Exercise walk-through

1.1
Forces interactions and motion

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1.1 Forces interactions and motion

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

KEY WORDS resultant force • limit of proportionality

Objective

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Build the skills to answer exam questions on **forces and motion** : contact and non-contact forces, scalars and vectors, weight, stretching springs, motion graphs and Newton's three laws.

You must be able to:

- tell scalars from vectors, and contact forces from non-contact forces
- use $W = mg$ and $F = ke$
- find speed, acceleration and distance from motion graphs

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- use Newton's laws and $F = ma$, and describe a spring investigation

1 Key knowledge and worked examples

Forces and motion

idea	equation or rule
scalar and vector	a scalar has size only (speed, mass, distance); a vector has size and direction (velocity, force, displacement)
weight	$W = mg$, with $g = 9.8$ N/kg on Earth; mass stays the same everywhere
spring	$F = ke$ (e = extension in m) up to the limit of proportionality
speed	$v = \frac{s}{t}$; the gradient of a distance–time graph
acceleration	$a = \frac{\Delta v}{t}$; the gradient of a velocity–time graph; the area under it is the distance
Newton's first law	balanced forces: an object stays still or keeps the same velocity
Newton's second law	resultant force $F = ma$
Newton's third law	two objects push or pull on each other with equal and opposite forces

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Worked example 1: weight. Find the weight of a 65 kg student on Earth.

1. Known: $m = 65$ kg, $g = 9.8$ N/kg.
2. Rule: $W = mg$.
3. Numbers: 65×9.8.
4. Result: $W = 637$ **N**.

Worked example 2: a resultant force. A 1200 kg car has a driving force of 3000 N and resistive forces of 600 N. Find its acceleration.

1. Known: resultant force $= 3000 - 600 = 2400$ N; $m = 1200$ kg.
2. Rule: $a = \frac{F}{m}$.
3. Numbers: $\frac{2400}{1200}$.
4. Result: $a = 2.0$ $\mathbf{m/s^2}$.

Answer shapes: write the equation, put in the numbers in SI units (m, kg, s), then give the answer with its unit.

Exercises 2.1·2.3

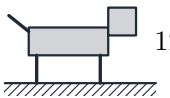
2.1 Give one contact force and one non-contact force. [2]

contact force non-contact force

2.2 Which two of these are vectors: mass, velocity, distance, acceleration? [2]

mass velocity distance acceleration

2.3 Calculate the weight of a 12 kg dog at g = 10 N/kg. [2]



Exercises 2.1·2.3

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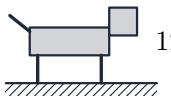
2.1 Contact – friction (or tension, air resistance, normal); non-contact – gravity (or electrostatic, magnetic).

2.2 Which two of these are vectors: mass, velocity, distance, acceleration? [2]

mass velocity distance acceleration

2.2 Velocity and acceleration.

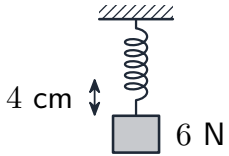
2.3 Calculate the weight of a 12 kg dog at g = 10 N/kg. [2]



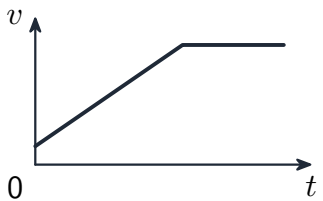
2.3 $F_W = 12 \times 10 = 120$ N.

Exercise 2.4

2.4 A spring stretches 4 cm under a 6 N load. Calculate k in N/m. [3]

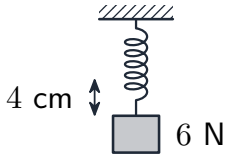


2.5 State what the gradient and the area represent on a velocity–time graph. [2]

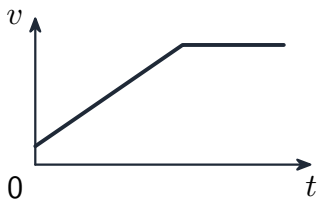


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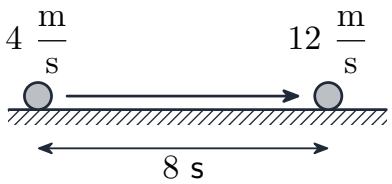


2.4 $e = 0.04$ m; $k = F/e = 6/0.04 = 150$ N/m.

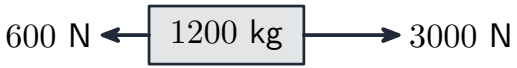
2.5 Gradient – acceleration; area – distance travelled.

Exercises 3.1·3.2

3.1 A cyclist accelerates from 4 m/s to 12 m/s in 8 s. Calculate the acceleration and the distance travelled. [4]

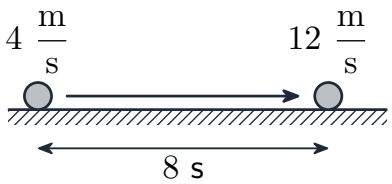


3.2 A 1200 kg car has a driving force of 3000 N and resistive forces of 600 N. Calculate its acceleration. [3]



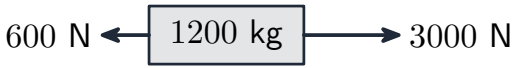
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3.1 $a = (12 - 4)/8 = 1$ m/s^2; distance = area = $\frac{1}{2}(4 + 12) \times 8 = 64$ m.

3.2 A 1200 kg car has a driving force of 3000 N and resistive forces of 600 N. Calculate its acceleration. [3]



3.2 Resultant = 3000 − 600 = 2400 N; $a = 2400/1200 = 2$ m/s^2.

Exercise 3.3

3.3 Describe how two coplanar forces of 30 N East and 40 N North may be combined by scale drawing, and state the resultant's size. [3]



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3.3 Draw the 30 N arrow East to scale, then the 40 N arrow North from its tip; join start to finish – the diagonal is the resultant; $F_{\text{res}} = \sqrt{30^2 + 40^2} = 50$ N.