Q: Ant-Man shrinks to a small size. Let's assume in this case that despite the Square-Cube Law, the mass is also decreased proportionally, considerably based on volume. A normal Scott Lang is about 78 kg and apparently about 1.78 m.

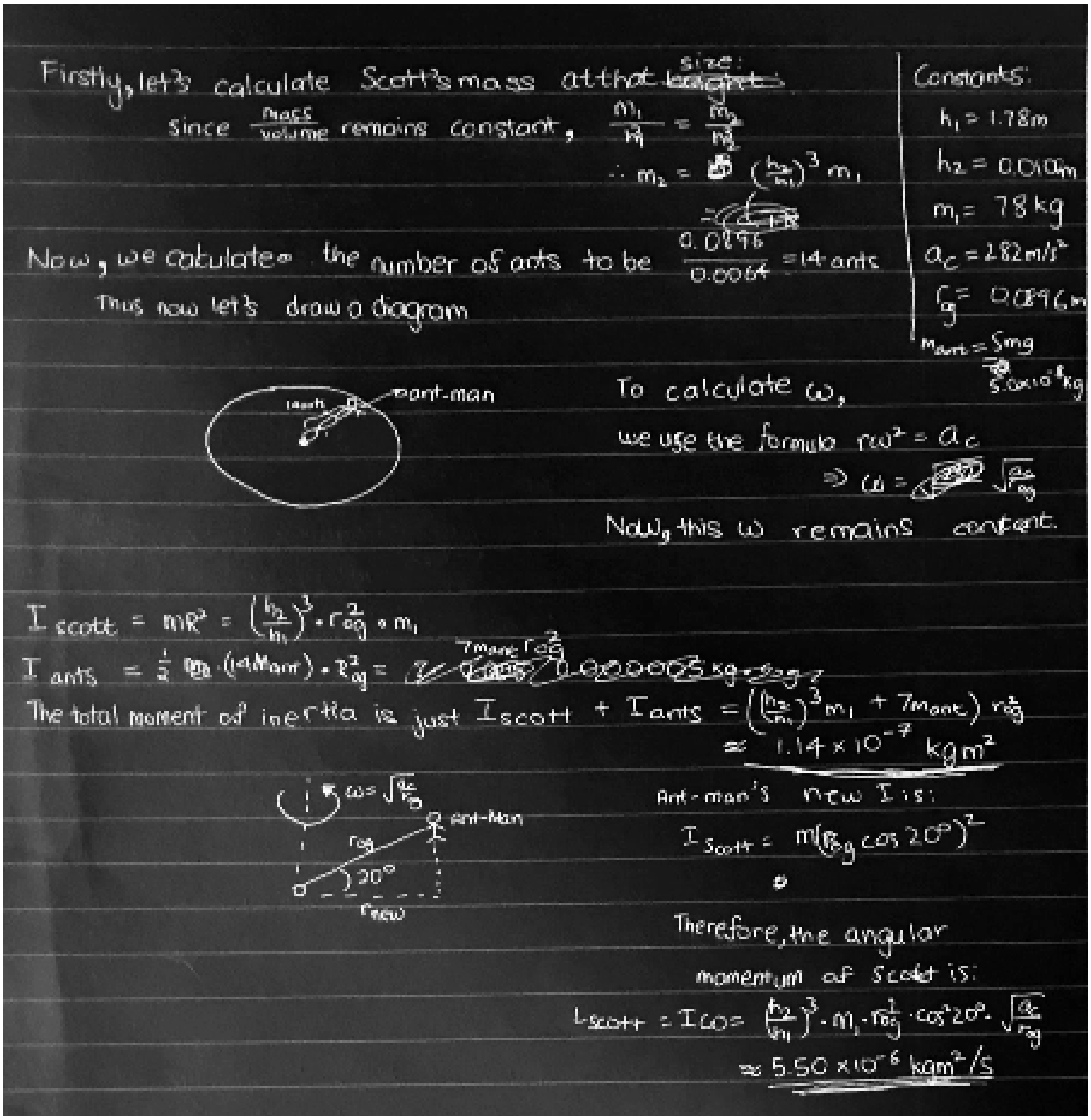
Ant-Man sits on a rotating CD disc. In this case he has become 1.00 cm tall. Now he is 0.0896 m from the disc and has an overall centripetal acceleration of 282 m/s^2. Here, he calls some of his 5 mg 0.64 cm long ant buddies (RIP Antony). They all line up next to each other from the centre till him and they all hold on to each other. Based on this, calculate the moment of inertia of the entire system and find the angular momentum of Scott when he jumps up such that it is in a straight line of ants and inclined at an angle of 20 degrees. Consider the ants and Scott himself point masses when calculating the moment of inertia.

Ans:

$I_{sys} = 1.14 \times 10^{-7} kgm^2$

$L_{Scott} = 5.50 \times 10^{-6} kgm^2/s$

Explanation:



Firstly, let's calculate Scott's mass at that ~~height~~ size:

since $\frac{mass}{volume}$ remains constant, $\frac{m_1}{h_1^3} = \frac{m_2}{h_2^3}$

$\therefore m_2 = \left(\frac{h_2}{h_1}\right)^3 m_1$

Now, we calculate the number of ants to be $\frac{0.0896}{0.0064} = 14$ ants

Thus now let's draw a diagram

Constants:

$h_1 = 1.78m$

$h_2 = 0.010m$

$m_1 = 78kg$

$a_c = 282 m/s^2$

$r_{og} = 0.0896m$

$m_{ant} = 5mg$

$5.0 \times 10^{-6} kg$

14 ants

ant-man

To calculate ω,

we use the formula $r\omega^2 = a_c$

$\Rightarrow \omega = \sqrt{\frac{a_c}{r_{og}}}$

Now, this ω remains constant.

$I_{scott} = mR^2 = \left(\frac{h_2}{h_1}\right)^3 \cdot r_{og}^2 \cdot m_1$

$I_{ants} = \frac{1}{2}(14 M_{ant}) \cdot r_{og}^2 = 7 m_{ant} r_{og}^2$

The total moment of inertia is just $I_{scott} + I_{ants} = \left(\left(\frac{h_2}{h_1}\right)^3 m_1 + 7m_{ant}\right) r_{og}^2$

$\approx 1.14 \times 10^{-7} kgm^2$

$\omega = \sqrt{\frac{a_c}{r_{og}}}$

Ant-Man

r_{og}

$20°$

r_{new}

Ant-man's new I is:

$I_{Scott} = m(r_{og} \cos 20°)^2$

Therefore, the angular momentum of Scott is:

$L_{scott} = I\omega = \left(\frac{h_2}{h_1}\right)^3 \cdot m_1 \cdot r_{og}^2 \cdot \cos^2 20° \cdot \sqrt{\frac{a_c}{r_{og}}}$

$\approx 5.50 \times 10^{-6} kgm^2/s$

(I apologise for making it black it wasn't really clear with the white background.)