Exercise walk-through

Newton's laws of motion ▪ 4.4

eXercise

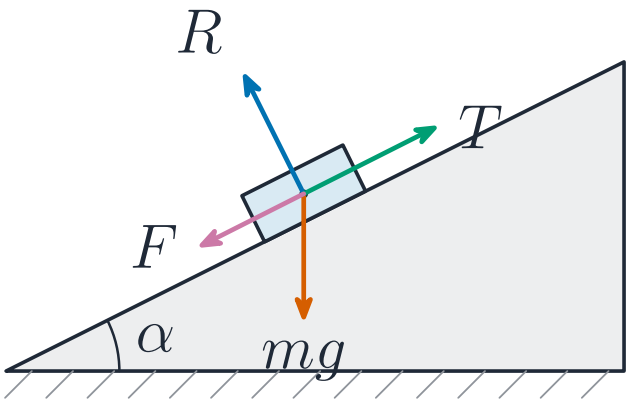
You must be able to

- apply $F = ma$ with weight, tension, friction and thrust
- resolve along and perpendicular to a slope
- analyse connected particles (string over a pulley)

Method — Inclined plane

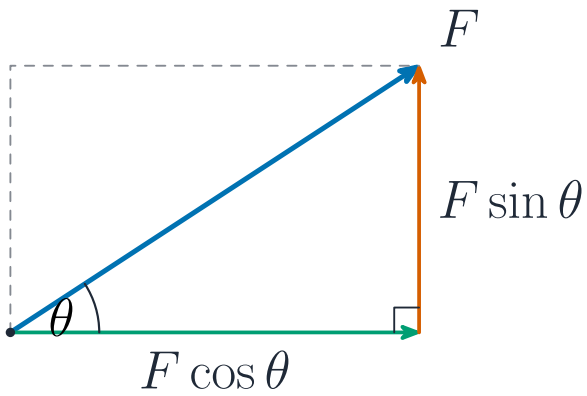
12 kg block pulled up a 20° rough slope ($\mu = 0.4$), $a = 2$ m s^{-2}:
$R = 120\cos 20^\circ = 112.8$ N; $F = \mu R = 45.1$ N. Up the slope:
$T - mg\sin 20^\circ - F = ma$, so $T = 24 + 41.0 + 45.1 = 110$ N.

Method — Inclined plane



A block on a slope: weight, normal reaction, tension up the slope, friction

Method — Inclined plane



Resolving a force into perpendicular components

Practice 2.1 ▪ 2 marks

A resultant force of 18 N acts on a 3 kg mass. Find the acceleration.

Solution 2.1

Worked steps

$$a = \frac{F}{m} = \frac{18}{3} = 6 \text{ m s}^{-2}$$ M1 A1.

Practice 2.2 ▪ 1 mark

Find the weight of a 7 kg object ($g = 10$).

Solution 2.2

Worked steps

$W = mg = 7 \times 10 = 70$ N B1.

Exam-style 3.1 ▪ 1 mark

A 5 kg mass is pulled along a smooth horizontal floor by a horizontal force of 20 N. Its acceleration is:

A $2\ \text{m s}^{-2}$

B $4\ \text{m s}^{-2}$

C $5\ \text{m s}^{-2}$

D $25\ \text{m s}^{-2}$

Solution 3.1

Method: Inclined plane

A $2\ \text{m s}^{-2}$

B $4\ \text{m s}^{-2}$ ✓

C $5\ \text{m s}^{-2}$

D $25\ \text{m s}^{-2}$

Worked steps

B. $a = \dfrac{20}{5} = 4\ \text{m s}^{-2}$.

Exam-style 3.2 ▪ 3 marks

A block of mass 4 kg is released from rest on a smooth plane inclined at 30° to the horizontal.

(a) Find the acceleration down the slope.

(b) Find the speed after it has slid 5 m.

Solution 3.2

Method: Inclined plane

Worked steps

(a) along the slope: $mg\sin 30^\circ = ma \Rightarrow a = g\sin 30^\circ = 10(0.5) = 5$ m s^{-2} M1 M1 A1.

(b) $v^2 = u^2 + 2as = 0 + 2(5)(5) = 50 \Rightarrow v = 7.07$ m s^{-1} M1 A1.

Exam-style 3.3 ▪ 4 marks

Two particles of masses 3 kg and 5 kg are joined by a light inextensible string over a smooth pulley, and released from rest.

(a) Find the acceleration of the system.

(b) Find the tension in the string.

Solution 3.3

Worked steps

(a) for the system, $5g - 3g = (5+3)a$ M1 M1; $20 = 8a \Rightarrow a = 2.5$ m s^{-2} A1 A1.
(b) for the 3 kg mass: $T - 3g = 3a \Rightarrow T = 30 + 3(2.5) = 37.5$ N M1 A1.