Guided Practice

Topic 1, 2.1 and 2.2
Guided Practice

Day 1
• Newton’s laws
• Net force & acceleration in different scenarios

Day 2
• Fluid resistance
• Motion graphs
• Analyzing graphs
• Uncertainties
True or false?

- If a body is travelling at a constant velocity there are no forces acting on the body
True or false?

• If a body is travelling at a constant velocity the net force acting on the body is 0
True or false?

- If the instantaneous velocity of a body is 0. The net force must be 0
True or false?

- When an object moves at constant speed, it is in translational equilibrium
True or false?

• If an object is in equilibrium it moves at constant speed
True or false?

- If an object is in equilibrium it moves at constant velocity
Newton’s laws

What will the spring scale read? (How many newtons?)

15 kg
Newton’s laws

What will the spring scale read?
Net force & acceleration

\[ m_1 \Rightarrow 15 \text{ kg} \]
\[ m_2 \Rightarrow 5 \text{ kg} \]

Distance from \( m_1 \) to the pulley = 25 cm

How long before \( m_1 \) collides with the pulley?

Assume no friction
Net force & acceleration

$m_1 = 15\, \text{kg}$
$m_2 = 5\, \text{kg}$
Distance from $m_1$ to the pulley = 25 cm

How long before $m_1$ collides with the pulley?

The coefficient of friction between $m_1$ and the table is 0.1
Net force & acceleration

\[ F_s = \mu R = \mu mg \]
\[ 50N = 0.1 \times 150 - 15N \]
\[ F_{\text{NET}} = 35N \]
\[ 35 = 20 \times a \Rightarrow a = \frac{35}{20} = \frac{7}{4} \]

\[ s = \frac{1}{2} at^2 \]
\[ 0.25 = \frac{1}{2} \left( \frac{7}{4} \right) t^2 \]
\[ \frac{1}{A} = \frac{1}{A} \times \frac{7}{2} t^2 \Rightarrow t = \sqrt{\frac{2}{7}} \]

\[ m_1 = 15 \text{ kg} \]
\[ m_2 = 5 \text{ kg} \]
Distance from \( m_1 \) to the pulley = 25 cm

How long before \( m_1 \) collides with the pulley?

The coefficient of friction between \( m_1 \) and the table is 0.1
A mass of 5 kg is moving downwards with a velocity \( v \). The angle shown is 40°. The coefficient of friction is 0.15. Find the net force on the mass
\[ F_t = \mu R = \mu W_y = \mu W \cos 40^\circ \]

\[ \sin 40^\circ = \frac{W_x}{3} \]

\[ \cos 40^\circ = \frac{3y}{3} \]

\[ F_{\text{NET}} = W_x - F_t \]

\[ = W \sin 40^\circ - \mu W \cos 40^\circ \]

\[ = 5 \times 10 \sin 40^\circ - 0.15 \times 5 \times 10 \cos 40^\circ \]

\[ \approx 26.4 \text{ N} \]
Net force & acceleration

A mass $m$, is moving upwards with a velocity $v$. The angle shown is $\theta$. The coefficient of friction is $\mu$. Find the acceleration of the object.
Net force & acceleration

A mass $m$, is moving upwards with a velocity $v$. The angle shown is $\theta$. The coefficient of friction is $\mu$. Find the acceleration of the object.

$$F = \mu R = \mu mg \sin \theta$$
$$\sin \theta = \frac{W}{mg}$$
$$\cos \theta = \frac{W}{mg}$$

$$F_{\text{net}} = W \cos \theta + F_r$$
$$ma = W \sin \theta + \mu W \cos \theta$$
$$a = g \left[ \sin \theta + \mu \cos \theta \right]$$
Net force & acceleration – do now

A car of weight $1.4 \times 10^4 \text{ N}$ is moving up an incline at a constant speed of $6.2 \text{ m s}^{-1}$. The incline makes an angle of $5.0^\circ$ to the horizontal. A frictional force of $600 \text{ N}$ acts on the car in a direction opposite to the velocity.

a i State the net force on the car.
ii Calculate the force $F$ pushing the car up the incline.
Net force & acceleration – do now

A car of weight $1.4 \times 10^4$ N is moving up an incline at a constant speed of $6.2 \text{ m s}^{-1}$. The incline makes an angle of $5.0^\circ$ to the horizontal. A frictional force of 600 N acts on the car in a direction opposite to the velocity.

**a**  
**i** State the net force on the car.  
**ii** Calculate the force $F$ pushing the car up the incline.

**i** It is zero (because the velocity is constant). ✓

**ii**  
$F - mg \sin \theta - f = 0 \checkmark$

$F = mg \sin \theta + f = 1.4 \times 10^4 \times \sin 5.0^\circ + 600 \checkmark$

$F = 1820 \text{ N} \checkmark$
Net force & acceleration – do now

Worked examples

1. A box is pushed across a level floor at a constant speed with a force of 280 N at 45° to the floor. The mass of the box is 50 kg.

Calculate:

a) the vertical component of the force
b) the weight of the box
c) the horizontal component of the force
d) the coefficient of dynamic friction between the box and the floor.
Solution

a) the vertical component is $280 \sin 45^\circ = 198 \text{ N}$

b) the weight of the box $= mg = 50 \times 9.8 = 490 \text{ N}$

c) the horizontal component of the force $= 280 \cos 45^\circ = 198 \text{ N}$

d) the vertical component of the force exerted by the floor on the box $= 490 + 198 \text{ N} = 688 \text{ N}$

the friction force $= \text{ the horizontal component (the box is travelling at a steady speed)}$, so

$$\mu_d = \frac{198}{688} = 0.29$$
Net force & acceleration – do now

2 A skier places a pair of skis on a snow slope that is at an angle of 1.7° to the horizontal. The coefficient of static friction between the skis and the snow is 0.025.

Determine whether the skis will slide away by themselves.
Call the weight of the skis $W$.

The component of weight down the slope = $W \sin 1.7^\circ$

The reaction force of the surface on the ski = $W \cos 1.7^\circ$.

Therefore, the maximum friction force up slope = $\mu_s W \cos 1.7^\circ$.

The skis will slide if

$\mu_s W \cos 1.7^\circ < W \sin 1.7^\circ$

in other words, if $\mu_s < \tan 1.7^\circ$.

The value of $\tan 1.7^\circ$ is 0.0296 and this is greater than the value of $\mu_s$, which is 0.025, so the skis will slide away.
Net force & acceleration

Find the tension in each rope.
Assume no friction
Net force & acceleration

\[ F_{\text{NET}} = ma \]

\[ 50 = 18a \Rightarrow a = \frac{50}{18} \approx 2.78 \]

\[ T_1 = 3 \times \frac{50}{18} = \frac{150}{18} \approx 8.33 \text{ N} \]

\[ T_2 = 8 \times \frac{50}{18} = \frac{400}{18} \approx 22.2 \text{ N} \]

Find the tension in each rope.
Assume no friction

\[ F_{\text{NET}} = ma \]

\[ 27.8 = 10 \times a \]

\[ a = \frac{27.8}{10} = 2.78 \]
Find the tension in each rope.
The coefficient of friction is 0.15
Net force & acceleration

Find the tension in each rope.
The coefficient of friction is 0.15

\[ F_{\mu} = \mu R = \mu mg = 0.15 \times 18 \times 10 \]
\[ F_{\text{NET}} = 50 - 27 = 23 \]
\[ F_{\text{NET}} = ma \]
\[ 23 = 18a \Rightarrow a = \frac{23}{18} \approx 1.27 \]

1) \[ F_C - 3 = T_1 \]
\[ F_{\text{NET}} = 5 \times 1.27 = 6.35 \]
\[ F_{\text{NET}} = T_1 - F_\mu \]
\[ T_1 = F_{\text{NET}} + F_\mu \]
\[ T_1 = 6.35 + 0.15 \times 3 \times 10 \]
\[ T_1 \approx 8.31 \text{ N} \]

2) \[ T_1 - T_2 = 5 \]
\[ F_\mu = 5 \times 1.27 = 6.35 \]
\[ F_{\text{NET}} = T_2 - T_1 - F_\mu \]
\[ T_2 = F_{\text{NET}} + T_1 + F_\mu \]
\[ T_2 = 6.35 + 8.31 + 0.15 \times 5 \times 10 \]
\[ T_2 = 22.1 \]