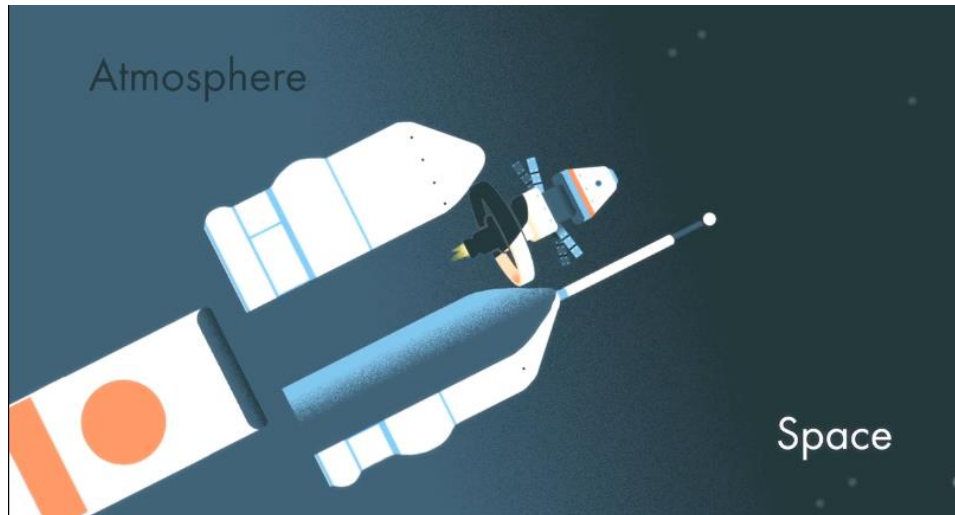


Resultant Force and Acceleration

Key Stage 4 (higher)

Topics covered: forces as vectors, standard form, 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/s^2
- 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:

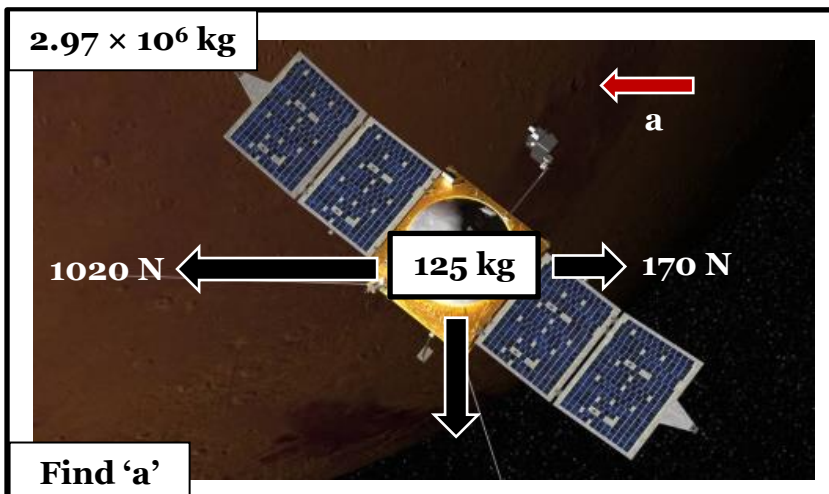
In the problem below, the acceleration in the horizontal direction needs to be calculated.

Use the formula for 'a' that you rearranged above to find the acceleration. The mass of the probe is 125 kg. First, you will need to work out the overall force in the horizontal direction.



$$a =$$

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

Diagram showing a rover on Mars. A central box labeled **190 kg** has several force vectors acting on it: an upward arrow labeled **462 N**, a downward arrow labeled **703 N**, a leftward arrow labeled **18 N**, a rightward arrow labeled **5 N**, and another rightward arrow labeled **f₁**. A red arrow indicates acceleration **a = 0.05 m/s²** pointing to the left.

Find f₁

2500 kg

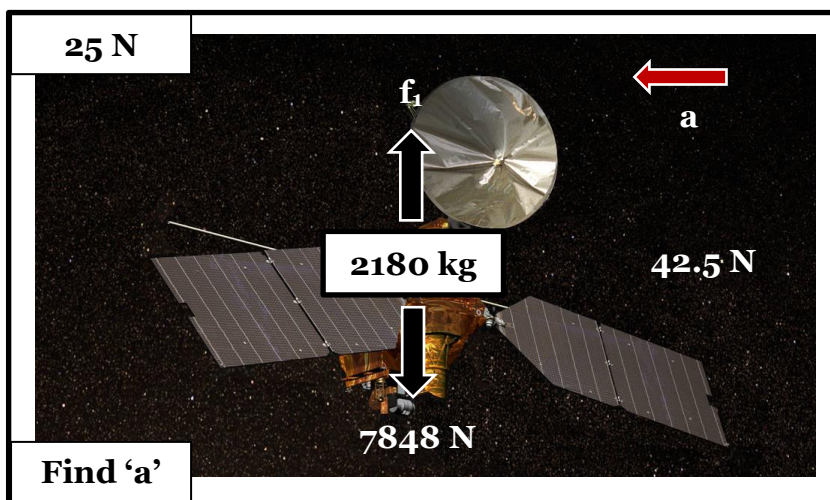
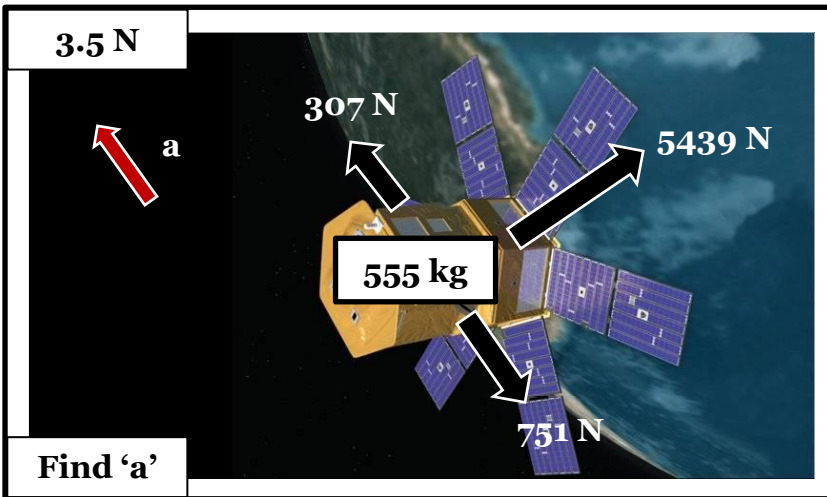
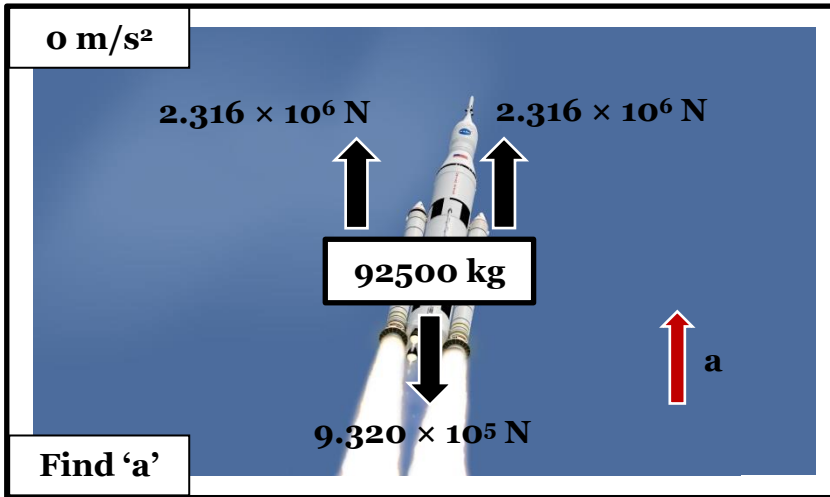
Diagram showing a rover in space. A central box labeled **190 kg** has force vectors: a leftward arrow labeled **f₁**, a rightward arrow labeled **89 N**, and another leftward arrow labeled **64 N**. A red arrow indicates acceleration **a = 0 m/s²** pointing to the right.

Find f₁

-0.8 m/s²

Diagram showing a rover on Mars. A central box labeled **190 kg** has force vectors: an upward arrow labeled **703 N**, a downward arrow labeled **f₁**, a leftward arrow labeled **f₂**, and a rightward arrow labeled **12 N**. A red arrow indicates acceleration **a = 0.04 m/s²** pointing to the right.

Find f₂



4.4 N

Diagram of a satellite in space. A central box labeled 'm' represents the satellite's mass. Three force vectors are shown: a black arrow pointing left labeled $4.5 \times 10^{-6} \text{ N}$, a black arrow pointing right labeled $2.3 \times 10^{-6} \text{ N}$, and a red arrow pointing down labeled 4.4 N . A red arrow labeled $a = 8.8 \times 10^{-10} \text{ m/s}^2$ points down from the satellite.

Find m

40 m/s²

Diagram of an astronaut on the moon. A central box labeled 'm' represents the astronaut's mass. Three force vectors are shown: a black arrow pointing left labeled 41 N, a black arrow pointing right labeled 60 N, and a black arrow pointing down labeled 40 N. A red arrow labeled $a = 1.6 \text{ m/s}^2$ points down from the astronaut.

Find m

70 kg

Diagram of a rocket accelerating upwards. A central box labeled 'm' represents the rocket's mass. Two force vectors are shown: a black arrow pointing up labeled $64 \times 10^6 \text{ N}$ and a black arrow pointing down labeled $29.251 \times 10^6 \text{ N}$. A red arrow labeled $a = 11.7 \text{ m/s}^2$ points up from the rocket.

Find m

Resultant Forces and Acceleration: **ANSWERS**

Key Stage 4 (higher)

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

