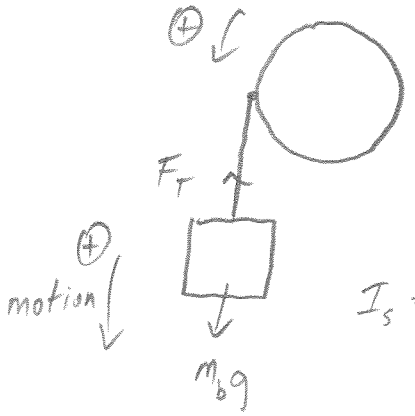
Physics 10154 - Exam #4d

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A 3.00 kg bucket is supported by a thin rope wrapped around a cylindrical spool with the system initially at rest. The spool is 6.0 kg with a radius of 0.75 meters. Determine the angular speed of the spool after the bucket has fallen 4.5 meters.



Bucket ΣF_y: $m_b g - F_T = m_b a$

Spool: $\Sigma \tau = R F_T = I \alpha$

$I_s = \frac{1}{2} M_s R^2 = 1.69$

$R F_T = \frac{1}{2} M R^2 \left(\frac{a}{R}\right)$

$F_T = \frac{1}{2} M a = 3a$

$m_b g - 3a = 3a$

$m_b g = 6a$

$9 = 2a \quad a = 4.9\ m/s^2$

$\alpha = \frac{a}{R} = 6.53\ rad/s^2$

$\Delta\theta = \frac{\Delta s}{R} = \frac{4.5}{0.75} = 6.0\ rad$

Alt: $\Sigma W_F = W_{grav} = \Delta K$

$m_b g h = \frac{1}{2} m_b v^2 + \frac{1}{2} I_s \omega^2$

$3(9.8)(4.5) = 1.5 v^2 + 0.84 \omega^2$

$132.3 = 1.5 v^2 + 1.5 v^2$

$v = 6.64$

$\omega = 8.9\ rad/s$

$\Delta\theta = 6.0\ rad$

$\omega_0 = 0$

$\omega = ?$

$\alpha = 6.53\ rad/s^2$

$t = ?$

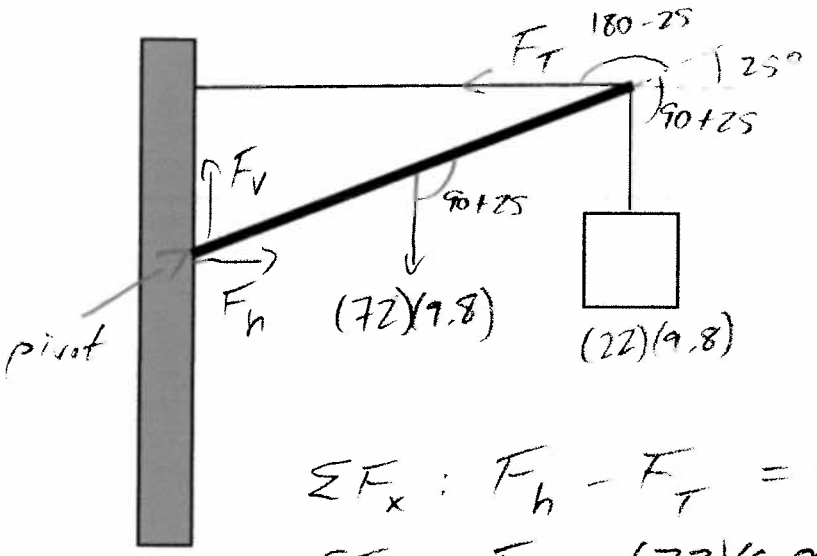
$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$

$\omega^2 = 2(6.53)(6.0)$

$\omega = 8.9\ rad/s$

2. (30 pts) A uniform 72-kg support pole is welded to a brick wall and extends outward, making a 25° angle above the horizontal. Hanging from the end of the pole is a 22-kg mass. A horizontal rope also supports the pole as shown below.

Determine the tension in the rope as well as the horizontal and vertical reaction forces of the wall acting on the pole.



$$\Sigma F_x : F_h - F_T = 0$$

$$\Sigma F_y : F_V - (72)(9.8) - (22)(9.8) = 0$$

$$\Sigma \tau \quad \tau_{72} + \tau_{22} + \tau_T = 0$$

$$-\tfrac{1}{2}\ell(72)(9.8)\sin 115^\circ - \ell(22)(9.8)\sin 115^\circ + \ell F_T \sin 155^\circ = 0$$

$$-319.74\ell - 195.4\ell + .423\ell F_T = 0$$

$$0.423F_T = 515.14$$

$$F_T = 1200\,N$$

$$F_h = F_T$$

$$F_h = 1200\,N$$

$$F_V = (72)(9.8) + (22)(9.8)$$

$$F_V = 920\,N$$

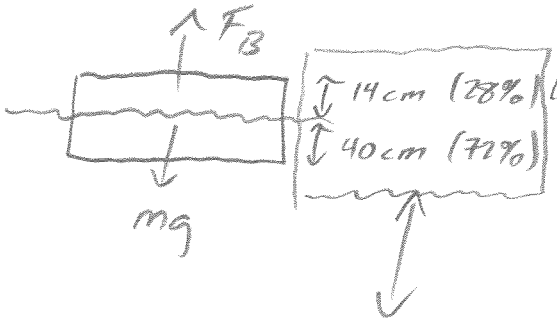
3. (40 pts) A 3900-kg solid wooden block is 2.0 meters x 5.0 meters in area and 54 cm vertically tall as it floats on water.

a) How many cm is the top of the block above the waterline?
b) How many 82-kg people can stand on the block before it is completely immersed?

$V_{block} = (2)(5)(.54) = 5.4\ m^3$

$\rho_{block} = \frac{m_{block}}{V_{block}} = 722\ kg/m^3$

a) Floating: $\Sigma F_y: \rho_f V_f g - \rho_b V_b g = 0$



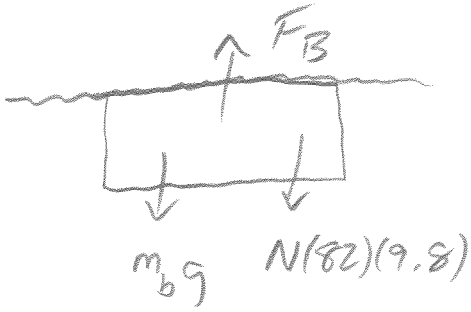
$\rho_f V_f = \rho_b V_b$

$\frac{V_f}{V_b} = \frac{\rho_b}{\rho_f} = 0.722$

Block is 72.2% submerged, so 27.8% above water

$(0.278)(0.52) = 0.14\ m$ or 14 cm

b) When block immersed $V_f = V_{block}$



$\Sigma F_y: F_B - m_b g - N(82)(9.8) = 0$

$\rho_f V_{block} g - m_b g - N(82) g = 0$

$(1000)(5.4) - 3900 - N(82) = 0$

$1500 = N(82)$

$N = 18$ people