Year 12 Physics - Mechanics

AS91171
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Chapter 1

Speed and Acceleration

1.1 Warm Up

1.1.1 Pātai Tahi: Who is the fastest?

1. Andy can run $100m$ in 11.9 seconds
2. Bob can run $100m$ in 10.8 seconds
3. Chris can run $100m$ in 12.4 seconds

1.1.2 Pātai Rua: Who is the fastest?

1. Aaron can run $534m$ in $1minute$
2. Billy can run $510m$ in $1minute$
3. Cameron can run $452m$ in $1minute$

1.1.3 Pātai Toru: Who is the fastest?

1. Ash can run $0.3km$ in $45seconds$
2. Bailey can run $420m$ in $1minute$
3. Caleb can run $510m$ in $1.5minutes$

1.2 Formula: Average Speed

$$v = \frac{d}{t} \tag{1.1}$$
$$d = \text{total distance travelled} \tag{1.2}$$
$$t = \text{time} \tag{1.3}$$
$$v = \text{speed} \tag{1.4}$$

1.2.1 What is the Unit?

1. ms^{-1}
2. It stands for **meters per second**
3. E.g. the speed of sound is $343ms^{-1}$ - it travels at 343 meters in one second

1.2.2 Example / Tauria

Ash runs $315m$ in $45s$. Calculate his average speed in *meters per second*.

1. Knowns
2. Unknowns
3. Formula
4. Substitute
5. Solve

1.2.3 Pātai Tahi: Unit Conversions

1. A skydiver (freefall) = $53ms^{-1}$
2. A handgun bullet = $660ms^{-1}$
3. A car on the road = $50km/hr$
4. A flying airplane = $1100kmh^{-1}$
5. Light = $300,000,000$

In pairs, convert the speed of the car and airplane into *meters per second*.

1.2.4 Pātai Rua: Velocity Calculation

A car is moving at a speed of $10ms^{-1}$. How far does the car travel in $12s$?

1. Knowns
2. Unknowns
3. Formula
4. Substitute
5. Solve

1.2.5 Pātai Toru: Running Man

A man is running at a speed of $4ms^{-1}$. How long does he take to run $100m$?

1. Knowns
2. Unknowns
3. Formula
4. Substitute
5. Solve

1.3 Average vs Instantaneous Speed

Velocity may refer to **average velocity** or **instantaneous velocity**. The formula $v = \frac{d}{t}$ can only be used to calculate **average velocity** or when **the velocity is constant** (acceleration is zero).

1.4 Formula: Acceleration

The rate of change in speed

$$a = \frac{\Delta v}{t} \tag{1.5}$$
$$\Delta v = \text{change in speed} \tag{1.6}$$
$$t = \text{time} \tag{1.7}$$
$$a = \text{acceleration} \tag{1.8}$$

1.4.1 What Does ms^{-2} Mean?

Whakatika: meters per second squared OR meters per second per second. For example, $a = 12ms^{-2}$ means that the velocity is increased by $12ms^{-1}$ every second.

Time (s)	0	1	2	3
Velocity (ms^{-1})	0	12	24	36

1.4.2 Pātai: Re-arranging Acceleration

Starting with $a = \frac{\Delta v}{t}$, re-arrange the equation for v and t.

(A) $a = \frac{\Delta v}{t}$

(B) $a = \frac{\Delta v}{t}$

1.5 Formula: Calculating Change (Δ)

This is the difference between the **initial** and the **final** value.

$$\Delta = final - initial \tag{1.9}$$

$$\text{e.g. } \Delta v = v_f - v_i \tag{1.10}$$

1.5.1 Pātai Whā: Walking

A man initially walking at $2.0 ms^{-1}$ notices that his house is on fire so he speeds up to $11 ms^{-1}$ in $1.3 s$.

1. Calculate the change in speed

1. Knowns
2. Unknowns
3. Formula
4. Substitute
5. Solve

2. Calculate his acceleration

1. Knowns
2. Unknowns
3. Formula
4. Substitute
5. Solve

1.5.2 Pātai Rimu: The Car

A car initially moving at $12.7 ms^{-1}$ accelerates at $1.3 ms^{-2}$ for **one minute**. What is the car's final speed?

1. Knowns
2. Unknowns
3. Formula
4. Substitute
5. Solve

1.5.3 Pātai Ono: Decelerating Car

A car decelerates at $1.8ms^{-2}$ for $9.4s$ to stop. What was the car's initial speed?

1. Knowns
2. Unknowns
3. Formula
4. Substitute
5. Solve

Chapter 2

Vectors and Scalars

2.1 Introduction

In pairs, think about and discuss the similarities and differences between these two questions:

1. Mr Chu puts 40 apples inside a box, except Miss Nam eats two of them. What is the total number of apples inside the box?
2. Mrs Carpenter lifts a plant off her desk with a force of $15N$ in the upwards direction, while the plant has a weight force of $5N$ acting down. What is the total force applied on the plant?

2.2 What is a Vector?

- **Scalar** = size only (e.g. mass)
- **Vector** = size + direction (e.g. velocity)

2.2.1 Distance vs. Displacement

- **Distance** is the amount an object has moved
  - It is a scalar
  - e.g. $3km$
- **Displacement** is the distance from start to finish in a straight line
  - It is a vector, because direction is also important
  - e.g. $3km$ South West

2.2.2 Pātai Tahi

Ella drives to Sumner beach in the weekend because it is far too hot. She drives $5km$ south and $10km$ west to get there.

1. What is the total distance travelled by Ella?

- Knowns
- Unknowns
- Formula
- Substitute
- Solve

2. What is the total displacement of Ella?

- Knowns
- Unknowns
- Formula
- Substitute
- Solve

2.2.3 Pātai Rua: Scalar or Vector

Use the units to help you decide whether each is a scalar or a vector.

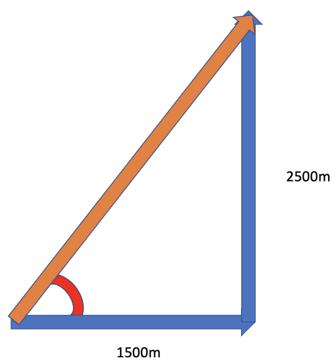
- Distance
- Displacement
- Speed
- Velocity
- Acceleration
- Momentum
- Energy
- Force
- Temperature
- Mass
- Work
- Power

2.2.4 Vectors

When dealing with problems which involve vector quantities (e.g. calculating velocity, force, etc.), you must consider the size and direction.

Which means: **you must use vector calculations and/or vector diagrams.**

- Have both **direction** and **magnitude**
- Drawn as an arrow
- Drawn with a ruler
- Drawn to scale (on a grid, typically)
- Drawn head-to-tail
- Can be added an subtracted
- Use Pythagoras and SOH CAH TOA to find values


2500m
1500m

Chapter 3

Kinematic Equations

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Chapter 5

Projectile Motion

Chapter 6

Torque and Equilibrium

Chapter 7

Circular Motion

Chapter 8

Momentum and Impulse

Chapter 9

Energy, Work, and Power