Resultant force and momentum

Worked solutions

GCSE science calculations

This topic online

1 A car has a driving force of 2400 N forwards. The total resistive force on the car is 900 N backwards.

Calculate the resultant force on the car. (1 mark)

Opposite directions, so subtract

resultant force = 2400 − 900

1500 N forwards

2 A loaded supermarket trolley has a mass of 30 kg. It accelerates at 1.5 m/s^2.

Calculate the resultant force on the trolley. (2 marks)

Resultant force = mass × acceleration

$F = ma$

$F = 30 \times 1.5$

$F = 45$ N

3 **Higher tier**

A rugby player of mass 70 kg runs at a velocity of 6 m/s.

Calculate the momentum of the player. (2 marks)

Momentum = mass × velocity

$p = mv$

$p = 70 \times 6$

$p = 420$ kg m/s

4 In a Year 10 practical, a trolley of mass 250 g accelerates down a runway at 0.8 m/s^2.

Calculate the resultant force on the trolley. (2 marks)

Resultant force = mass × acceleration

250 g = 0.25 kg

$F = 0.25 \times 0.8$

$F = 0.2$ N

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5 A train carriage has a mass of 32 000 kg. It accelerates at 0.6 m/s^2.

Calculate the resultant force on the carriage. Give your answer in kilonewtons (kN). (3 marks)

Resultant force = mass x acceleration

$F = 32\,000 \times 0.6$

$F = 19\,200$ N

1 kN = 1000 N

$F = 19.2$ kN

6 **Higher tier**

A cricket ball of mass 160 g is bowled at a velocity of 30 m/s.

Calculate the momentum of the ball. (2 marks)

Momentum = mass x velocity

160 g = 0.16 kg

$p = 0.16 \times 30$

$p = 4.8$ kg m/s

7 A cyclist and her bike have a total mass of 80 kg. The resultant force on them is 360 N.

Calculate their acceleration. (2 marks)

Resultant force = mass x acceleration

$360 = 80 \times a$

$a = 360 \div 80$

$a = 4.5$ m/s^2

8 A small car has a driving force of 1800 N. The resistive forces on it total 600 N. The car accelerates at 0.8 m/s^2.

Calculate the mass of the car. (3 marks)

Resultant force = driving force - resistive forces

resultant force = 1800 - 600

resultant force = 1200 N

Resultant force = mass x acceleration

$1200 = m \times 0.8$

$m = 1200 \div 0.8$

$m = 1500$ kg

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9 **Higher tier**

A car of mass 1200 kg has a momentum of 18 000 kg m/s.

Calculate the velocity of the car. (2 marks)

Momentum = mass x velocity

$18\,000 = 1200 \times v$

$v = 18\,000 \div 1200$

$v = 15$ m/s

10 A car of mass 1400 kg speeds up from rest to 18 m/s in 6.0 s.

Calculate the resultant force on the car. Show your working. (3 marks)

Acceleration = change in velocity ÷ time taken

$a = (18 - 0) \div 6.0$

$a = 3$ m/s^2

Resultant force = mass x acceleration

$F = 1400 \times 3$

$F = 4200$ N

11 An e-scooter and its rider have a total mass of 100 kg. They speed up from rest to 7.0 m/s in 5.0 s. The resistive force on them is 40 N.

Calculate the driving force from the motor. Show your working. (4 marks)

Acceleration = change in velocity ÷ time taken

$a = (7.0 - 0) \div 5.0$

$a = 1.4$ m/s^2

Resultant force = mass x acceleration

$F = 100 \times 1.4$

$F = 140$ N

Resultant force = driving force - resistive force

$140 =$ driving force $- 40$

driving force $= 140 + 40$

180 N

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12 **Higher tier**

In a Year 11 practical, trolley A has a mass of 0.80 kg and moves at 0.50 m/s. It collides with trolley B, which has a mass of 1.20 kg and is not moving. The trolleys stick together and move off in the same direction that A was moving.

Momentum is conserved in the collision.

Calculate the velocity of the trolleys just after the collision. Show your working.

(4 marks)

Momentum = mass x velocity

momentum before = 0.80 x 0.50 + 1.20 x 0

momentum before = 0.40 kg m/s

Momentum is conserved, so momentum after = 0.40 kg m/s

0.40 = (0.80 + 1.20) x v

0.40 = 2.00 x v

v = 0.40 ÷ 2.00

v = 0.2 m/s

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