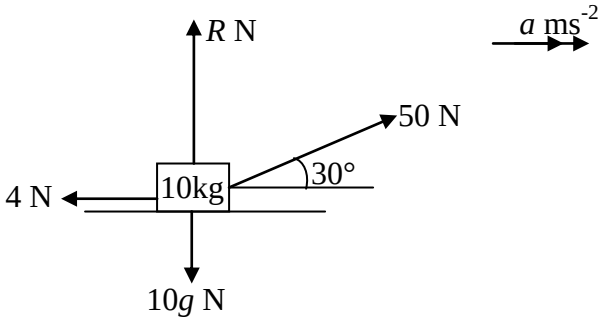
Section 2: Newton's second law

Section test

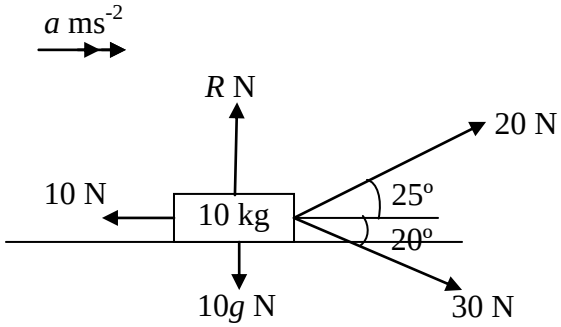
(Throughout this test, unless instructed otherwise, take $g = 9.8$ ms^{-2} and round answers, where necessary, to 3 s.f.)

1.



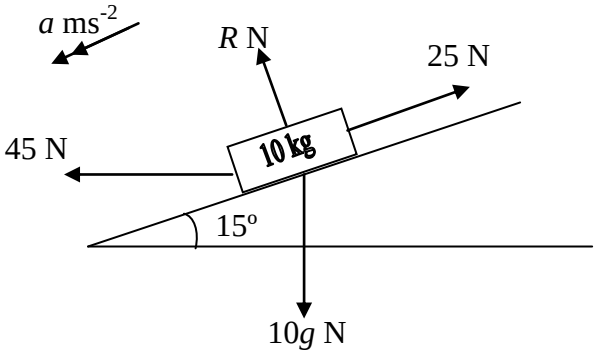
Find the acceleration of the block in the diagram above.

2. The diagram below shows a block being pulled along a surface by two forces.



What is the value of the normal reaction force R?
What is the acceleration of the block?

3. The diagram below shows a block moving down an inclined plane.



What is the value of the normal reaction force R?
What is the acceleration of the block?

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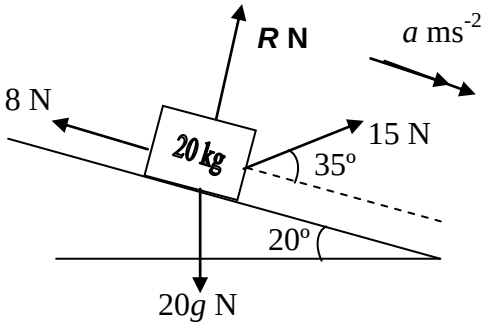
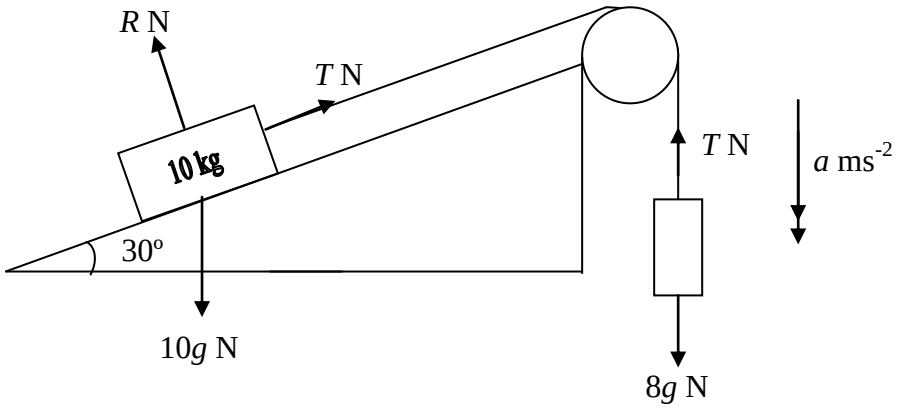
4. The diagram below shows a block moving down an inclined plane.



Find the value of the normal reaction force R.
Find the acceleration of the block.

5. The diagram below shows a block attached to a light string which passes over a smooth pulley and is attached to another block which hangs freely.



Find the acceleration of the system.
Find the tension in the string.
Find the reaction force between the plane and the block.

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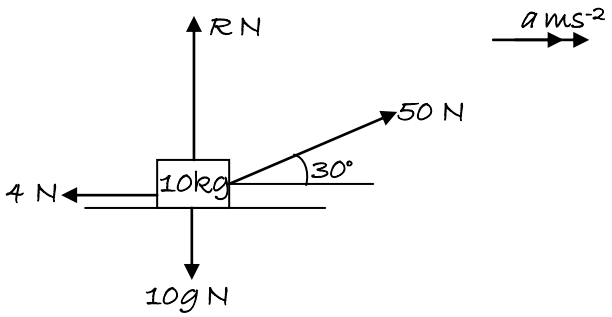
Solutions to section test

1.

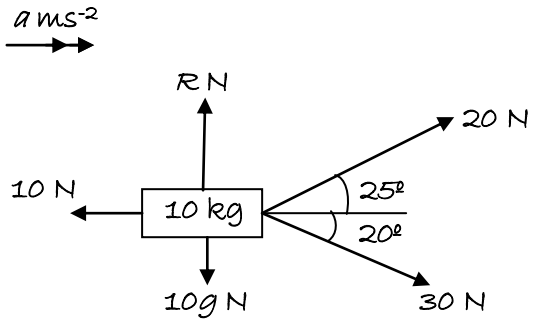


Resolving horizontally: $50\cos 30° - 4 = 10a$

$a = 3.93$

The acceleration of the block is 3.93 ms^{-2}.

2.



Vertically: $R + 20\sin 25° - 30\sin 20° - 10g = 0$

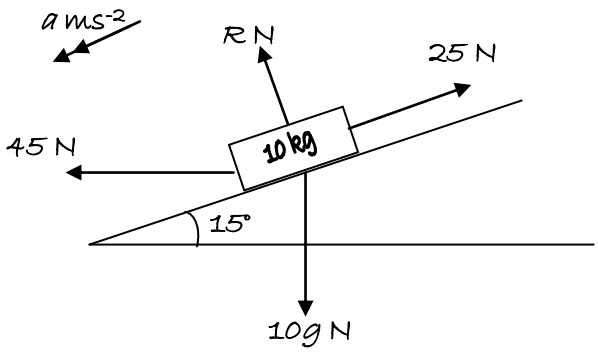
$R = 30\sin 20° + 10 \times 9.8 - 20\sin 25° = 99.8$ N

Horizontally: $F = ma$

$20\cos 25° + 30\cos 20° - 10 = 10a$

$a = 2\cos 25° + 3\cos 20° - 1 = 3.63\ ms^{-2}$

3.



Resolving perpendicular to the plane: $R + 45\sin 15^\circ - 10g\cos 15^\circ = 0$

$$R = 10 \times 9.8\cos 15^\circ - 45\sin 15^\circ = 83.0$$

The value of R is 83.0 N.

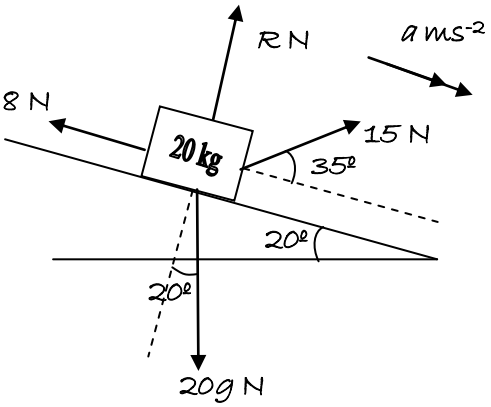
Resolving parallel to the slope: $F = ma$

$$45\cos 15^\circ + 10g\sin 15^\circ - 25 = 10a$$

$$a = 4.38$$

The value of a is 4.38 ms^{-2}.

4.



Resolving perpendicular to slope: $R + 15\sin 35^\circ - 20g\cos 20^\circ = 0$

$$R = 20 \times 9.8\cos 20^\circ - 15\sin 35^\circ = 176$$

The value of R is 176 N.

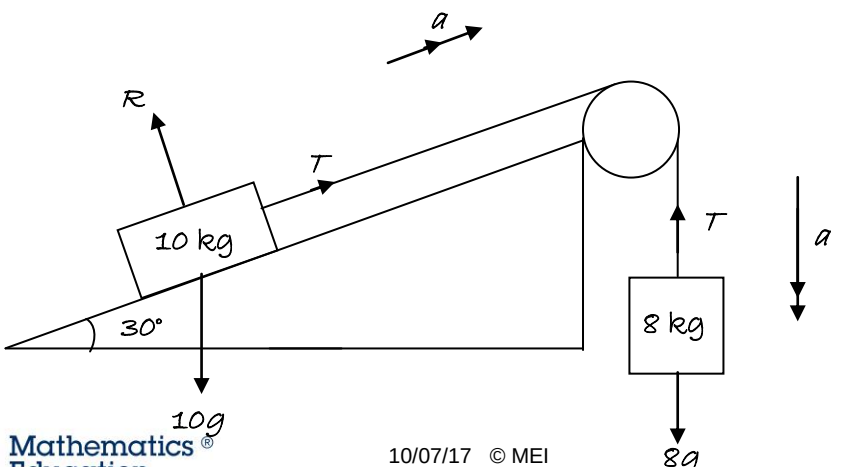
Resolving down the slope: $F = ma$

$$15\cos 35^\circ + 20g\sin 20^\circ - 8 = 20a$$

$$a = \frac{15\cos 35^\circ + 20 \times 9.8\sin 20^\circ - 8}{20} = 3.57$$

The acceleration of the block is 3.57 ms^{-2}.

5.



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Considering the 8 kg mass: $8g - T = 8a$ (1)

Considering the 7 kg mass (resolving up the plane):

$$T - 10g\sin 30° = 10a$$

$$T - 5g = 10a \quad (2)$$

Adding: $3g = 18a$

$$a = \frac{3 \times 9.8}{18} = 1.63$$

The acceleration of the system is 1.63 ms^{-2}.

(1) gives $T = 8g - 8a$

$$= (8 \times 9.8) - 8\left(\frac{3 \times 9.8}{18}\right)$$

$$= 65.3$$

The tension in the string is 65.3 N (3 s.f.)

Resolving perpendicular to the plane: $R - 10g\cos 30° = 0$

$$R = 10 \times 9.8\cos 30°$$

$$R = 84.9$$

The reaction between the plane and the block is 84.9 N (3 s.f.)