a) $Q = Q_0 e^{-kt}$

(i) when $t = 0$, $Q = 6$ mg

$\therefore 6 = Q_0 e^0$

$Q_0 = 6$

$Q = 6e^{-kt}$

when $t = 15$, $Q = 3$

$\therefore 3 = 6e^{-15k}$

$e^{-15k} = \frac{1}{2}$

$-15k = \ln \frac{1}{2}$

$k = -\frac{1}{15} \ln \frac{1}{2}$

(ii) $\frac{1}{8} = e^{\left(\frac{1}{15} \ln \frac{1}{2}\right) t}$

$\left(\frac{1}{15} \ln \frac{1}{2}\right) t = \ln \frac{1}{8}$

$t = 45$ hours

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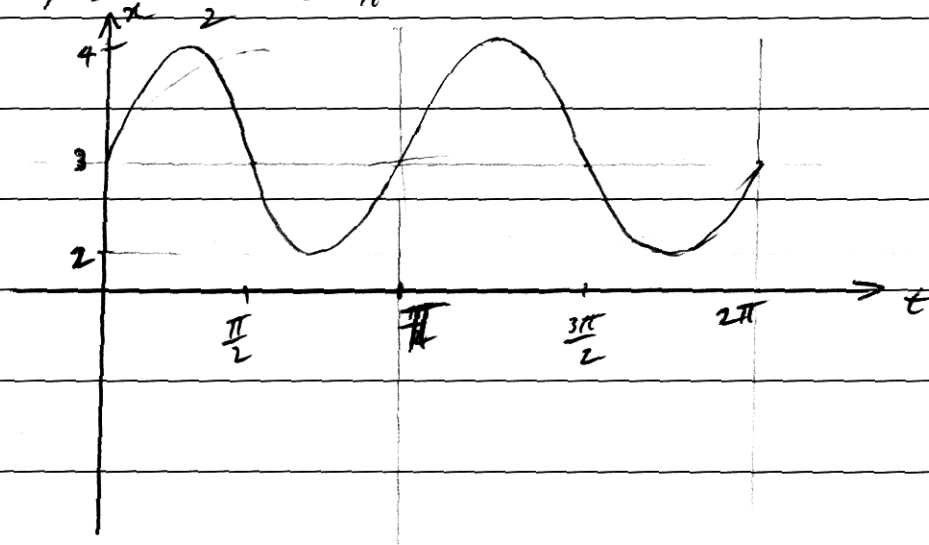
6) (i) $T = \frac{2\pi}{2} = \pi$



(ii) $x = \sin 2t + 3$

$\frac{dx}{dt} = 2\cos 2t$

when $\frac{dx}{dt} = 0$, $2\cos 2t = 0$

$\cos 2t = 0$

$2t = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \frac{7\pi}{2}$

$t = \frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}$ s

(iii) The particle increases velocity from $0 \le t < \frac{\pi}{4}$, then stops at $\frac{\pi}{4}$ s, continues to move in the same direction while increasing velocity from $\frac{\pi}{4} < t < \frac{\pi}{2}$, then begins to travel in opposite direction from $\frac{\pi}{2} < t < \pi$, in the same motion as before ie, increase v, then decrease.