

$$(1) F = 6 \text{ N}, x = 0.03 \text{ m}$$

$$m = 3 \text{ kg}, x_{\max} = A = 0.06 \text{ m}$$

$$(a) k = \frac{F}{x} = \frac{6}{0.03} = 200 \text{ N/m}$$

$$(b) T = \frac{2\pi}{\omega} = 2\pi \sqrt{\frac{m}{k}}$$

$$T = 2\pi \sqrt{\frac{3}{200}} = \frac{2\pi}{10} \sqrt{\frac{3}{2}}$$

$$= 0.2\pi \times \sqrt{1.5} = 0.7698$$

$$f = 1/T = 1.3 \text{ Hz}$$

$$(c) v_{\max} = \omega A = (2\pi f) A$$

$$= 2 \times 3.14 \times 1.3 \times 0.06$$

$$= 0.49 \text{ m/s}$$

$$(d) |a_{\max}| = \omega^2 A$$

$$= (8.168)^2 \times 0.06$$

$$= 4.003 \text{ m/s}^2$$

$$(e) \text{ Now, } x = \frac{A}{2} = 0.03 \text{ m}$$

$$v = \omega (A^2 - x^2)^{1/2}$$

$$= 8.168 \times (27 \times 10^{-4})^{1/2}$$

$$= 0.42 \text{ m/s}$$

$$|F| = ma = kx$$

$$\Rightarrow a = \frac{kx}{m} = \frac{200 \times 0.03}{3}$$

$$= 2 \text{ m/s}^2$$

$$(f) x(t=0) = A = 0.06 \text{ m}$$

$$x(t) = A/2 = 0.03 \text{ m}$$

$$\text{If } x(t) = A \sin(\omega t + \phi)$$

$$\text{At } t=0 \Rightarrow \phi = \pi/2$$

$$\therefore x(t) = A \cos(\omega t)$$

$$\text{If } x(t) = A \cos(\omega t + \phi)$$

$$\text{At } t=0 \Rightarrow \phi = 0$$

$$\therefore x(t) = A \cos(\omega t)$$

$$\Rightarrow \frac{A}{2} = A \cos(2\pi f t)$$

$$\therefore 8.168 t = \cos^{-1}(1/2) = \frac{\pi}{3}$$

$$t = 0.128 \text{ s}$$

$$(2) m_1 = 50 \times 10^{-3} \text{ kg}$$

$$m_2 = 20 \times 10^{-3} \text{ kg}$$

$$x = 5 \times 10^{-2} \text{ m}$$

$$(a) k = |F|/x = \frac{m_2 g}{x}$$

$$= \frac{20 \times 10^{-3} \times 9.8}{5 \times 10^{-2}}$$

$$= 3.92 \text{ N/m}$$

$$(b) T = 2\pi \sqrt{\frac{m_1}{k}} = 0.718$$

$$(3) m = 4 \text{ kg}, k = 400 \text{ N/m}$$

$$x = 0.15 \text{ m} = A$$

$$(a) A = 0.15 \text{ m}$$

$$T = 2\pi \sqrt{\frac{m}{k}} = 0.628 \text{ s}$$

$$f = 1/T = 1.59 \text{ Hz}$$

$$(b) x = 0.1 \text{ m}$$

$$\text{K.E.} = \text{Total Energy} - \text{P.E.}$$

$$= \frac{1}{2} k A^2 - \frac{1}{2} k x^2$$

$$= 200 \times (A^2 - x^2) = 2.5 \text{ J}$$

$$(4) L = 10^{-4} \text{ H}, C = 2 \times 10^{-5} \text{ F}$$

$$R = 0.1 \Omega$$

$$\omega = \left(\frac{1}{LC} - \frac{R^2}{4L^2} \right)^{1/2} = 22355.09$$

$$f = \omega / 2\pi = 3.56 \text{ kHz}$$

$$(5) f = 90 \text{ Osc. per minute}$$

$$= 90/60 = 1.5 \text{ Hz}$$

$$\text{Time taken for 15 Osc. } t = 15/f$$

$$\therefore t = 15/1.5 = 10 \text{ s}$$

$$A(t) = A_0 e^{-t/T_r}$$

$$\text{or, } A_0/2 = A_0 e^{-t/T_r}$$

$$\Rightarrow t/T_r = \ln 2 \Rightarrow T_r = t/\ln 2$$

$$\therefore T_r = 10/0.693 = 14.43 \text{ s}$$

$$(6) T = 5 \text{ s}, A_0 = 76 \text{ s.d.}$$

$$A_1 = 34.2 \text{ s.d.}, A_2 = 15.5 \text{ s.d.}, A_3 = 6.9 \text{ s.d.}$$

$$\delta_1 = \ln(A_0/A_1) = 0.7985$$

$$\text{Damping factor} = \delta/T = 0.8/5 = 0.16 \text{ s}^{-1}$$

$$= 0.16 \text{ s}^{-1}$$