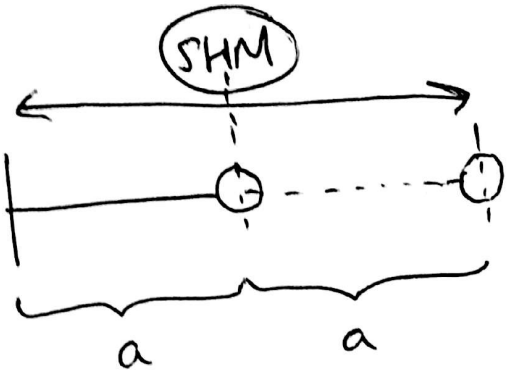
2005

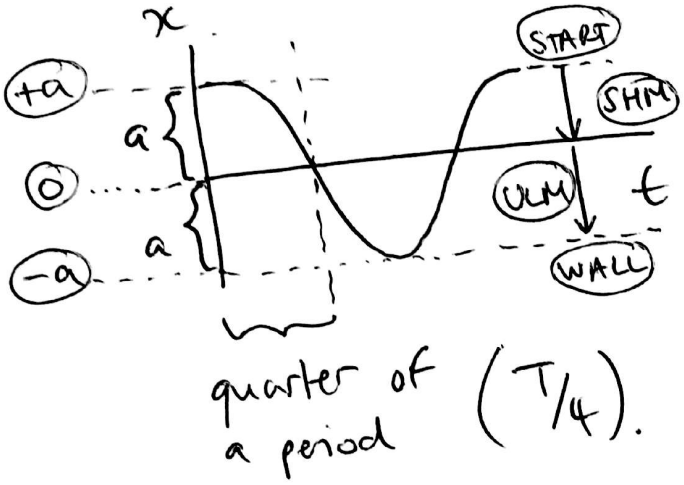
(6) b



* but! once string gets to natural length, SHM will no longer apply!

* Smooth, horizontal, ∴ equilibrium position = natural length!

- particle released from extreme position, ∴ cos(ωt)



* particle undergoes SHM from +a to 0, then linear motion.

- Hooke's Law: $F = -k(x)$ ← displacement/extension

$$ma = -kx.$$

$$a = \frac{-k}{m}x. \quad \therefore \omega^2 = \frac{k}{m}$$

$$\text{also: } a = -\omega^2 x. \quad \omega = \sqrt{k/m}.$$

$$\therefore T = \frac{2\pi}{\sqrt{k/m}} = \boxed{2\pi\sqrt{\frac{m}{k}}}$$

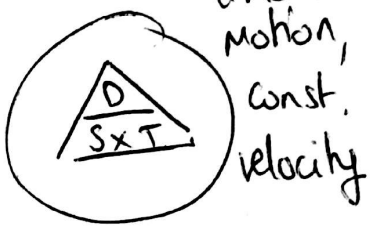
- time particle undergoes SHM

$$t_1 = \frac{1}{4}T = \frac{1}{4}\left[2\pi\sqrt{\frac{M}{k}}\right]$$

$$= \frac{\pi}{2}\sqrt{\frac{M}{k}}$$

- from this point, particle undergoes ULM at max. velocity

$$v_{max} = \omega A = a\sqrt{\frac{k}{M}}$$



linear motion, const. velocity

$$t_2 = \frac{s}{v} = \frac{a}{a\sqrt{\frac{k}{M}}} = \sqrt{\frac{M}{k}}$$

$\therefore$ total time $= t_1 + t_2$

$$= \frac{\pi}{2}\sqrt{\frac{M}{k}} + \sqrt{\frac{M}{k}}$$

$$= \boxed{\sqrt{\frac{M}{k}}\left(\frac{\pi}{2} + 1\right)}$$