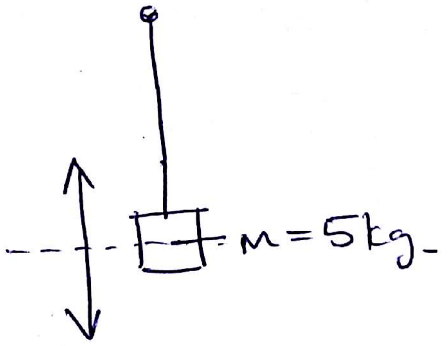
1 $\boxed{2014}$

6 (a).

4 osc / second



$\therefore f = 4.$

$T = \frac{1}{f} = 1/4$

$\omega = \frac{2\pi}{T} = 8\pi$

(i). $\boxed{F = -kx}$ ← Hooke's Law

↑ constant of elasticity

also, $\boxed{a = -\omega^2 x}$. ← SHM

$\therefore \quad F = -kx$

$ma = -kx$

$a = \frac{-k}{m} x.$

$\therefore \omega^2 = \frac{k}{m}.$

$k = \omega^2 m$

$= (8\pi)^2(5)$

$= (64\pi^2)(5)$

$= \boxed{320\pi^2}$ N/m.

$= 3158.27$

(ii). $F = -kx$.

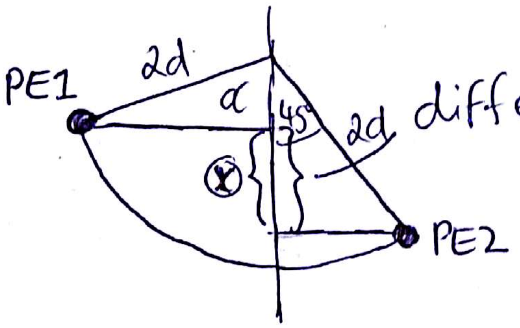
$F = -320\pi^2(0.015)$

$= (-)\boxed{47.4}\ N$

11 | 2014

★ tricky!

⑥ (b).



difference in PE
= KE at end!

(i). • diff in PE = $mg\,x$

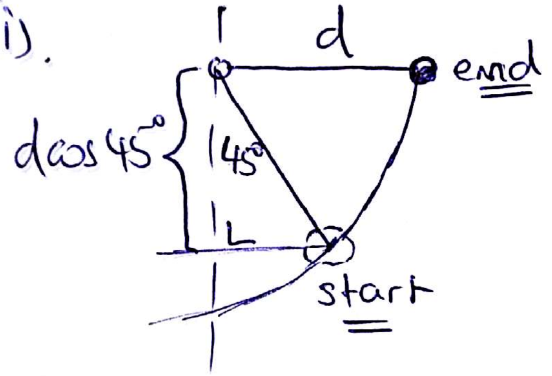
$$x = 2d\cos 45° - 2d\cos\alpha$$
$$= 2d(\cos 45° - \cos\alpha)$$
$$= 2d\left(\frac{\sqrt{2}}{2} - \frac{1}{4}\right)$$
$$= \sqrt{2}d - \frac{d}{2}$$

• ∴ diff in PE = $\boxed{mg\left(\sqrt{2}d - \frac{d}{2}\right)}$

• diff in PE = KE at end.

$$\therefore \frac{1}{2}\cancel{m}v^2 = \cancel{m}g\left(\sqrt{2}d - \frac{d}{2}\right)$$
$$\frac{1}{2}v^2 = gd\left(\sqrt{2} - \frac{1}{2}\right)$$
$$v^2 = 2gd\left(\sqrt{2} - \frac{1}{2}\right)$$
$$\boxed{v = \sqrt{gd(2\sqrt{2} - 1)}} = 4.233\sqrt{d}$$

(ii).



KE (Start) $\longrightarrow$ PE (to raise particle to end) + KE (whatever is left at end).

$$\frac{1}{2}\cancel{m}v_s^2 = \cancel{m}gd\cos 45° + \frac{1}{2}\cancel{m}v_e^2$$

$$v_s^2 = 2gd\cos 45° + v_e^2$$

$$v_e^2 = v_s^2 - 2gd\cos 45°$$

$$v_e^2 = gd(2\sqrt{2}-1) - 2gd\left(\sqrt{2}/2\right).$$

$$= 2gd\sqrt{2} - gd - gd\sqrt{2}.$$

$$= gd\sqrt{2} - gd$$

$$v_e^2 = \boxed{gd(\sqrt{2}-1)} = \underline{\underline{4.06d}}$$

at end, particle is horizontal

$\therefore$ no mass/weight contribution to centripetal force

$$\therefore T = \frac{mv^2}{r}$$

$$= \frac{mg\cancel{d}(\sqrt{2}-1)}{\cancel{d}}$$

$$= \boxed{mg(\sqrt{2}-1)}$$

$$= \underline{\underline{4.06m}}$$