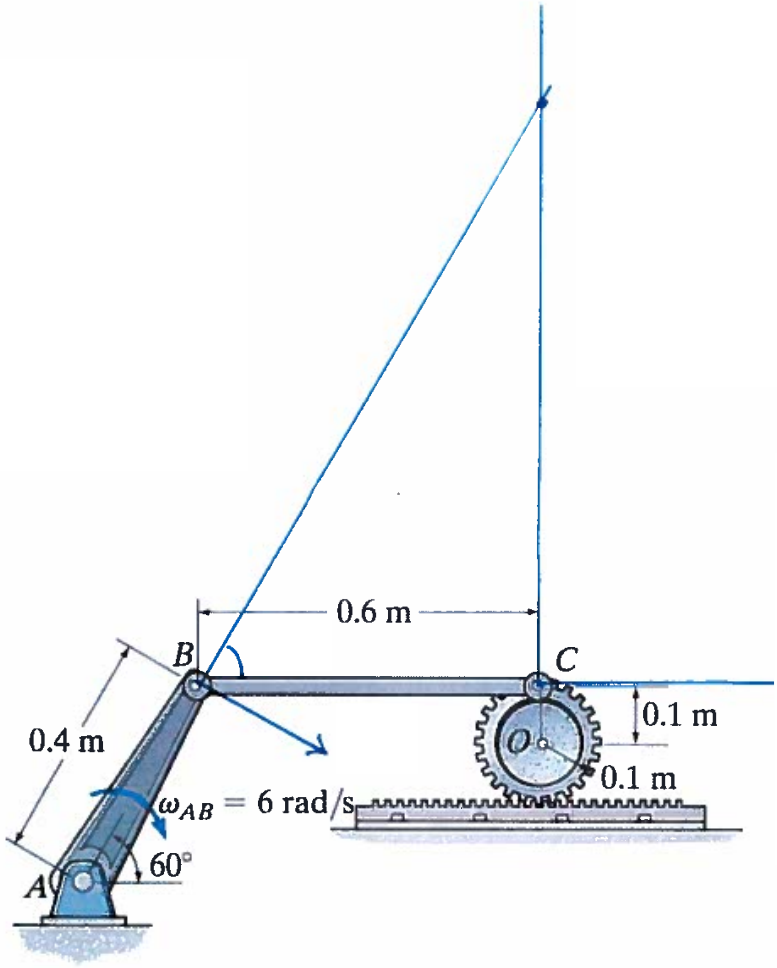
Name:_____ Section:_____

SA1 [5 Marks] Consider the mechanism below and visualize how it moves.

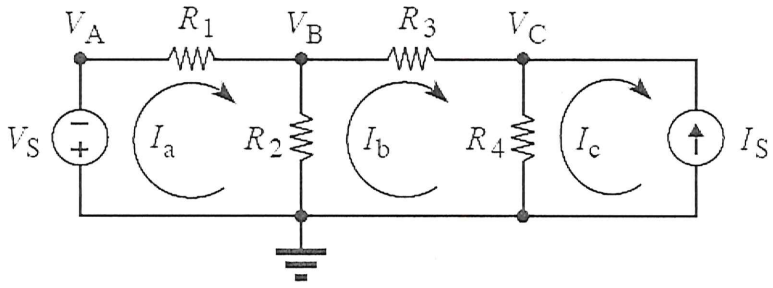


To get credit for the following questions you will need to show your solution method by drawing or by calculations:

a) [2 marks] Bar BC rotates **counterclockwise**. Using a straightedge, on the diagram, draw **and label** a vector showing

1. Direction of velocity of point B, $\mathbf{v}_B$.
2. Direction and velocity of point C, $\mathbf{v}_C$.

SA1 [5 Marks]. Consider the following circuit for which all the resistor and source values are known:



(a) [2.5 Marks] Write the minimal set of equations that could be solved for the labeled node voltages V_A, V_B and V_C.

(b) [2.5 Marks] Write the minimal set of equations that could be solved for the labeled mesh currents I_a, I_b and I_c.

Prob 1 [25 marks] ***This question has 5 parts: (a), (b), (c), (d) & (e).***

Consider the following mixing problem for parts (a), (b) and (c) below.
A small tank initially contains 100L of pure water. At time $t = 0$, a salt-water solution with concentration 20g/L is poured into the tank at 1L/min and solution from the tank is drained at 2L/min. Assume the solution in the tank is perfectly mixed.

(a) [5 marks] Show that the total mass $M(t)$ of salt in the tank (as a function of time t) satisfies the differential equation

$$\frac{dM}{dt} = 20 - \frac{2M}{100 - t}$$

(Note that M is measured in grams and t is measured in minutes.)

(b) [10 marks] Solve the equation in part (a) and find a formula for the **concentration** $C(t)$ of the salt solution in the tank (in g/L) as a function of time t.

(c) [3 marks] What is the concentration of the solution in the tank at the instant just before it is empty?

Consider the following differential equation in parts (d) and (e):

$$y' = -y^2 - 2y + 8 \quad (*)$$

(d) [5 marks] Sketch the phase line for the first order equation $(*)$ above including critical points and flow directions.

(e) [2 marks] Compute the steady state

$$\lim_{t\to\infty} y(t)$$

for the solution $y(t)$ of the differential equation $(*)$ above satisfying $y(2) = 1$. Justify your answer.