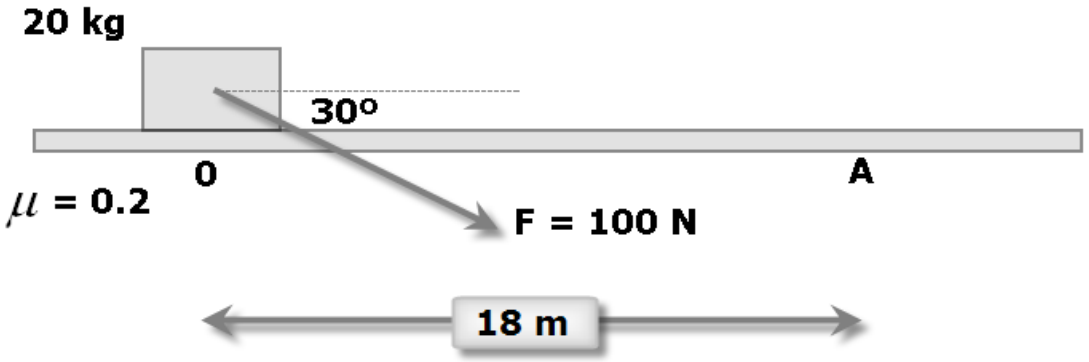
EXAM: DYNAMICS	
Name:	**Group:**

1	**A body is moving according to the picture below. Initially, the body is at rest. Determine:** **a) the value of the normal force** **b) the acceleration of the body** **c) the velocity of the body at point "A"**



① a) The values of normal and friction forces:

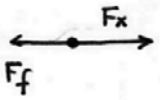
$N = W + F_y \rightarrow \boxed{N = 250\,N}$

$W = 20\,kg \times 10\,m/s^2 = 200\,N$

$F_y = 100\,N \times \sin 30^\circ = 50\,N$

$F_f = \mu \times N = 0.2 \times 250\,N \rightarrow \boxed{F_f = 50\,N}$

b) The acceleration



$F_{net} = m \times a \rightarrow a = \frac{36.6\,N}{20\,kg} \rightarrow \boxed{a = 1.83\,m/s^2}$

$F_{net} = F_x - F_f = 86.6\,N - 50\,N = 36.6\,N$

$F_x = 100\,N \times \cos 30^\circ = 86.6\,N$

c) The velocity at $x = 18\,m$

The position vector and the equation of velocity are:

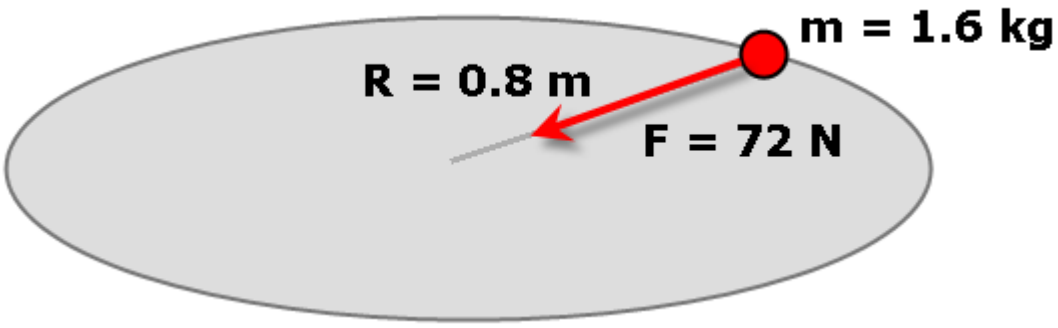
$x = 0.92\,\frac{m}{s^2} \times t^2 \rightarrow v = 1.83\,\frac{m}{s^2} \times t$

The condition is that x must be 18 m:

$18 = 0.92\,t^2 \rightarrow t = \sqrt{\frac{18}{0.92}} = 4.42\,s$

$v = 1.83\,\frac{m}{s^2} \times 4.42\,s \rightarrow \boxed{v = 8.1\,\frac{m}{s}}$

2	**The body is rotating due to a centripetal force (tension) of 72 N. The mass of the body is 1.6 kg and the radius of the circle is 0.8 m. Determine:** **a) the centripetal acceleration** **b) the angular (in rad/s and rpm) and linear velocities** **c) the frequency and the period of the motion** **d) the number of revolutions performed in 15 minutes**



(2) a) The centripetal acceleration is

$$F_c = m \times a_c \rightarrow a_c = \frac{F_c}{m} = \frac{72\ N}{1.6\ kg} \rightarrow \boxed{a_c = 45\ m/s^2}$$

b) The linear velocity

$$a_c = \frac{v^2}{R} \rightarrow v = \sqrt{a_c \times R} = \sqrt{45\ m/s^2 \times 0.8\ m} \rightarrow \boxed{v = 6\ m/s}$$

c) Angular velocity in rad/s and rpm

$$v = \omega \times R \rightarrow \omega = \frac{v}{R} = \frac{6\ m/s}{0.8\ m} = 7.5\ \frac{rad}{s} \quad \boxed{\omega = 7.5\ rad/s}$$

$$\omega = 7.5\ \frac{rad}{s} \times \frac{60\ s}{1\ min} \times \frac{1\ rev}{2\pi\ rad} \rightarrow \boxed{\omega = 71.6\ rpm}$$

d) The period and frequency

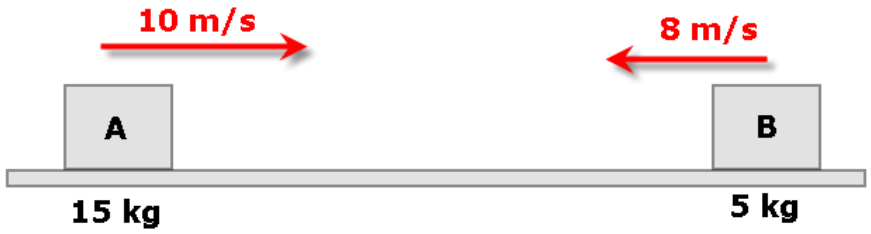
$$\omega = \frac{2\pi}{T} \rightarrow T = \frac{2\pi}{\omega} = \frac{2\pi}{7.5\ rad/s} \rightarrow \boxed{T = 0.84\ s}$$

$$f = \frac{1}{T} = \frac{1}{0.84\ s} \rightarrow \boxed{f = 1.19\ Hz}$$

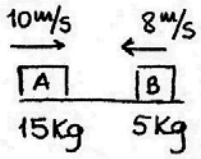
e) Number of revolutions in 15 min

$$n = 71.6\ \frac{rev}{min} \times 15\ min = \boxed{1074\ rev}$$

3	**Two bodies collide as shown in the picture. Determine:** **a) the velocity after the collision (suppose that both bodies are moving together after the collision)** **b) if after the collision a force of $20\,\vec{i}$ (N) is applied during 10 seconds, what is the final velocity?**



③ a) The velocity after the collision



$$\vec{P}_{initial} = \vec{P}_{final}$$

$$P_{initial} = m_A v_A + m_B v_B = 15kg \times 10\frac{m}{s} + 5kg \times (-8\frac{m}{s})$$

$$P_{initial} = 150\frac{kgm}{s} - 40\frac{kgm}{s} = 110\frac{kgm}{s}$$

$$P_{final} = (m_A + m_B)\,v = 20kg \times v$$

$$110\frac{kgm}{s} = 20kg \times v \rightarrow v = \frac{110\frac{kgm}{s}}{20\,kg} = 5.5\frac{m}{s}$$

$$\boxed{v = +\,5.5\frac{m}{s}}$$

direction: to the right

b) After applying the force

$$\vec{J} = \vec{F} \times t = 20\vec{i}\,(N) \times 10\,s \rightarrow \boxed{J = 200\,N.s}$$

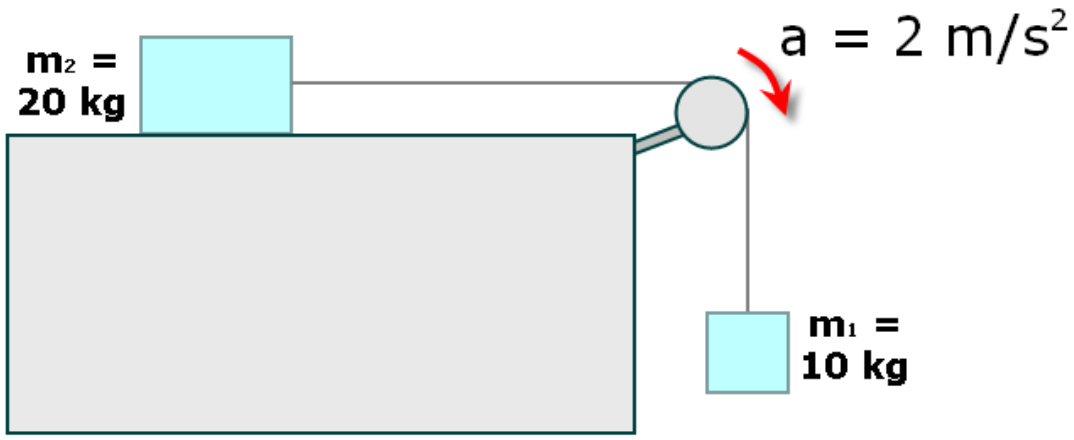
$$J = P_{final} - P_{initial} \rightarrow 200\,N.s = P_{final} - 110\frac{kgm}{s}$$

$$\boxed{P_{final} = 310\frac{kg.m}{s}}$$

$$P_{final} = (m_A + m_B)\,v \rightarrow 310\frac{kg.m}{s} = 20kg \times v$$

$$v = \frac{310\frac{kg.m}{s}}{20\,kg} \rightarrow \boxed{v = 15.5\frac{m}{s}}$$

4	**Two bodies are moving as shown in the picture. The acceleration of the system is 2 m/s^2. Determine:** **a) the friction force and friction coefficient** **b) the tension of the rope**



④ a) The friction force and friction coefficient

$F_{net} = m \times a = (20kg + 10kg) \times 2\frac{m}{s^2} = 60\,N$

$\downarrow$

$F_{net} = W_1 - F_f \rightarrow 60\,N = 100\,N - F_f$

$\boxed{F_f = 40\,N}$

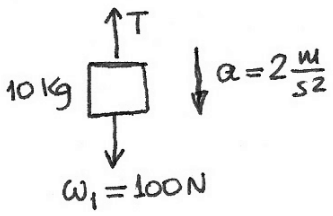
$\downarrow$

$F_f = \mu \times N \rightarrow 40\,N = \mu \times 200\,N \rightarrow \mu = \frac{40N}{200N} \rightarrow \boxed{\mu = 0.2}$

$\uparrow$

$N = W_2 = 200\,N$

b) The tension force



$F_{net} = m \times a$

$\downarrow$

$W_1 - T = m \times a$

$\downarrow$

$100N - T = 10\,kg \times 2\frac{m}{s^2} = 20\,N$

$\boxed{T = 80\,N}$