Solve the problems below on this paper in the spaces provided. In your solutions you need to show not only the answers but the steps or rationale you used to arrive at the answer. If you perform special actions on your calculator (like a SOLVE or a cross product), write out the steps you used and precisely what you entered into the calculator. Your answers need to be complete enough to make your work checkable. Box your final answers. If you need more space, you may attach a paper with the continued part of the problem clearly designated as the continued part.

Points: a=24, b=3, c=2, d=6, e=4, f=4, g=6, h=6, i=8, j=6

1. The mechanism at right is called a four-bar linkage, even though it only has three moving bars. It has the dimensions shown. The mechanism is driven by link AB, which has a given constant rotational velocity, $\omega_{AB}$, counter-clockwise. Give all answers below in terms of $\ell$, $\omega_{AB}$, and $\theta$. Use cross products and unit vectors in your solution methodology.

a. Find $\vec{v}_C$. Show all work.
b. Find $\vec{\omega}_{CD}$.

c. Find $\vec{\omega}_{BC}$.

d. Mark the instant centers of all three links on the drawing. Provide an explanation, if necessary.

e. Find $\vec{a}_{B/A-n}$, $\vec{a}_{B/A-t}$, and $\vec{a}_B$ in terms of the given variables (only).

f. On the drawing of link CD, draw at C $\vec{a}_{C/D-n}$ and $\vec{a}_{C/D-t}$. Assume $\omega_{CD}$ and $\alpha_{CD} > 0$ (so the rotational vectors are in the +z direction). Label these vectors.

g. On the drawing of link BC, draw at C $\vec{a}_{C/B-n}$ and $\vec{a}_{C/B-t}$. Assume $\omega_{BC}$ and $\alpha_{BC} > 0$ (so the rotational vectors are in the +z direction). Draw also at B $\vec{a}_B$. Label all vectors.
h. On the origin at right, draw the vector sum for \( \vec{a}_C \) using the vectors drawn in part f. Use the tip-to-tail graphical method for adding vectors. Label the vectors using the names given in part f. Where the angle \( \theta \) is important in your drawing, draw it.

i. On the origin at right, draw the vector sum for \( \vec{a}_C \) using the vectors drawn in part g. Use the tip-to-tail graphical method for adding vectors. Label the vectors using the names given in part g. Where the angle \( \theta \) is important in your drawing, draw it.

j. Now compare the results of h and i. Write relationships for the x and y directions that give the connections between the magnitudes of the vectors in h and i. Use the relative acceleration variables given in parts f and g and also \( \theta \) for your answers.

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x:
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y:
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