

Exercise walk-through

5.7

Forces, accelerations and Newton's laws (4.5.6.2)

AQA · GCSE · Physics

Exercises 2.1·2.3

2.1 State Newton's first law for a moving object. [1]

2.2 A resultant force of 48 N acts on a 12 kg trolley. Calculate the acceleration. [2]

2.3 State Newton's third law and give one example with names on both objects. [2]

Exercises 2.1·2.3

2.1 State Newton's first law for a moving object. [1]

2.1 With zero resultant force, a moving object continues at the same velocity (same speed and direction).

2.2 A resultant force of 48 N acts on a 12 kg trolley. Calculate the acceleration. [2]

2.2

$$a = F/m = 48/12 = \mathbf{4.0} \text{ m/s}^2$$

(C1, A1)

2.3 State Newton's third law and give one example with names on both objects. [2]

2.3 Two interacting objects exert equal and opposite forces on each other; e.g. the foot pushes the ground backwards and the ground pushes the foot forwards (both named, B1).

Exercise 3.1

3.1 A student investigates how the force on a trolley affects its acceleration (mass constant).

- (a) State the independent and dependent variables and one control. [3]
- (b) Describe how the student obtains the force and the acceleration values. [3]
- (c) The a – F graph is a straight line through the origin. State the relationship. [1]

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3.1 (a) Independent: the pulling force (masses on the hanger); dependent: the acceleration; control: total mass of the system (or friction compensation / runway angle). (b) Force: $F = mg$ of the hanger and masses; acceleration: light gates measure velocities at two points and $a = (v_2 - v_1)/t$ – or ticker-tape spacing; repeat each force and average. (c) Acceleration is directly proportional to the force.

Exercise 3.2

3.2 A skydiver of mass 70 kg falls with acceleration 3.2 m/s^2 ($g = 9.8 \text{ N/kg}$).

(a) Calculate the skydiver's weight.

[2]

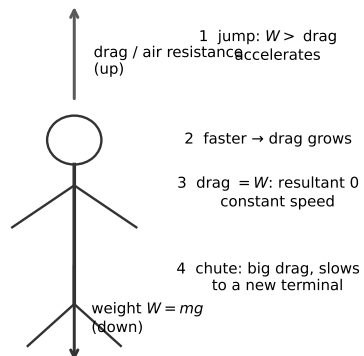
(b) Calculate the resultant force.

[2]

(c) Calculate the drag force.

[2]

free-body diagram: only forces ON the skydiver
terminal velocity story

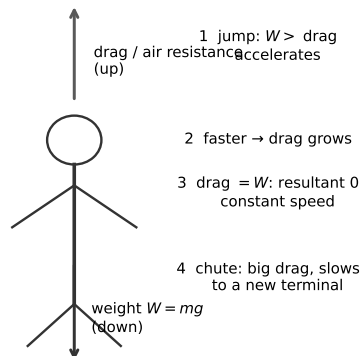


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- (a) Calculate the skydiver's weight. [2]
 (b) Calculate the resultant force. [2]
 (c) Calculate the drag force. [2]

free-body diagram: only forces ON the skydiver
 terminal velocity story



3.2 (a) $W = mg = 70 \times 9.8 = \mathbf{686 \text{ N}}$ (C1, A1). (b) $F = ma = 70 \times 3.2 = \mathbf{224 \text{ N}}$ down (C1, A1). (c) Drag = weight – resultant = $686 - 224 = \mathbf{462 \text{ N}}$ up (C1, A1).

Full solution 3.2

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Exercise 3.3

3.3 A 1400 kg car travelling at 18 m/s brakes and stops in 25 m.

- (a) Calculate the deceleration using $v^2 - u^2 = 2as$. [3]
- (b) Calculate the braking force. [2]
- (c) (HT) State Newton's third-law pair for the braking force on the car, and explain why the two forces do not cancel out. [3]

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3.3 (a)

$$0 - 18^2 = 2a \times 25 \quad \Rightarrow \quad a = -\frac{324}{50} = -\mathbf{6.5} \text{ m/s}^2$$

(substitution C1, rearrangement C1, answer A1) (b) $F = ma = 1400 \times 6.48 = \mathbf{9072} \approx 9100 \text{ N}$ (2 s.f.) (C1, A1). (c) The car's brakes (wheels) push the road forwards... the third-law pair: the car exerts a forward force on the road surface, and the road exerts an equal backward friction force on the tyres. They act on **different objects** (road vs car), so neither balances the other on the car – the backward friction on the tyres is what decelerates it.