

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

length $= 0.8 \text{ m}$

Temp $= 415^\circ \text{C}$

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

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

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

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

$$\begin{aligned} Q &= 390 (\pi \times 0.015^2 + \pi \times 0.03 \times 0.8) (415 - 20) \\ &= 390 (0.0076) 395 \\ &= 11723.99 \\ &= \underline{\underline{11.723 \text{ kW}}} \end{aligned}$$

13. Absorber $E = 760 \text{ W/m}^2$

Perfect radiator ($e = 1$)

Temp in Kelvin.

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

Stefan Boltzmann Law

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

$$= 340.25 \text{ K}$$

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

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

Input force F_1 (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 $L_0 = ?$

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

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

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

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

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

$$\begin{aligned}
 1. \quad F &= -kx & k &= 1.75 \text{ kN/m} \\
 F_e &= kx & &= 1750 \text{ N/m} \\
 &= 1750 \text{ N/m} \times 0.8 \text{ m} \\
 x &= 800 \text{ mm} & F_e &= 1400 \text{ N} \\
 &= 0.8 \text{ m} & &= 1.4 \text{ kN}
 \end{aligned}$$

$$\begin{aligned}
 2. \quad F &= kx & F &= 1.5 \text{ N} \\
 & & k &= ? \\
 & & x &= 30 \mu\text{m} \\
 & & &= 0.00003 \text{ m} \\
 \frac{1.5}{0.00003 \text{ m}} &= \frac{k \times 0.00003 \text{ m}}{0.00003 \text{ m}} \\
 k &= 50000 \text{ N/m} \\
 &= 50 \text{ kN/m}
 \end{aligned}$$

$$\begin{aligned}
 3. \quad k &= 0.125 \text{ MN/m} \\
 &= 125000 \text{ N/m} \\
 x &= 0.08 \text{ m} = 80 \text{ mm} \\
 \text{Load} &= 1000 \text{ kg} = 10000 \text{ N} \\
 F_e &= kx \\
 F &= 125000 \times 0.08 = 10000 \text{ N} \\
 &= 10 \text{ kN/m} \\
 10 \text{ kN/m} &= 10 \text{ kN} \cdot g \\
 g &= \frac{10 \text{ kN/m}}{10 \text{ kN}} = \underline{\underline{1 \text{ m/s}^2}}
 \end{aligned}$$

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 $|v| = \omega/k$

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

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

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

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

$$\begin{aligned} \text{load} &= 4000 \text{ g} \\ &= 0.4 \text{ kg} \\ &= 4 \text{ N} \end{aligned}$$

$$v_0 = 20 \text{ m/s}$$

$$A = ?$$

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

$$v_t = \omega A \sin \omega t$$

$$v = \omega A$$

$$A = v/\omega \quad \omega = \sqrt{k/m}$$

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

$$= \sqrt{62.5}$$

$$= 7.9$$

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

5. 1.2 oscillation in 2s

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

$$\lambda = ?$$

$$\lambda = v/f$$

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

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

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

$$d = 1.86\text{m}$$

Source 4 mW

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

$$\text{Distance } d = 1.86\text{m}$$

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

$$A = 4\pi d^2 = \frac{4000\mu\text{W}}{4\pi \times 1.86^2} = \frac{4000\mu\text{W}}{43.47\text{m}^2}$$
$$= \underline{\underline{92.017\mu\text{W}/\text{m}^2}}$$

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

$$= \frac{2000\mu\text{W}/\text{m}^2}{20\mu\text{W}/\text{m}^2}$$
$$= 1980\mu\text{W}/\text{m}^2$$

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

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