sec. 6.5 Work

Work (constant force) - $W = FD$ where D is the distance an object is moved and F is the constant force applied to the object.

Force - roughly a push or a pull

Work (variable force) - $W = \int_a^b F(x)\,dx$ where $F(x)$ is a continuously varying force applied to an object moving along a straight line from a to b.

Hooke's Law - $F = kd$ force is proportional to distance in compressing or stretching a spring (within its elastic limits). k depends on specific nature of spring.

Law of Universal Gravitation - $F = k\frac{m_1 m_2}{d^2}$ force of attraction between two particles of masses m_1 & m_2 is proportional to their masses product and inversely proportional to the square of the distance between the particles.

Coulomb's Law - $F = k\frac{q_1 q_2}{d^2}$ force between two charges q_1 & q_2 in a vacuum is proportional to the product of the charges and inversely proportional to the square of the distance between the charges

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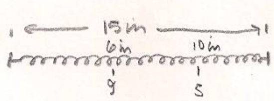
2) $W = (2400\text{ lb})(6\text{ ft})$
$= \underline{14{,}400 \text{ ft-lb}}$

6) 

from #5 $F = kd$
$5 = k4$
$\frac{5}{4} = k$

$W = \int_5^9 \frac{5}{4}x\,dx$
$= \frac{5}{8}x^2 \Big|_5^9 = \frac{5}{8}(81-25) = \underline{35 \text{ in-lb}}$

10)  2 springs $F = kd$
$15 = k(1)$

$W = 2\int_0^4 15x\,dx$ [doubled because 2 springs]

$W = 2\left[\frac{15}{2}x^2\right]_0^4$

$W = 15x^2\Big|_0^4 = \underline{240 \text{ ft-lb}}$

11) $F = \frac{k}{x^2}$ [neglecting air resistance & propellant]

$4 = \frac{k}{(4000)^2}$ [earth radius = 4000 miles]

$64{,}000{,}000 = k$

$w = \int_{4000}^{4200} \frac{64{,}000{,}000}{x^2}\, dx$

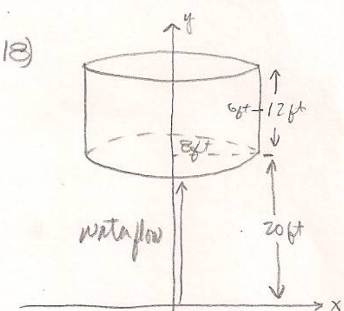
$W = -\frac{64{,}000{,}000}{x}\Big|_{4000}^{4200}$

$= -\frac{320{,}000}{21} + \frac{16000}{1}$

$= \frac{16000}{21}$ mi-tons

b) $w = \int_{4000}^{4400} \frac{64{,}000{,}000}{x^2}\, dx$

18)



distance ↓ force

$W = \int_{20}^{26} y\, (62.4\ pds/ft^3)(64\pi)\, dy$

$w = 3993.6\pi \int_{20}^{26} y\, dy$

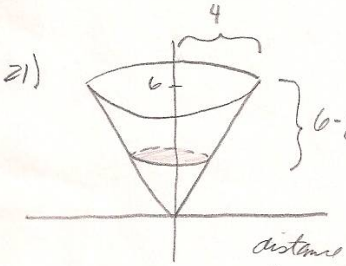
$W = 3993.6\pi \left[\frac{1}{2}y^2\right]\Big|_{20}^{26}$

$W = 3993.6\pi\left[\frac{1}{2}(676 - 400)\right]$

$w = 3993.6\pi[138]$

$w = 551116.8\pi$ ft-lb

21)



$r = \frac{4}{6}y = \frac{2}{3}y$ for any slice of the cone

distance ↓ force

$W = \int_0^6 (6-y)(62.4)\left(\pi\left(\frac{2}{3}y\right)^2\right) dy$

27) Bottom end at 10 foot level ⇒ 10 feet cranked up
Five feet left hanging.
last 5 feet pulled by constant force

$w_1 = 5(3)(10) = 150$ ft-lb

top 10 feet pulled by variable force

$w_2 = \int_0^{10} (10-y)\, 3\, dy$

$w_2 = 3\int_0^{10} 10 - y\, dy$

$w_2 = 3\left[10y - \frac{1}{2}y^2\right]\Big|_0^{10}$

$w_2 = 3[100 - 50] = 150$ ft-lb

$W = 150 + 150 = 300$ ft-lb

34) $V = 1\ ft^3$ $p = 2000$ psf $p = \frac{k}{V} \Rightarrow k = 2000$

$W = \int_1^4 \frac{k}{V}\, dv$

$W = \int_1^4 \frac{2000}{V}\, dV$

$W = 2000 \ln|V|\Big|_1^4$

$W = 2000 \ln 4$ ft-lb