Answer on Question#57690 - Physics - Mechanics - Relativity

2 blocks of masses $m_1 = 10\text{kg}$ and $m_2 = 5\text{kg}$ connected to each other by a massless in extensible string of length $L = 0.3\text{m}$ and placed along the diameter of a turn table coefficient of friction $\mu_1 = 0.5$ between surface of table and m_1 and there is no friction between table and m_2. The table is rotating with $\omega = 10\frac{\text{rad}}{\text{s}}$ about the vertical axis. The mass m_1 is at a distance of $l_1 = 0.124\text{m}$ from centre.

1) If the masses are at rest, calculate the frictional force on m_1.

2) What should be the angular speed of table if the masses just start to slip?

Solution:

1) The centrifugal force acting on m_1 is
$$F_1 = m_1\omega^2 l$$
The centrifugal force acting on m_2 is
$$F_2 = m_2\omega^2(L - l)$$
The frictional force on m_1 is equal to the difference of the above forces:
$$F_f = |F_2 - F_1| = \omega^2|m_2(L - l) - m_1 l| =$$
$$= \left(10\frac{\text{rad}}{\text{s}}\right)^2 |5\text{kg} \cdot (0.3\text{m} - 0.124\text{m}) - 10\text{kg} \cdot 0.124\text{m}| = 36\text{N}$$
2) If masses start to slip, the force F_f must be equal to the force of kinetic friction $F_f^k = m_1 g\mu_1$ acting on the mass m_1:
$$F_f^k = F_f$$
$$m_1 g\mu_1 = \omega^2|m_2(L - l) - m_1 l|$$
Thus,
$$\omega = \sqrt{\frac{m_1 g\mu_1}{|m_2(L - l) - m_1 l|}} = \sqrt{\frac{10\text{kg} \cdot 9.8\frac{\text{m}}{\text{s}^2} \cdot 0.5}{|5\text{kg} \cdot (0.3\text{m} - 0.124\text{m}) - 10\text{kg} \cdot 0.124\text{m}|}} = 11.7\frac{\text{rad}}{\text{s}}$$

Answer:

1) 36N
2) $11.7\frac{\text{rad}}{\text{s}}$