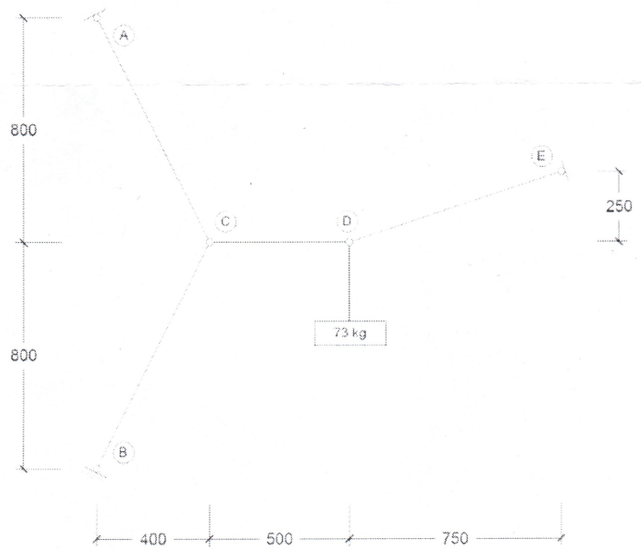
CIV102F Problem Set # 1- September 12 and 13, 2019

1. The following equations will be used later in the course. Derive the units of the specified parameters so that the equations remain dimensionally consistent (i.e. the units work out without requiring any conversion parameters). For example, the equation $v_{av} = {}^{\Delta x}/_{\Delta t}$ is dimensionally consistent if the average velocity v_{av} is in [m/s], the distance Δx is in [m] and the change in time Δt is in [s].

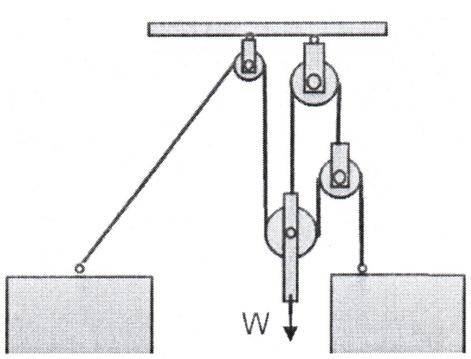
	Equation	Derive the units of the following:	Units of other variables
a)	$\sigma = \frac{P}{A}$	P, a force	σ is in MPa A is in m^2
b)	$\sigma = \frac{My}{I}$	M, a moment with dimension of [force × distance]	σ is in MPa y is in mm I is in mm^4
c)	$\phi = \frac{M}{EI}$	E, a material stiffness with dimensions of force per unit area	M is in Nmm I is in mm^4 ϕ is in rad/mm
d)	$E_{strain} = \frac{1}{2}\sigma\varepsilon AL$	L, a length	E_{strain} is in J σ is in MPa ε is in mm/mm A is in mm^2

For questions 2-5, a free body diagram showing a sign convention and corresponding equations of equilibrium must be presented for full marks

2. For the system of weights and wires shown below, solve for the forces in each of the three cables. All dimensions are in mm.

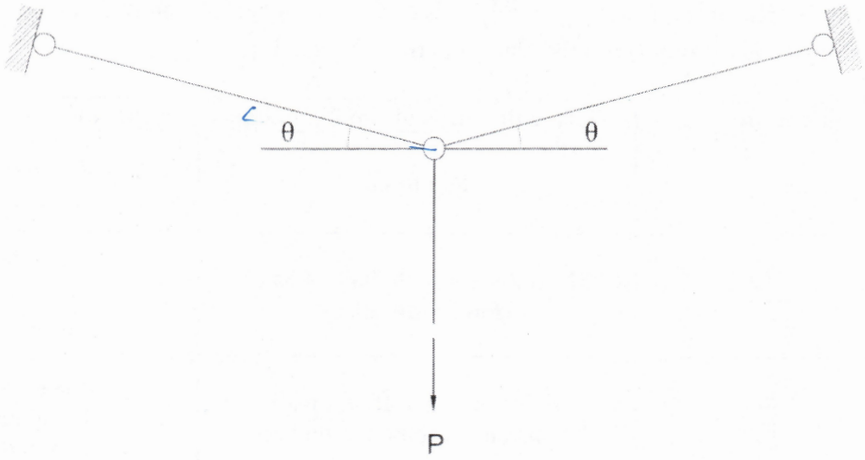


3. For the system of pulleys, weights and wires shown below, solve for the forces in each of the wires.



Reminder: Please report all final answers using slide-rule precision (ie, four significant figures if the first digit is a "1", three otherwise). Submit your completed assignment on engineering computation paper and write only on the non-grid side. Staple all pages together.

4. For the three-wire system shown below, each of the wires can carry a force of 500 N before breaking. Plot the relationship between the angle θ and the failure load P over values of θ over the domain $0 \leq \theta < 90°$ in increments of 15°. What is θ which causes all three wires to fail simultaneously?

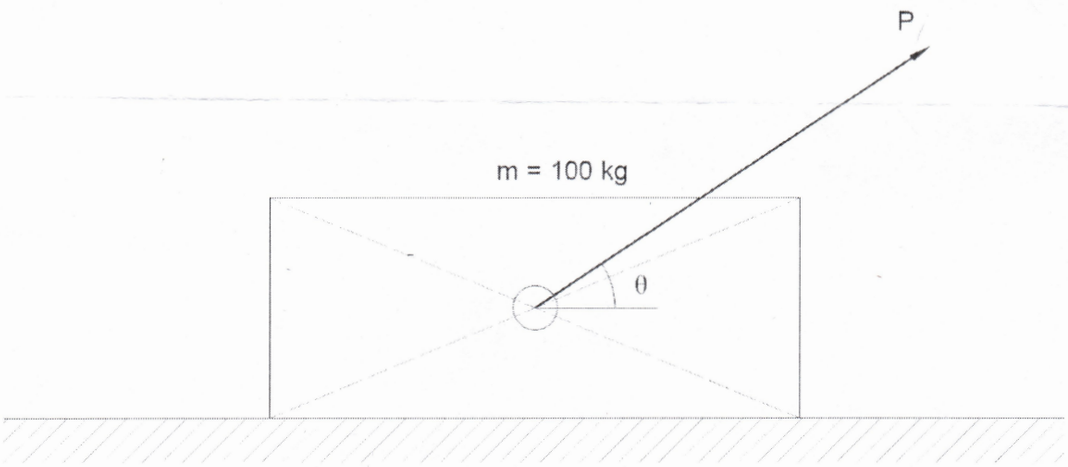


5. Shown below is a heavy box which you would like to move along the floor by pulling on an attached rope. Calculate P which causes the box to move if θ is 45°. Calculate the minimum pulling force P_{min} and the associated θ_{min} which makes the box easiest to move.

When solving this question, recall that the static friction force which must be overcome before sliding occurs is:

$$F_{Friction,static} = \mu_s F_n$$

Where μ_s is the coefficient of static friction and F_n is the normal force. For this question, μ_s is 0.75.



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