

12 Ramped Questions on Resultant Force and $F = ma$ Calculations

In real situations, objects are usually acted on by more than one force. First calculate the resultant force, then use Newton's Second Law to determine the acceleration, mass or force. These questions are ramped from straightforward calculations to multi-step challenges involving acceleration, deceleration and motion.

1. A supermarket trolley is pushed with a force of 80 N. Friction opposes the motion with a force of 30 N. The trolley has a mass of 25 kg. Calculate its acceleration.
2. A cyclist and bicycle have a combined mass of 75 kg. The cyclist produces a driving force of 180 N while air resistance is 60 N. Calculate the acceleration.
3. An e-scooter experiences a forward force of 250 N and a resistive force of 100 N. The total mass of the rider and scooter is 50 kg. Calculate the acceleration.
4. A rowing boat is pulled forward by a force of 900 N. Water resistance acts backwards with a force of 300 N. The mass of the boat and crew is 400 kg. Calculate the acceleration.
5. A family car joins a motorway. The engine provides a force of 5000 N while air resistance and friction total 2000 N. The mass of the car is 1250 kg. Calculate the acceleration.
6. A delivery van is travelling downhill. The engine provides a force of 1500 N but the brakes produce a force of 4500 N. The van has a mass of 1500 kg. Calculate the deceleration.
7. A train has a mass of 80000 kg. The motors provide a force of 100000 N while friction and air resistance total 40000 N. Calculate the acceleration.
8. An aircraft lands on a runway. The engines provide a forward force of 20000 N while braking and air resistance provide a total backward force of 140000 N. The aircraft has a mass of 60000 kg.
 - a) Calculate the resultant force.

b) Calculate the deceleration.

9. A sports car has a mass of 1000 kg. The engine provides a force of 12000 N and resistive forces total 2000 N.

a) Calculate the resultant force.

b) Calculate the acceleration.

c) If the car starts at 8 m/s, calculate its velocity after 5 seconds.

10. A rocket has a mass of 25000 kg. During launch, the engines produce a thrust of 750000 N while the rocket's weight acts downward with a force of 250000 N.

a) Calculate the resultant force.

b) Calculate the acceleration.

c) Calculate the rocket's velocity after 20 seconds if it starts from rest.

11. A Formula 1 car is travelling at 72 m/s when the driver brakes heavily. The braking force is 18000 N and other resistive forces total 2000 N. The mass of the car is 800 kg.

a) Calculate the resultant force.

b) Calculate the deceleration.

c) Calculate the velocity after 2 seconds.

12. Challenge Question

A train of mass 200000 kg is travelling at 30 m/s. The motors provide a forward force of 50000 N while the brakes provide a backward force of 250000 N.

a) Calculate the resultant force.

b) Calculate the deceleration.

c) Calculate the velocity after 10 seconds.

d) State whether the train would have stopped before the 10 seconds had elapsed.