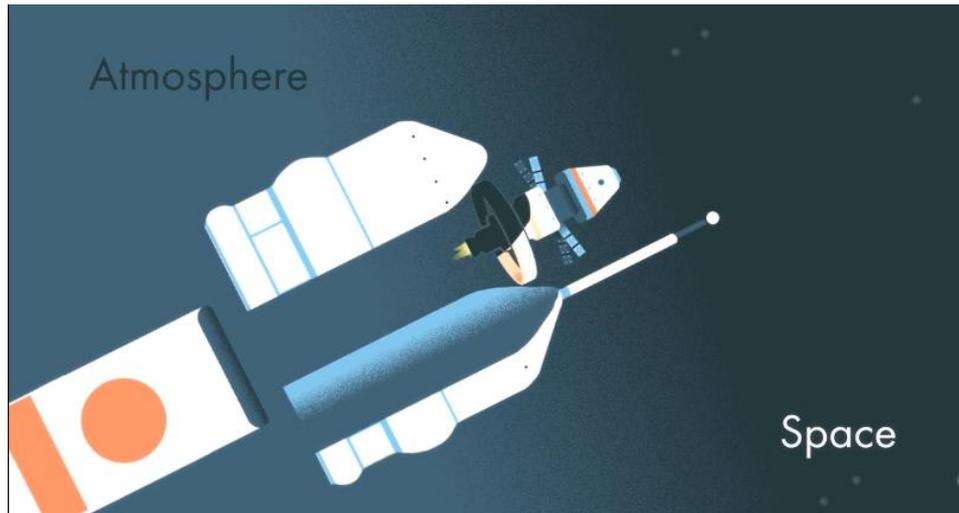


Resultant Force and Acceleration

Key Stage 4 (foundation)

Topics covered: forces as vectors, resultant forces, acceleration, Newton's First and Second Laws of Motion

Watch the video "Newton's Laws of Motion", <https://vimeo.com/159043081>



Objects experience many forces which determine their movement. Forces have size and direction (they are vector quantities), unlike the mass of an object which has a size but no assigned direction – mass is a scalar quantity. Newton determined that the acceleration, a (m/s^2), of an object in a particular direction is proportional to the overall or net force, F (N), in that direction. This relationship is shown below where m is the mass of the object in kg.

$$F = ma$$

Rearrange this equation to find 'a' and 'm'.

$$a = \quad \text{and} \quad m =$$

Instructions:

- Cut out the 10 cards on the following pages.
- On each card, there is a value that needs to be calculated - stated in the bottom left corner. E.g. Find 'a'
- The solution to the problem is found on **another card** - stated in the top left corner. E.g. 6.8 m/s²
- Like a game of dominoes, the cards can be matched together and the solution for the final card should be stated in the top left corner of the first card.

NB: You can start with any card - the cards loop around full circle so there's no particular start or end. The answer in the top left corner is linked to the previous card and is unrelated to the problem on that particular card.

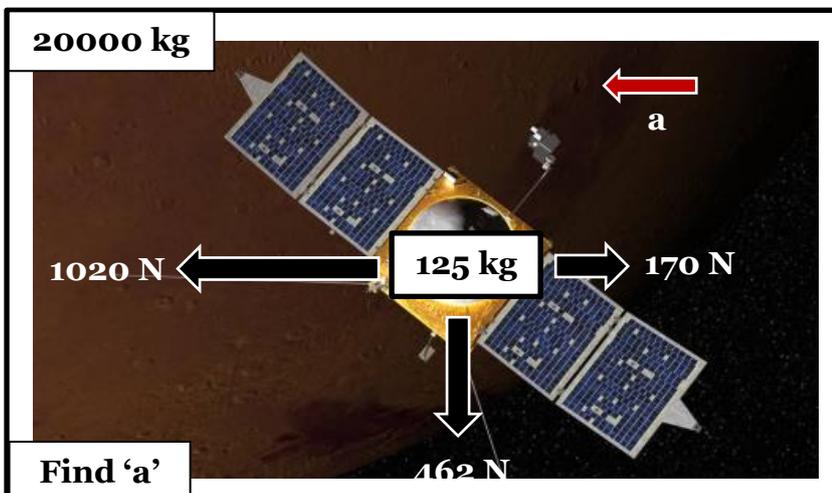
To begin:

In the problem below, the acceleration in the horizontal direction needs to be calculated. ←

The mass is 125 kg and the overall force in the horizontal direction is 850 N (1020-170 = 850).

$$a = \frac{F}{m} = \frac{850 \text{ N}}{125 \text{ kg}} = 6.8 \text{ m/s}^2$$

The solution is 6.8 m/s². Find the card with this solution, place it beneath this first card and continue by solving the problem on the second card.



6.8 m/s²

703 N

$a = 0.05 \text{ m/s}^2$

18 N

190 kg

5 N

f_1

703 N

Find f_1

Detailed description: A diagram of a rover on the Martian surface. A central box labeled '190 kg' has four force vectors: an upward arrow labeled '703 N', a downward arrow labeled '703 N', a leftward arrow labeled '18 N', and a rightward arrow labeled '5 N'. A smaller rightward arrow labeled ' f_1 ' is also shown. A red arrow in the top right indicates an acceleration $a = 0.05 \text{ m/s}^2$. The background shows a reddish landscape with hills.

2500 kg

$a = 0 \text{ m/s}^2$

f_1

190 kg

89 N

64 N

Find f_1

Detailed description: A diagram of a rover in space. A central box labeled '190 kg' has three force vectors: a leftward arrow labeled ' f_1 ', a rightward arrow labeled '89 N', and another leftward arrow labeled '64 N'. A red arrow at the top indicates an acceleration $a = 0 \text{ m/s}^2$. The background is a light blue gradient.

0.8 m/s²

703 N

$a = 0.04 \text{ m/s}^2$

f_2

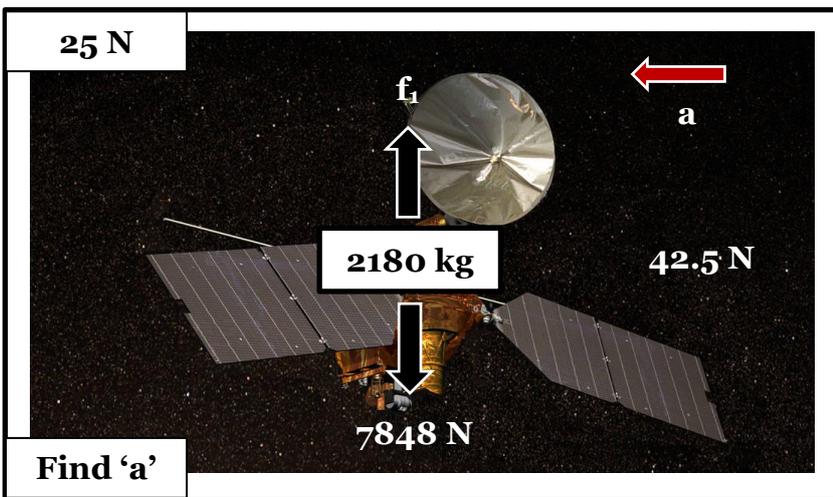
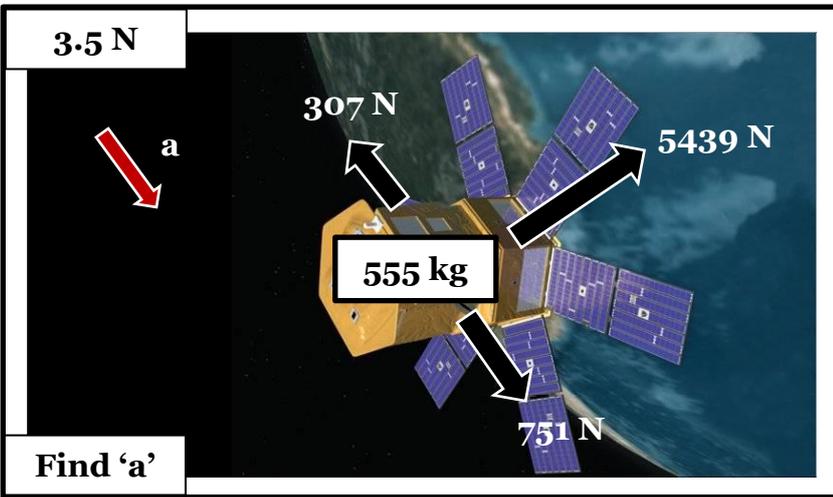
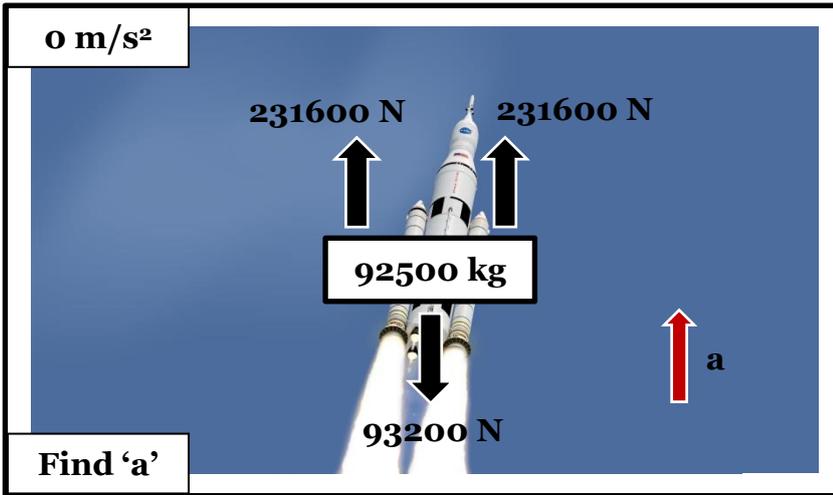
190 kg

12 N

f_1

Find f_2

Detailed description: A diagram of a rover on the Martian surface. A central box labeled '190 kg' has four force vectors: an upward arrow labeled '703 N', a downward arrow labeled ' f_1 ', a leftward arrow labeled ' f_2 ', and a rightward arrow labeled '12 N'. A red arrow in the top right indicates an acceleration $a = 0.04 \text{ m/s}^2$. The background shows a reddish landscape with rocks.



4.4 N

2300 N

m

4500 N

$a = 0.88 \text{ m/s}^2$

Find m

Detailed description: A satellite is shown in space. A box labeled 'm' is placed on the satellite. Four force vectors are shown: a black arrow pointing left labeled '4500 N', a black arrow pointing right labeled '2300 N', a black arrow pointing up-left labeled '4.4 N', and a red arrow pointing down-right labeled ' $a = 0.88 \text{ m/s}^2$ '.

4 m/s²

$a = 1.6 \text{ m/s}^2$

41 N

m

60 N

112 N

Find m

Detailed description: An astronaut is on the moon next to a lunar rover. A box labeled 'm' is placed on the astronaut. Four force vectors are shown: a red arrow pointing down labeled ' $a = 1.6 \text{ m/s}^2$ ', a black arrow pointing left labeled '41 N', a black arrow pointing right labeled '60 N', and a black arrow pointing down labeled '112 N'.

70 kg

640000 N

m

$a = 11.7 \text{ m/s}^2$

406000 N

Find m

Detailed description: A rocket is accelerating upwards against a blue sky. A box labeled 'm' is placed on the rocket. Three force vectors are shown: a black arrow pointing up labeled '640000 N', a black arrow pointing down labeled '406000 N', and a red arrow pointing up labeled ' $a = 11.7 \text{ m/s}^2$ '.

Resultant Force and Acceleration: ANSWERS

Key Stage 4 (foundation)

$$a = \frac{F}{m} \quad \text{and} \quad m = \frac{F}{a}$$

