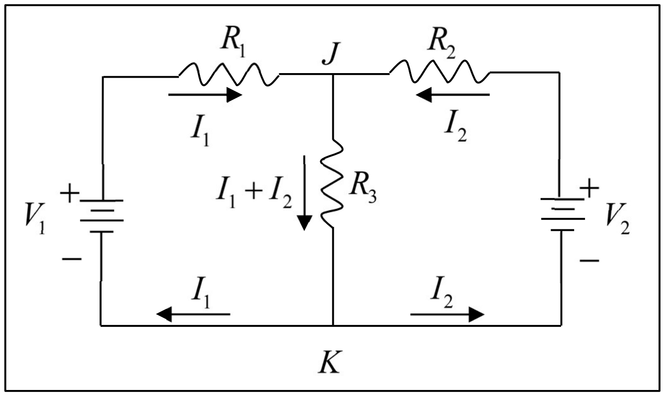
Elementary Engineering Mathematics
Exercises #6 – Two-Dimensional Vectors and Simultaneous Equations

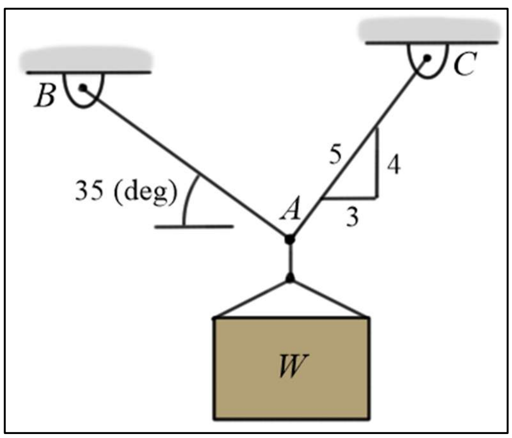
1. For the double-loop DC circuit shown, the currents I_1 and I_2 can be found by solving the following simultaneous equations.

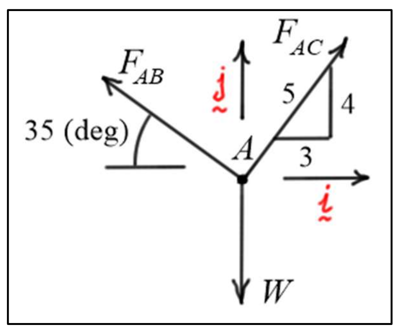
$$\begin{aligned}(R_1+R_3)I_1+(R_3)I_2&=V_1\\(R_3)I_1+(R_2+R_3)I_2&=V_2\end{aligned}$$



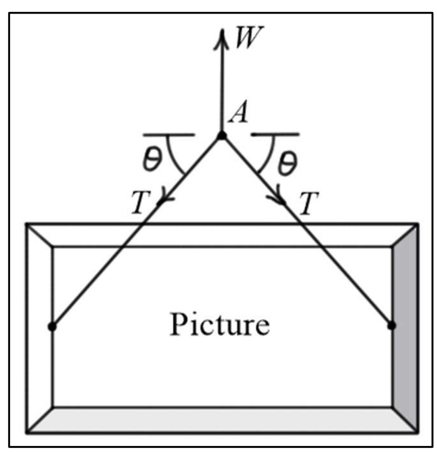
Given the resistances $R_1=8\,(\Omega)$, $R_2=10\,(\Omega)$, and $R_3=5\,(\Omega)$, and the voltages $V_1=12$ (volts), and $V_2=24$ (volts), find the currents I_1 and I_2 using (a) Gaussian elimination (substitution), (b) Cramer's rule, and (c) matrix inversion. Compare the results.

2. Given the weight $W=1000$ (lbs), find $\underset{\sim}{F}_{AB}$ and $\underset{\sim}{F}_{AC}$ the forces in the supporting wires by setting the sum of the forces to zero at A, using (a) Gaussian elimination (substitution), (b) Cramer's rule, and (c) matrix inversion. Compare the results.





3. The figure shows a picture hanging on a wall at point A. The weight of the picture is W. Assuming the picture wire is aligned symmetrically (at an angle θ to the horizontal), find the tension T in the wire as a function of the weight W and angle θ. How does the tension change as the picture wire is shortened, moving A closer to the picture frame? What is the limiting value of T?



4. The diagram shows a simple truss that is connected to the ground with a pin support at A and a pin and roller support at C. Free body diagrams of the truss and the pin at B are also shown. Using the free body diagram of the ***truss***, find (a) the moment of the force $\underset{\sim}{P}$ about point A, (b) the force $\underset{\sim}{C}$ so the sum of the moments of forces $\underset{\sim}{A}$, $\underset{\sim}{P}$, and $\underset{\sim}{C}$ about A is zero, and (c) the X and Y components of the force $\underset{\sim}{A}$ so the sum of the forces $\underset{\sim}{A}$, $\underset{\sim}{P}$, and $\underset{\sim}{C}$ is zero. Using the free body diagram of pin B, (d) find a set of simultaneous equations you can solve for the magnitudes of forces $\underset{\sim}{F}_{AB}$ and $\underset{\sim}{F}_{BC}$ by setting $\underset{\sim}{P}+\underset{\sim}{F}_{AB}+\underset{\sim}{F}_{BC}=\underset{\sim}{0}$, and (e) solve the simultaneous equations using Cramer's rule.