RT9NE ①

late 9-1

Work:

Work = Force × displacement (in direction of force)

English: lb × ft ft-lbs

Metric: N × m N-m (joule) J.

To convert kg to N, multiply by 9.81 m/sec²
newton, N

If force varies with distance, say F(x),

then $dW(x) = F(x)dx$

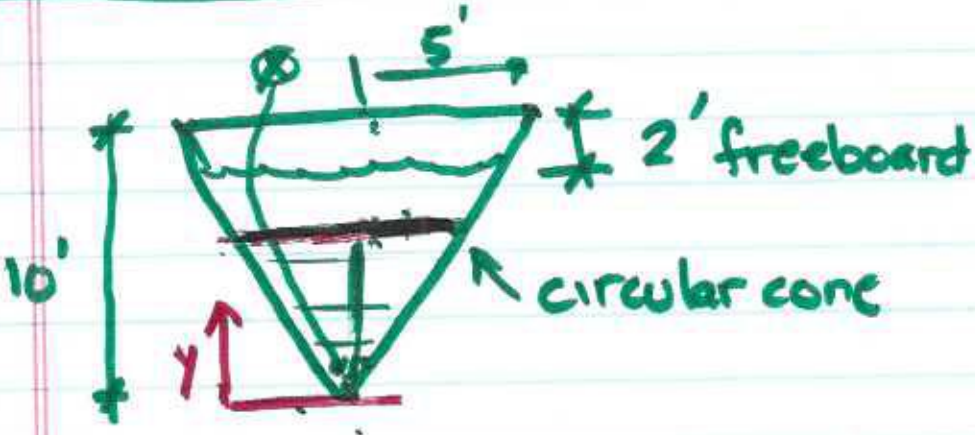
Spring Law $F(x) = -kx$ (k: spring constant)

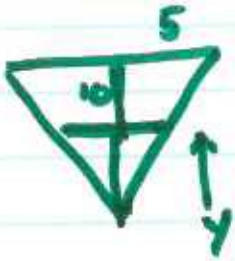
$dW(x)$ [done by spring] $= F(x)\,dx$ ⇒

$-kx\,dx$

Total work [by spring] $= \int_0^L -kx\,dx$ ⇒

$$-k\frac{x^2}{2}\Big|_0^L = -\frac{kL^2}{2}$$





Q: What is work to empty

density of oil is 57 lbs/ft^3

$\frac{r(y)}{y} = \frac{5}{10}$

so $r(y) = \frac{1}{2}y$

$F(y) = \left(\frac{\pi}{4}y^2\,dy\right)\cdot 57$

Dist thru which $F(y)$ must travel is $10-y$

(3)

$$dW(y) = \frac{57\pi}{4} y^2(10-y)\,dy$$

$$\text{Total Work} = \frac{57\pi}{4}\int_0^8 y^2(10-y)\,dy$$

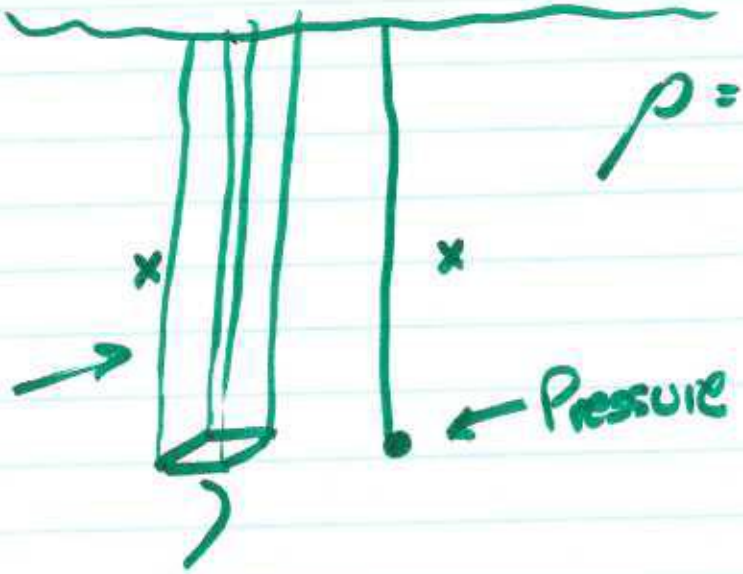
$$= \frac{57\pi}{4}\cdot\left[\int_0^8 10y^2\,dy - \int_0^8 y^3\,dy\right]$$

$$\left[\frac{10y^3}{3} - \frac{y^4}{4}\right]_0^8$$

$$= \frac{57\pi}{4}\left[\frac{5120}{3} - \frac{4096}{4}\right]$$ ft·lbs

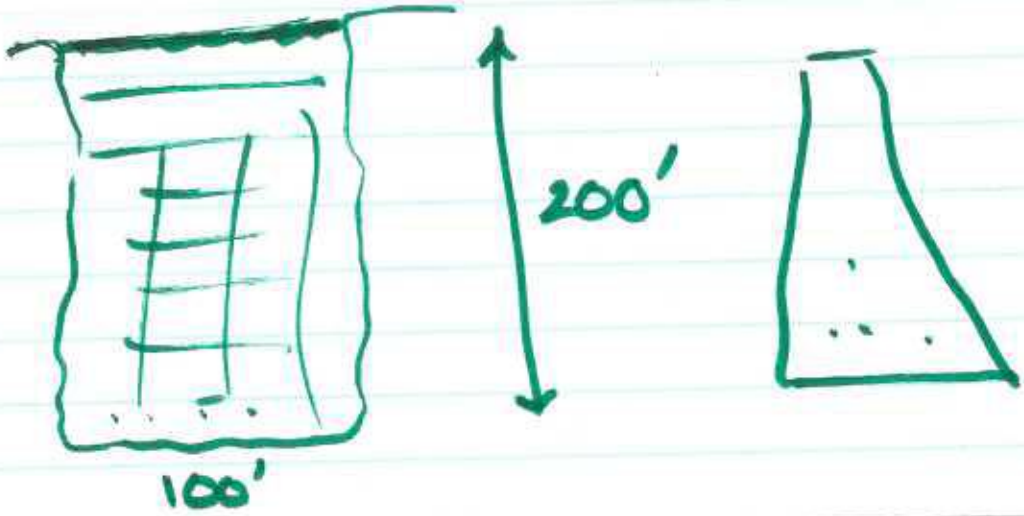
(4)

Pressure is force per unit area



$\rho = 62.4 \frac{lbs}{ft^3}$

$x\ ft^3 \cdot 62.4\ lbs/ft^3 = 62.4x\ \frac{lbs}{s.ft}$



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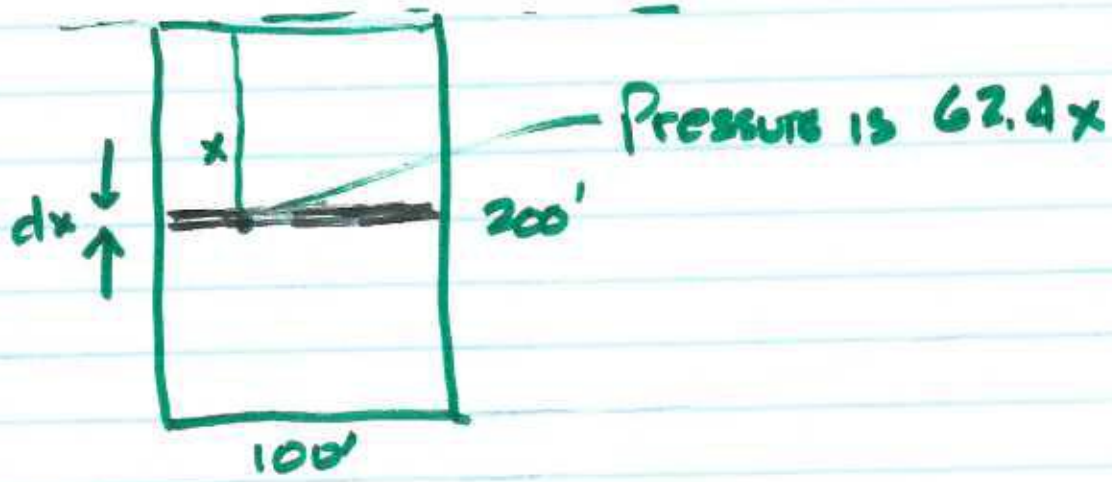


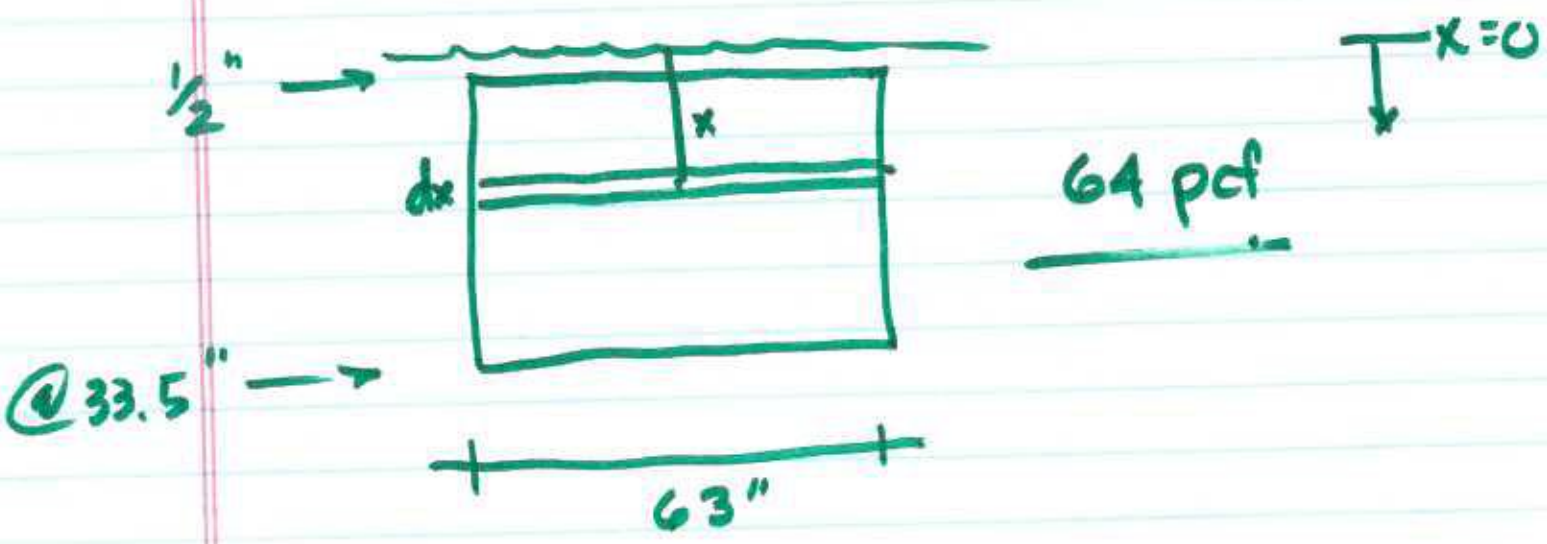
Area of strip is $100\,dx$ $\quad \underbrace{P} \quad \underbrace{A}$

Force on strip $dF(x) = (62.4x)(100\,dx)$

$$\text{Total Force} = \int_0^{200} 6240x\,dx = \frac{6240}{2}\left[x^2\right]_0^{200}$$

$(20{,}000)(6240) =$ # lbs on dam

#41 Aquarium



What is pressure on viewing window.

64x is pressure @ depth x

$$\frac{64}{1728} = .037 \frac{lbs}{in^3}$$

$$\rightarrow \underline{.037x} \frac{lbs}{in^2}$$

so $dF(x) = (63 \cdot dx)(.037x)$

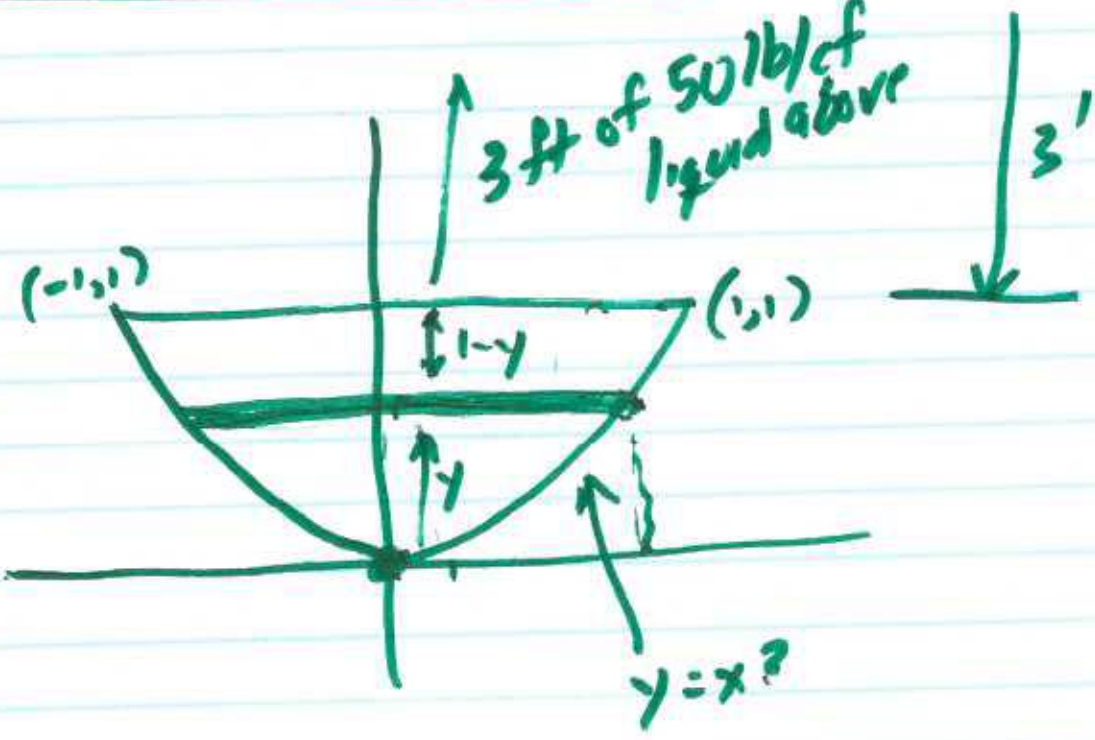
$= 2.331x\,lbs \cdot dx$

(7)

Total force = $\int_{.5}^{33.5} 2.331 x \, dx$ 2

$= \int_{.5}^{33.5} 2.331 \times dx$

$\frac{2.331}{2} \cdot \left[x^2\right]_{.5}^{33.5}$ = TOTAL FORCE



depth of section @ y is $3 + (1-y) = \underline{4-y}$

(8)

Pressure @ y from bottom is $(4-y)\,50$

Area @ y is $2\sqrt{y}\cdot dy$

$dF(y) = 100(4-y)\sqrt{y}\,dy$

Total Force $= \int_0^1 dF(y) =$

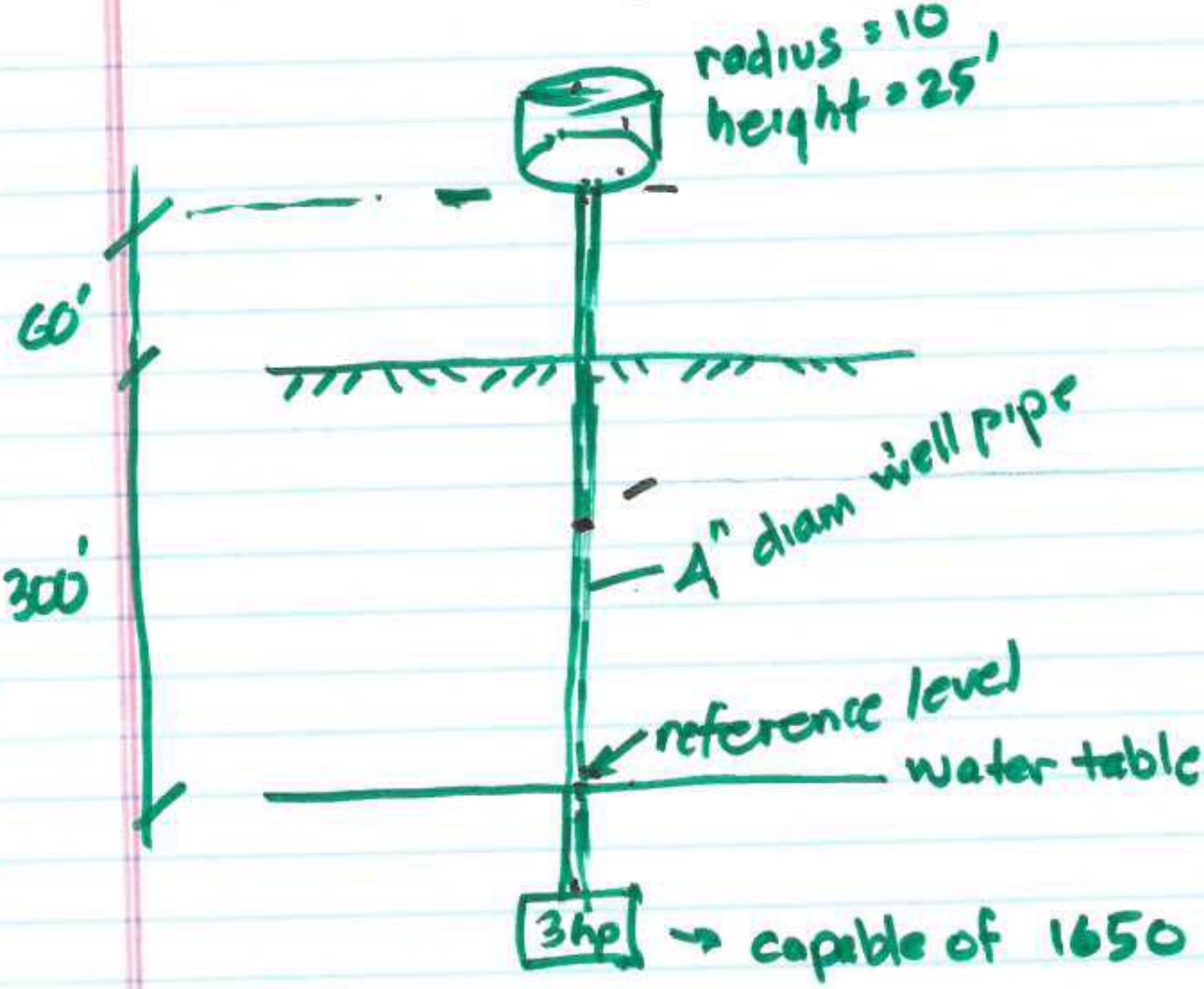
$$100\int_0^1 (4-y)\sqrt{y}\,dy$$

$$= 100\left[\int_0^1 4\sqrt{y}\,dy - \int_0^1 y^{3/2}\,dy\right]$$

$$100\left\{\left[4\cdot\frac{2}{3}y^{3/2}\right]_0^1 - \left[\frac{2}{5}y^{5/2}\right]_0^1\right\}$$

$$100\left(\frac{8}{3}-\frac{2}{5}\right) = \left(\frac{40}{15}-\frac{6}{15}\right)100$$

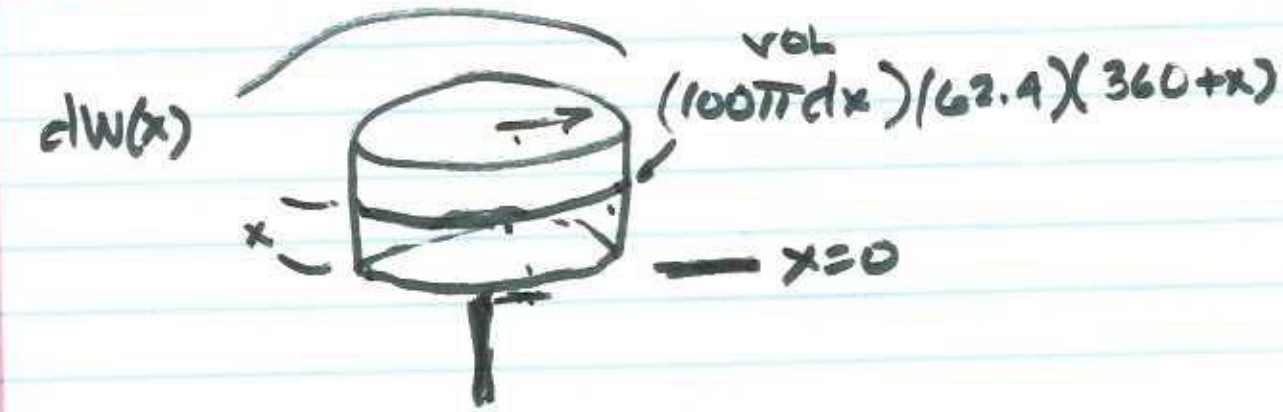
(9)



→ capable of 1650 $\frac{\text{ft-lbs}}{\text{sec}}$

pipe volume : $\pi \cdot (.166)^2 \cdot 360 =$

tank volume : $\pi \cdot 10^2 \cdot 25 = 2500\pi \text{ ft}^3$



(10)

Work to fill tank : $\int_0^{25} 6240\pi(360+x)\,dx$

work to fill feed pipe – homework