# Solutionbank M1

**Heinemann Modular Maths for Edexcel AS and A-level**

## 4 Forces

**Exercise Test yourself, Question 1**

**Question:**

Draw diagrams to show the forces acting on each of the following. You should include air resistance where appropriate, and model each body as a particle.

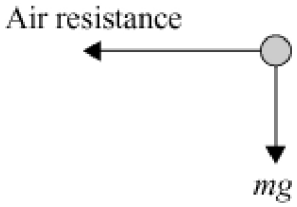
(a) A golf ball at its maximum height.

(b) A cyclist travelling up a slope at a constant speed.

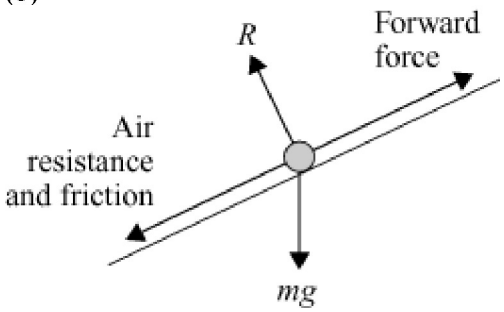
(c) A child on a swing at her lowest position.

**Solution:**

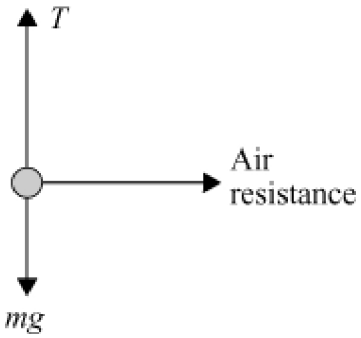
(a)




(b)




(c)



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**Heinemann Modular Maths for Edexcel AS and A-level**

## 4 Forces

**Exercise Test yourself, Question 2**

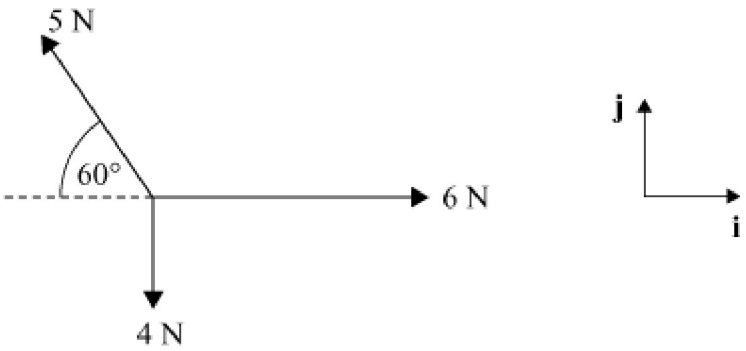
**Question:**

The diagram shows three forces and the perpendicular unit vectors **i** and **j**.

(a) Find the resultant of these three forces in terms of the unit vectors **i** and **j**.

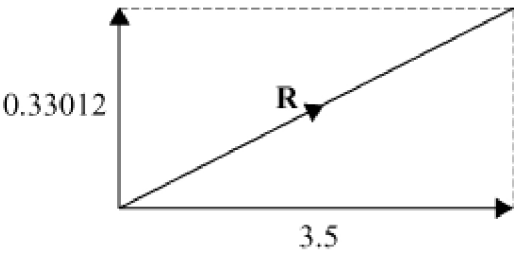
(b) Find the magnitude of the resultant of these three forces and draw a diagram to show the direction in which it acts.

(c) When a fourth force acts at the same point the forces are in equilibrium. Find the magnitude of this force and describe the direction in which it acts.




**Solution:**

(a)
$$R = 6i - 4j + ( -5 \cos 60° i + 5 \sin 60° j )$$
$$R = ( 6 - 5 \cos 60° ) i + ( 5 \sin 60° - 4 ) j$$
$$R = 3.5i + 0.33012...j$$
$$R = 3.5i + 0.330j \text{ (3 s.f.)}$$




(b)
$$|R| = \sqrt{3.5^2 + 0.33012...^2}$$
$$|R| = 3.5155...$$
$$|R| = 3.52 \text{ N (3 s.f.)}$$

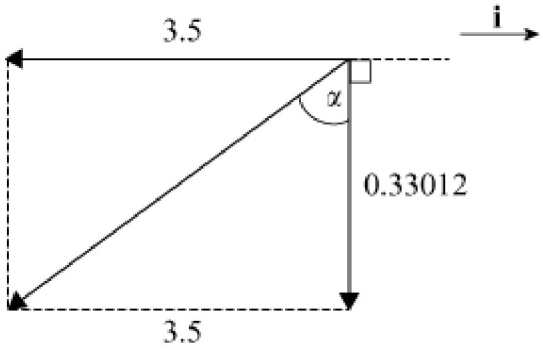
(c) Fourth force has magnitude 3.52 N (3 s.f.)

then $\tan \alpha = \frac{3.5}{0.33012...}$

$\alpha = 84.611...°$

i.e. at angle $90° + \alpha = 90° + 84.611°$

$= 175°$ (3 s.f.) below the i direction.



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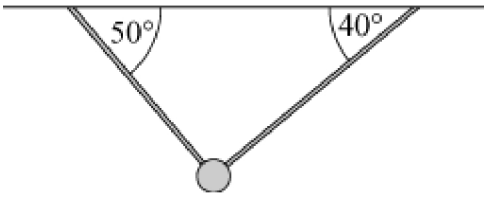
**Heinemann Modular Maths for Edexcel AS and A-level**

## 4 Forces

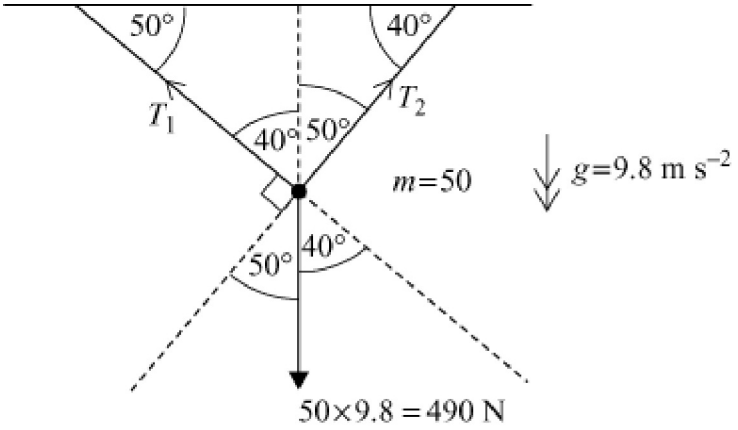
**Exercise Test yourself, Question 3**

**Question:**

The diagram shows an object of mass 50 kg, which is supported by two cables. Find the tension in each of the supporting cables.




**Solution:**




Resolving perpendicular to $T_1$

$T_2 = 490 \times \cos 50°$

$T_2 = 314.96...$

$T_2 = 315$ N (3 s.f.)

Resolving perpendicular to $T_2$

$T_1 = 490 \times \cos 40°$

$T_1 = 375.36...$

$T_1 = 375$ N (3 s.f.)

# Solutionbank M1

**Heinemann Modular Maths for Edexcel AS and A-level**

## 4 Forces

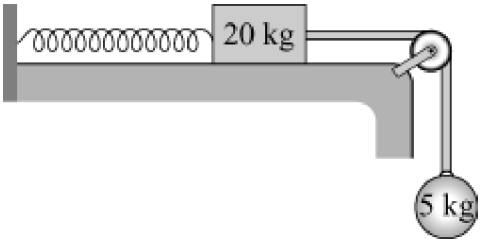
**Exercise Test yourself, Question 4**

**Question:**

The diagram shows a spring fixed to a wall and a block of mass 20 kg, that is at rest on a rough horizontal plane. A string attached to the block passes over a small smooth pulley and is attached to a second block of mass 5 kg. The situation is shown in the diagram.
The tension in the spring is 8 N when the block is on the point of sliding towards the pulley.

(a) Find the coefficient of friction between the block and the plane.

(b) Describe what happens to the 20 kg block if the string attached to it is cut. Give reasons to support your answer.



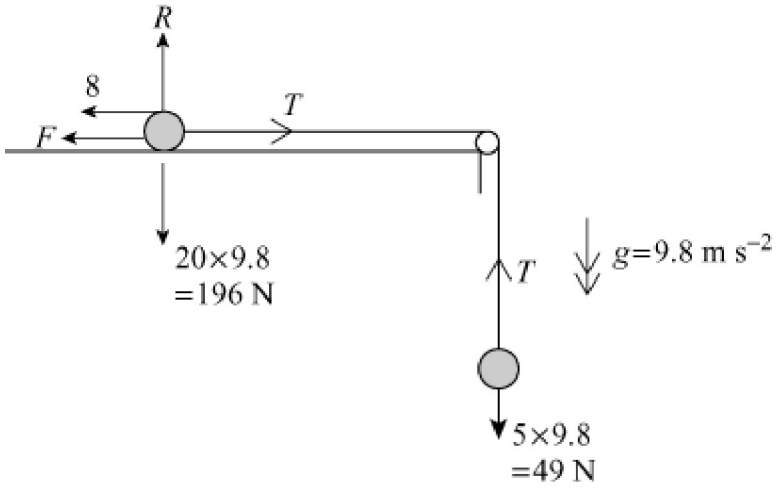

**Solution:**

(a) Vertically $m = 5$ $T = 49$
Horizontally $m = 20$

$$F + 8 = T$$
$$\therefore F = T - 8$$
$$F = 49 - 8$$
$$\therefore F = 41 \text{ N}$$

Vertically, $m = 20$ $R = 196$ N

$$\text{Limiting equilibrium } F = \mu \times R$$
$$\therefore 41 = \mu \times 196$$
$$\text{i.e. } \mu = \frac{41}{196}$$
$$\mu = 0.20918...$$
$$\mu = 0.209 \text{ (3 s.f.)}$$




(b) Maximum available friction is $\mu \times R$ $= 0.20922... \times 196$
$= 41$ N

If string is cut the block stays at rest since 8 N is less than this value.

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## 4 Forces

**Exercise Test yourself, Question 5**

**Question:**

A particle, of mass 5 kg, is at rest on a slope inclined at an angle of 48° to the horizontal. A force, of magnitude 10 N, that is directed up the slope acts on the particle.

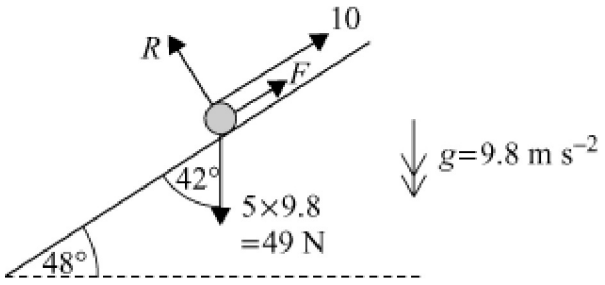
(a) Find the magnitude of the friction force acting on the particle.

(b) Find an inequality that the coefficient of friction between the particle and the slope must satisfy.

**Solution:**

(a)

$$\begin{aligned} \text{Along plane } F + 10 &= 49 \times \cos 42^\circ \\ \therefore F &= 49 \cos 42^\circ - 10 \\ \text{i.e. } F &= 26.414... \\ \text{i.e. } F &= 26.4 \text{ N (3 s.f.)} \end{aligned}$$




(b) Perpendicular to plane

$$\begin{aligned} R &= 49 \times \sin 42^\circ \\ \therefore R &= 32.787... \end{aligned}$$

$$\begin{aligned} \text{Limiting equilibrium } F &\leq \mu \times R \\ 26.414.. &\leq \mu \times 32.787... \\ \frac{26.414}{32.787} &\leq \mu \\ \mu &\geq 0.80561... \\ \mu &\geq 0.806 \text{ (3 s.f.)} \end{aligned}$$