2024 A3

FREE-BODY DIAGRAMS WITH FRICTION & SLOPES

Level 1: 7.057 m/s²

To solve the first part of this problem, we will first be solving for the net force by subtracting the frictional force from the force applied.

$$F_{net} = F_{applied} - F_{frictional}$$
$$F_{net} = 1000\ Newtons - \mu * N$$
$$F_{net} = 1000\ N - (0.30)(100\ kg)(9.81\ m/s^2)$$
$$F_{net} = 1000 Newtons - 294.3 \frac{kg * m}{s^2}$$
$$\left(\frac{kg * m}{s^2}\right) = Newton$$
$$F_{net} = 1000\ Newtons - 294.3\ Newtons = 705.7\ Newtons$$

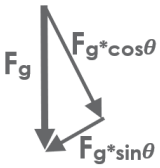
Then with the net force we can plug in the values to the acceleration equation.

$$F_{net} = mass * acceleration$$
$$705.7\ Newtons = 100kg * acceleration$$
$$\frac{705.7\ Newtons}{100\ kg} = acceleration$$
$$\boldsymbol{acceleration = 7.057\ m/s^2}$$

Level 2: 3.187 m/s²

This problem can be solved identically to the problem above, with the exception of the normal force being at an angle. To adjust for this, we will be breaking the gravitational force into its parts, then solving for the net force.

$$F_g cos\theta = N$$
$$m * g * \cos(25°) = N$$
$$100\ kg * 9.81 \frac{m}{s^2} * \cos(25°) = N = 889.1\ Newtons$$



Now we can solve for the frictional force using the normal force and the coefficient of friction. Then solve for net force.

$$F_{frictional} = \mu * N = (0.30) * (889.1\ Newtons)$$
$$F_{frictional} = 266.7\ Newtons$$
$$F_{net} = F_{applied} - F_{frictional} - F_g sin\theta$$
$$F_{net} = 1000\ Newtons - 266.7\ Newtons - (100\ kg) * \left(9.81 \frac{m}{s^2}\right) * (sin25)$$
$$F_{net} = 318.71\ Newtons$$

Plugging in net force and mass into the acceleration equation can lead us to determining the value of acceleration.

$$F_{net} = m * a$$
$$\frac{F_{net}}{m} = a = \frac{318.71\ Newtons}{100\ kg} = \boldsymbol{3.187\ m/s^2}$$