=0, its position and velocity are $+1.2$ cm and $-0.7$ cm/s, respectively. Find the acceleration of the needle at t=0.5 seconds.

\[ \omega = 2\pi f = 2\pi (8.5) = 52.35 \text{rad/s} \]

\[ a = \frac{d^2x}{dt^2} = \frac{d^2}{dt^2} (\cos(\omega t)) = -\omega^2 \sin(\omega t) \]

\[ a(0.5) = -52.35 \sin(52.35 \times 0.5) = -37.3 \text{cm/s}^2 \]

9. (6 pts) Patrick ties a rope to a post and finds several frequencies at which he can oscillate the other end of the rope so that a light clothespin 1.25 ft from the post doesn't move. If the speed of the wave is 4.3 ft/s, what is the fundamental frequency of this oscillation?

\[ f = \frac{v}{\lambda} = \frac{4.3}{1.25} = 3.44 \text{Hz} \]

10. (6 pts) A bat flies toward a wall, emitting a steady sound of frequency 2000 Hz. The bat hears its own sound plus the sound reflected by the wall. If the bat is flying 22 m/s, what beat frequency does it hear? The speed of sound in air is 343 m/s.

\[ f_1 = 2000 \]

\[ f_2 = f_1 - \frac{420}{343} = 2137 \text{Hz} \]

11. (6 pts) Shane strikes a brass rod at one end. Patrick hears the sound at the other end 0.22 seconds later. How long is the brass rod? $\rho_{\text{brass}} = 8600 \text{ kg/m}^3$, $E_{\text{brass}} = 9 \times 10^{10} \text{ Pa}$

\[ \frac{712}{v} = \sqrt{\frac{E}{ho}} \]

\[ d = \sqrt{\frac{E}{ho} \pi^2} \]

\[ d = 712 \text{ m} \]

12. (6 pts) Geoff is designing an electronic circuit element made of $25 \times 10^4 \text{ kg}$ of silicon. The current going through it adds energy at a rate of $8.3 \times 10^3 \text{ W}$. His design does not allow any heat transfer out of the element. By how much will its temperature increase in one minute? Specific heat of silicon is 705 J/kg K.

\[ Q = m \cdot C \cdot \Delta T \]

\[ 6.3 \times 10^3 \cdot 705 = \frac{25 \times 10^4}{1057} \cdot \Delta T \]

\[ \Delta T = 600 \text{ K} \]

13. (6 pts) Frances pours 0.375 kg of coffee at 100°C into a well-insulated mug. How much ice at 0°C must be added to achieve optimum drinking temperature of 92°C? Assume no heat is transferred to the mug.

\[ Q_{\text{coffee}} = Q_{\text{ice}} = 0 \]

\[ -12558 \cdot 7 = m \cdot C \cdot (92 - 100) \]

\[ m = 17.58 \text{ kg} \]

\[ Q = m \cdot C \cdot \Delta T \]

\[ m \cdot C \cdot \Delta T = 733 \text{ m} \cdot \text{C} \cdot (92 - 0) \]

\[ m = 361.5 \text{ m} \cdot \text{C} \]
14. (6 pts) Water at 80°C is brought to a boil and 20% of its original mass is converted to steam. If the total change in entropy of the system is 9600 J/K, what was the original mass of water?

\[ \Delta S = m c \ln \frac{T_f}{T_i} = m \cdot 4.18 \times 10^3 \times \ln \frac{373}{300} = 2.38 \times 10^3 \text{ J/m}^3 \]

- Math Error: For using L(1)
- Sig. Fig. (2): For using Q
- For using C
- For missing \( \Delta S = m c \ln \frac{T_f}{T_i} \)
- For missing \( \Delta S = m c \ln \frac{T_f}{T_i} \)
- For missing \( \Delta S = m c \ln \frac{T_f}{T_i} \)

15. (6 pts) A refrigerator removes 950 J of heat. If the interior is 10°C and the outside is 35°C, how much heat is transferred to the outside?

\[ k_{	ext{refrigerator}} = \frac{T_i}{T_i - T_{	ext{outside}}} = \frac{283}{283 - 283} = 11.32 \]

- Math Error
- For missing \( k = \frac{Q}{W} \)
- For missing \( w \)
- For missing \( Q_k \)
- For missing \( Q_k \)

16. (6 pts) What must the charge (sign and magnitude) of a 1.65g particle be for it to remain stationary when placed in a downward directed electric field of 720 N/C?

\[ F = W = E q \]

\[ q = -2.25 \times 10^{-8} \text{ C} \]

- 1 sign error
- 1 g
- 1 kg • m/s
- 2 \( n = 0 \) m • kg

17. (6 pts) A circuit operates as shown. How much electrical energy does it consume during 2 hours?

\[ 21,600 \text{ J} \]

- No time calc
- \( R_{\text{eq}} (E = 12 \Omega) \)
- \( P = \frac{V^2}{R} = \frac{220}{27} = 81 \text{ W} \)
- 2 divided by 2200 s

18. (6 pts) For the system shown, the total charge is 47 \( \mu \text{C} \). What is the potential drop from A to B?

\[ q = 9.4 \text{ V} \]

- Capacitors in parallel
- \( C_{\text{eq}} = 2 \mu \text{F} + 3 \mu \text{F} \)
- \( C_{\text{eq}} = 1.2 \mu \text{F} \)
- \( C_{\text{eq}} = 3.92 \text{ V} \)

19. (6 pts) An electron moves at \( 1.6 \times 10^8 \) m/s as shown. Find the magnitude and direction of the magnetic field this electron produces at point A, 2.0 \times 10^{-8} \text{ m} \) away.

\[ F = q \left( \frac{V}{r} \right) \]

\[ B = \frac{2 \times 10^{-8}}{2} \]

\[ B = -6.4 \times 10^{-8} \text{ T} \]

\[ \mathbf{F} = -6.4 \times 10^{-8} \text{ T} \times \mathbf{r} \]