# 1.2 Forces and movement

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

## Objective

Build the skills to answer exam questions on **forces and movement** : scalars and vectors, resultant force, $F = ma$, weight, stopping distances, terminal velocity and Hooke's law.

**You must be able to:**

- find resultant forces and use $F = ma$ and $W = mg$
- explain the factors that affect stopping distance
- explain terminal velocity
- analyse a spring experiment and find the limit of proportionality

## 1 Key knowledge and worked examples

### Forces

| idea | equation or rule |
|---|---|
| resultant force | add forces in the same direction; subtract opposite forces |
| force and acceleration | $F = m \times a$ |
| weight | $W = m \times g$, with $g = 10$ N/kg on Earth |
| stopping distance | thinking distance + braking distance |
| Hooke's law | extension is directly proportional to the force, up to the limit of proportionality: $F = kx$ |

**Worked example 1: $F = ma$.** A resultant force of 3000 N acts on a 1200 kg car. Find its acceleration.

1. Known: $F = 3000$ N; $m = 1200$ kg.
2. Rule: $a = F \div m$.
3. Numbers: $3000 \div 1200$.
4. Result: 2.5 $\mathbf{m/s^2}$.

**Worked example 2: a spring.** A spring has $k = 40$ N/m. Find its extension with



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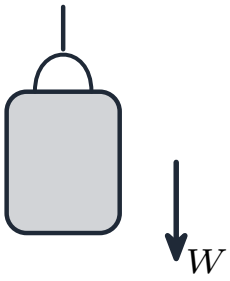
a 6.0 N load.

1. Known: $F = 6.0$ N; $k = 40$ N/m.
2. Rule: $x = F \div k$.
3. Numbers: $6.0 \div 40$.
4. Result: 0.15 **m** (15 cm).

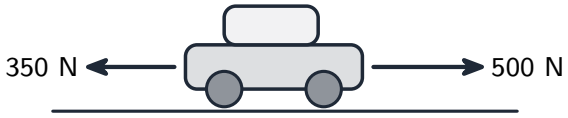
**Answer shapes:** for terminal velocity, compare the sizes of the forces at each stage: weight against air resistance.

## 2 Practice

**2.1** Calculate the weight of a 6.0 kg bag on Earth. [2]




**2.2** A car's engine gives a forward force of 500 N. Air resistance and friction total 350 N. Calculate the resultant force and give its direction. [2]



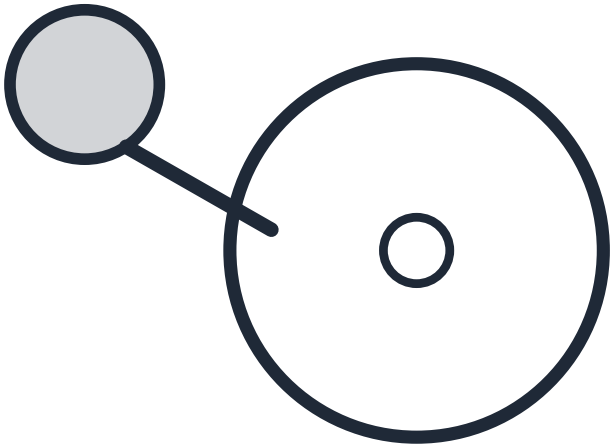

**2.3** Explain the difference between a scalar and a vector quantity, giving an example of each. [2]





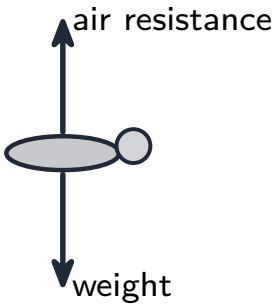

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**2.4** Give **two** factors that increase a driver's thinking distance. [2]



## 3 Exam-style questions

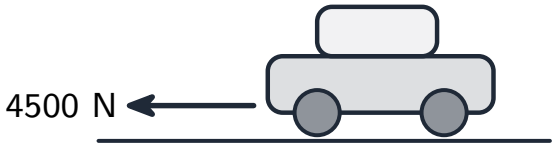
**3.1** A skydiver jumps from a plane. Explain why she reaches a terminal velocity. [3]



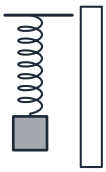



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**3.2** A 900 kg car travelling at 20 m/s brakes with a resultant force of 4500 N. Calculate its deceleration and the time it takes to stop. [3]




**3.3** A student hangs loads on a spring and measures its length. The results are shown.



| load / N | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| length / cm | 20.0 | 22.0 | 24.0 | 26.0 | 28.0 | 30.5 | 34.0 |

(a) Calculate the extension for a load of 3.0 N, and the spring constant in N/m. [3]

(b) Use the results to find the limit of proportionality. Explain your answer. [4]



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(c) An unknown mass makes the spring 25.0 cm long. Calculate the mass. [3]

(d) Describe how the student should carry out this experiment accurately and safely. [6]



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