Exercise walk-through

Forces and equilibrium ▪ 4.1

eXercise

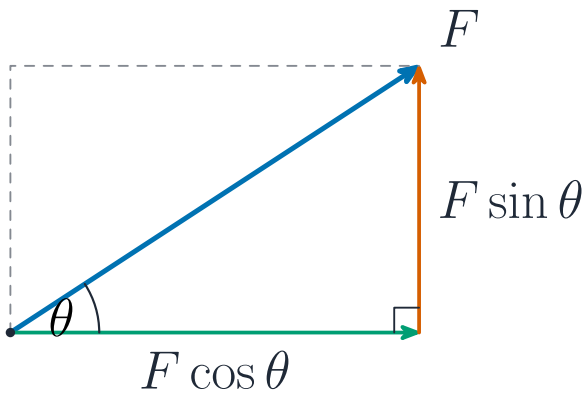
You must be able to

- resolve a force into horizontal and vertical components
- use "components in any direction sum to zero" for equilibrium
- use $F \leqslant \mu R$ and limiting friction $F = \mu R$

Method — Resolving & friction

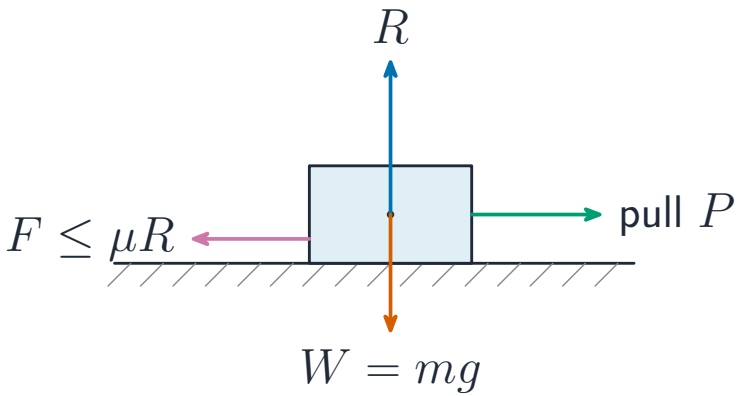
A 5 kg block rests on a rough horizontal floor ($\mu = 0.3$). Max friction $= \mu R = 0.3 \times 50 = 15$ N — a horizontal pull below 15 N will not move it.

Method — Resolving & friction



A force resolved into horizontal and vertical components

Method — Resolving & friction



A block on a rough surface: normal reaction, weight, pull and friction

Practice 2.1 ▪ 2 marks

A force of 20 N acts at 60° above the horizontal. Find its horizontal component.

Solution 2.1

Method: Resolving & friction

Worked steps

$20\cos 60^\circ = 20 \times 0.5 = 10$ N **M1** **A1**.

Practice 2.2 ▪ 2 marks

A block of weight 40 N rests on a rough surface, $\mu = 0.25$. Find the maximum friction available.

Solution 2.2

Method: Resolving & friction

Worked steps

$F_{\max} = \mu R = 0.25 \times 40 = 10$ N M1 A1.

Exam-style 3.1 ▪ 1 mark

A particle is in equilibrium under three forces. The sum of the forces is:

A maximum

B zero

C equal to the weight

D equal to μR

Solution 3.1

A maximum

B zero ✓

C equal to the weight

D equal to μR

Worked steps

B. In equilibrium the resultant (vector sum) of the forces is zero.

Exam-style 3.2 ▪ 1 mark

A box of mass 8 kg rests on a rough horizontal floor. A horizontal force of 30 N is applied but the box does not move.
(a) Find the normal reaction.
(b) Given the box is on the point of slipping, find the coefficient of friction.

Solution 3.2

Method: Resolving & friction

Worked steps

(a) $R = mg = 8 \times 10 = 80$ N **B1**.

(b) on the point of slipping $F = \mu R$ and $F = 30$ N **M1**; $\mu = \dfrac{30}{80}$ **M1**; $= 0.375$ **A1**.

Exam-style 3.3 ▪ 5 marks

A particle of weight W hangs in equilibrium from two light strings making angles 30° and 60° with the horizontal. The tensions are T_1 and T_2. Given $W = 20$ N, find T_1 and T_2.

Solution 3.3

Method: Resolving & friction

Worked steps

resolve: horizontal $T_2\cos 60^\circ = T_1\cos 30^\circ$; vertical $T_1\sin 30^\circ + T_2\sin 60^\circ = 20$ M1 M1; from the first $T_2(0.5) = T_1(0.866) \Rightarrow T_2 = 1.732\,T_1$ M1; substitute: $0.5\,T_1 + 0.866(1.732\,T_1) = 20 \Rightarrow 2\,T_1 = 20 \Rightarrow T_1 = 10$ N, $T_2 = 17.3$ N A1 A1.