The figure below right shows Atwood's machine, in which two containers are connected by a cord of negligible mass passing over a frictionless pulley. At time $t = 0$, container 1 has mass 1.50 kg and container 2 has mass 3.00 kg, but container 1 is losing mass through a leak at a constant rate of 0.250 kg/s.

a) At what rate is the acceleration magnitude of the containers changing at $t = 2.00$ s?

Since $m_2 > m_1$, we take our positive directions for $m_1$ and $m_2$ upward and downward respectively. In these coordinate systems, $m_1$ and $m_2$ have the same acceleration. Newton’s 2\textsuperscript{nd} law yields

$m_1a = T - m_1g, m_2a = m_2g - T$

Solving these equations for $a$, we get

$(m_1 + m_2)a = (m_2 - m_1)g$

$\Rightarrow a = (m_2 - m_1)g/(m_1 + m_2) = (1.5 + 0.25t)g/(4.5 - 0.25t)$

The rate of change in the acceleration is

$\frac{da}{dt} = 1.5g/(4.5 - 0.25t)^2$

At $t = 2$ s, we have

$\frac{da}{dt}(t = 2) = 1.5g/(4.5 - 0.25\times2)^2 = 0.919 \text{ m/s}^3$

b) When does the acceleration reach its maximum value?

The acceleration of the blocks increases with time. Therefore, the maximum acceleration is achieved when the mass of block 1 becomes zero.

$1.5 - 0.25t = 0 \Rightarrow t = 6.00 \text{ s}$