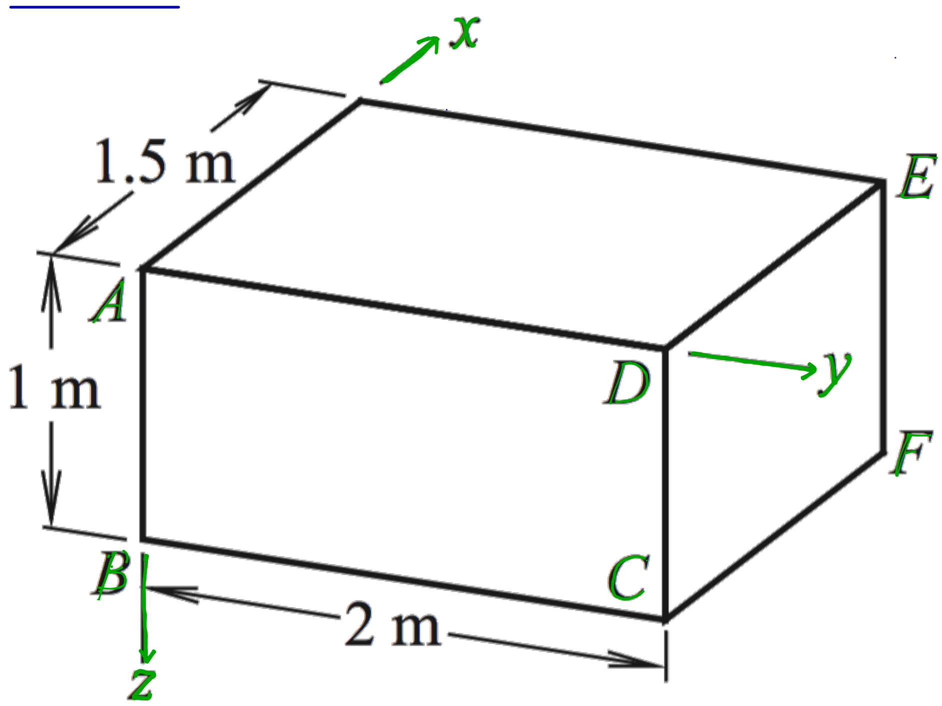
Example 4.1

EXAMPLE 4.1 Observation of the motion of the block reveals that at a certain instant the velocity of corner B is parallel to the diagonal BE. At this instant components relative to the body-fixed xyz coordinate system of the velocities of the other corners are believed to be $(v_A)_y = 10$, $(v_C)_y = 20$, $(v_D)_z = 10$, $(v_E)_x = 5$ m/s. Determine whether these values are possible, and if so, evaluate the velocity of corner F.



$\bar{V}_A \cdot \bar{J} = 10$ m/s
$\bar{V}_C \cdot \bar{J} = 20$ m/s
$\bar{V}_D \cdot \bar{k} = 10$ m/s
$\bar{V}_E \cdot \bar{I} = 5$ m/s

Is there some $\bar{\omega}$ such that all of these are true?

$\bar{V}_B = V_B \bar{e}_{E/B}$ $\quad$ $\bar{e}_{E/B} \equiv$ unit vector from B to E

Q: What is $\bar{e}_{E/B}$?

Write $\bar{r}_{E/B}$ then normalize. $\quad \bar{r}_{E/B} = 1.5\bar{I} + 2\bar{J} - 1\bar{k}$

$$\bar{e}_{E/B} = \frac{\bar{r}_{E/B}}{|\bar{r}_{E/B}|} = \frac{1.5\bar{I} + 2\bar{J} - 1\bar{k}}{(1.5^2 + 2^2 + 1^2)^{1/2}}$$

We don't know $\bar{\omega}$ so write it as $\bar{\omega} = \omega_x\bar{I} + \omega_y\bar{J} + \omega_z\bar{k}$

Q: How (else) can we write the velocities of the box corners?

$\bar{V}_A = \bar{V}_B + \bar{\omega} \times \bar{r}_{A/B}$, $\bar{r}_{A/B} = -\bar{k}$
$\bar{V}_C = \bar{V}_B + \bar{\omega} \times \bar{r}_{C/B}$, $\bar{r}_{C/B} = 2\bar{J}$
$\bar{V}_D = \bar{V}_B + \bar{\omega} \times \bar{r}_{D/B}$, $\bar{r}_{D/B} = 2\bar{J} - \bar{k}$
$\bar{V}_E = \bar{V}_B + \bar{\omega} \times \bar{r}_{E/B}$, $\bar{r}_{E/B} = 1.5\bar{I} + 2\bar{J} - \bar{k}$

equate to parameters given and attempt to solve

Find that a solution is not possible.