

$$1. \quad F = -kx \quad k = 1.75 \text{ kN/m}$$

$$F_e = kx = 1750 \text{ N/m}$$

$$= 1750 \text{ N/m} \times 0.8 \text{ m}$$

$$x = 80 \text{ cm}$$

$$= 0.8 \text{ m}$$

$$F_e = 1400 \text{ N}$$

$$= 1.4 \text{ kN}$$

$$2. \quad F = kx \quad F = 1.5 \text{ N}$$

$$k = ?$$

$$x = 30 \mu\text{m}$$

$$= 0.00003 \text{ m}$$

$$\frac{1.5}{0.00003 \text{ m}} = \frac{k \times 0.00003 \text{ m}}{0.00003 \text{ m}}$$

$$k = 50000 \text{ N/m}$$

$$= 50 \text{ kN/m}$$

$$3. \quad k = 0.125 \text{ MN/m}$$

$$= 125000 \text{ N/m}$$

$$x = 0.08 \text{ m} = 80 \text{ mm}$$

$$\text{Load} = 1000 \text{ kg} = 10000 \text{ N}$$

$$F_e = kx$$

$$F = 125000 \times 0.08 = 10000 \text{ N}$$

$$= 10 \text{ kN/m}$$

$$10 \text{ kN/m} = 10 \text{ kN} \cdot g$$

$$g = \frac{10 \text{ kN/m}}{10 \text{ kN}} = \underline{\underline{1 \text{ m/s}^2}}$$

4. Spring constant
 $k = 0.25 \text{ kN/m}$

$$\begin{aligned} \text{load} &= 400 \text{ g} \\ &= 0.4 \text{ kg} \\ &= 4 \text{ N} \end{aligned}$$

$$V_0 = 20 \text{ m/s}$$

$$A = ?$$

$$x(t) = A \sin(\omega t + \varphi)$$

$$V_t = \omega A \sin \omega t$$

$$V = \omega A$$

$$A = V/\omega$$

$$\omega = \sqrt{k/m}$$

$$= \sqrt{250 \text{ N/m} / 4 \text{ N}}$$

$$= \sqrt{62.5}$$

$$= 7.9$$

$$A = V/\omega = 20 / 7.9 = \underline{\underline{2.5}}$$

5. 1.2 oscillation in 2s

$$V = 31.2 \text{ m/s}$$

$$\lambda = ?$$

$$\lambda = V/f$$

$$\lambda = \frac{31.2 \text{ m/s}}{0.6 \text{ Hz (s}^{-1}\text{)}}$$

$$= \underline{\underline{52 \text{ m}}}$$

6. linear density $= 8.0 \times 10^{-4} \text{ kg/m}$

$$f = 400 \text{ Hz}$$

$$\lambda = 60 \text{ cm} = 0.6 \text{ m}$$

tension $(T) = ?$

$$v = \sqrt{F/\mu}$$

$$v^2 = F/\mu$$

$$F = v^2 \mu \quad v = \lambda \cdot f$$

$$= (\lambda \cdot f)^2 \mu = (400 \times 0.6)^2 \times 8.0 \times 10^{-4}$$

$$= 46.08 \text{ kg}$$

$$= 452.04 \text{ N}$$

7. Wave $= y = 4.2 \text{ m} \sin(1.2 \text{ rad/m} \cdot x - 9.6 \text{ rad/s} \cdot t)$

Speed in m/s?

$$y(x, t) = A \sin(kx - \omega t)$$

$$= 4.2 \text{ m} \sin(1.2 \text{ rad/m} \cdot x - 9.6 \text{ rad/s} \cdot t)$$

Speed $|v| = \omega/k$

$$\omega = 9.6 \text{ rad/s}$$

$$k = 1.2 \text{ rad/m}$$

$$9.6/1.2 = \underline{\underline{8 \text{ m/s}}}$$

8. Sound Intensity. in $\mu\text{W}/\text{m}^2$

$d = 1.86\text{m}$

source 4mW

Power $P = 4\text{mW} = 4000\mu\text{W}$

Distance $d = 1.86\text{m}$

$$I = P/A \quad I = P/4\pi d^2 = \text{Constant}/d^2$$

$$A = 4\pi d^2 = \frac{4000\mu\text{W}}{4\pi \times 1.86^2} = \frac{4000\mu\text{W}}{43.47\text{m}^2}$$

$$= \underline{\underline{92.017\mu\text{W}/\text{m}^2}}$$

9. Intensity Amplified. $20\mu\text{W}/\text{m}^2$ to $2\text{mW}/\text{m}^2$

$$= \frac{2000\mu\text{W}/\text{m}^2}{20\mu\text{W}/\text{m}^2}$$

$$1980\mu\text{W}/\text{m}^2$$

$$10 \log_{10} \left(\frac{1.98\text{W}/\text{m}^2}{10^{-12}\text{W}/\text{m}^2} \right)$$

$$= \underline{\underline{122.97\text{dB}}}$$

10. Input piston $r = 2\text{cm} = 0.02\text{m}$
output plunger $r = 0.4\text{m}$

Mass (Cart + Plunger) = 1.2 tonne = 1200 kg

Input force in (N)

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_1 = F_2 \left(\frac{A_1}{A_2} \right)$$

$$= F_2 \left(\frac{0.02^2}{0.4^2} \right) = F_2 \left(\frac{0.02^2}{0.4^2} \right)$$

$$= (12000\text{N}) \times \left(\frac{0.02^2}{0.4^2} \right)$$

$$= \underline{\underline{30\text{N}}}$$

11. $\Delta L = +90\text{mm}$

$$\Delta T = 30^\circ \quad -9^\circ\text{C to } 21^\circ\text{C}$$

Original length $L_0 = ?$

$$\alpha, \text{ coefficient of L.E.} = 12 \times 10^{-6} \text{ } ^\circ\text{C}^{-1}$$

$$\Delta L = \alpha L_0 \Delta T$$

$$0.09\text{m} = 12 \times 10^{-6} \text{ } ^\circ\text{C}^{-1} \times L_0 \times 30^\circ\text{C}$$

$$L_0 = \frac{0.09}{12 \times 10^{-6} \text{ } ^\circ\text{C}^{-1} \times 30^\circ\text{C}} = \frac{0.09}{0.00036} = 250$$

$$\underline{\underline{250\text{m}}}$$

12. Copper rod $r = 1.5 \text{ cm} = 0.015 \text{ m}$

length = 0.8 m

Temp = 415°C

rate of heat transfer i.e. $(W) = ?$

Room $T = 20^\circ \text{C}$

Thermal Conductivity of copper = $390 \text{ W/m}\cdot\text{K}$

$$Q/t = \frac{KA(T_2 - T_1)}{d}$$

$$Q = 390 (\pi \times 0.015^2 + \pi \times 0.03 \times 0.8) (415 - 20)$$

$$= 390 (0.076) 395$$

$$= 11723.99$$

$$= \underline{11.723 \text{ kW}}$$

13. Absorbs E at 760 W/m^2

Perfect radiator ($e = 1$)

Temp in Kelvin.

$$Q = 760 \text{ W/m}^2 = P/A$$

Stefan Boltzmann Law

$$T = \left[\frac{P/A}{e\sigma} \right]^{1/4} = \left\{ \frac{760 \text{ W/m}^2}{(1.00) 5.67 \times 10^{-8} \text{ J/(s}\cdot\text{m}^2\cdot\text{K}^4)} \right\}^{1/4}$$

$$= 340.25 \text{ K}$$

4. Balloon contains 0.3 m^3 of helium
Pressure $1.01 \times 10^5 \text{ Pa} = 1.09 \text{ atm}$
Temperature $= 310 \text{ K}$
Mass (in kg) of helium.

$$V = 0.3 \text{ m}^3$$

$$PV = nRT$$

Molar mass of He $= 4$

$$M = \frac{m}{n}$$

$$M = m \cdot \frac{RT}{PV}$$

$$M =$$

$$4 = \frac{m \cdot 0.082 \times 310 \text{ K}}{1.09 \text{ atm} \times 300 \text{ L}}$$

$$m = \frac{4 \times (1.09 \text{ atm} \times 300)}{0.082 \times 310} = 1302.738$$
$$= \underline{\underline{51.25 \text{ g}}}$$