Projectile Motion

12PHYS - Mechanics

Mahi Tuatahi

1. Yssy travels 30km south and then 20km west. Draw a vector diagram to show her total **displacement (resultant)**.
2. Max and Lena are pushing a box. Max is pushing it with force 500N to the right, and Lena is pushing it with force 400N up. Draw a vector diagram to show the **net (resultant) force**.
3. Phoebe is flying at $7ms^{-1}$ east. Phoebe changes direction so she flying at $7ms^{-1}$ south. Draw a vector diagram to show her **change in velocity**.

Te Whāinga Ako

1. Be able to describe the motion of an object undergoing projectile motion.

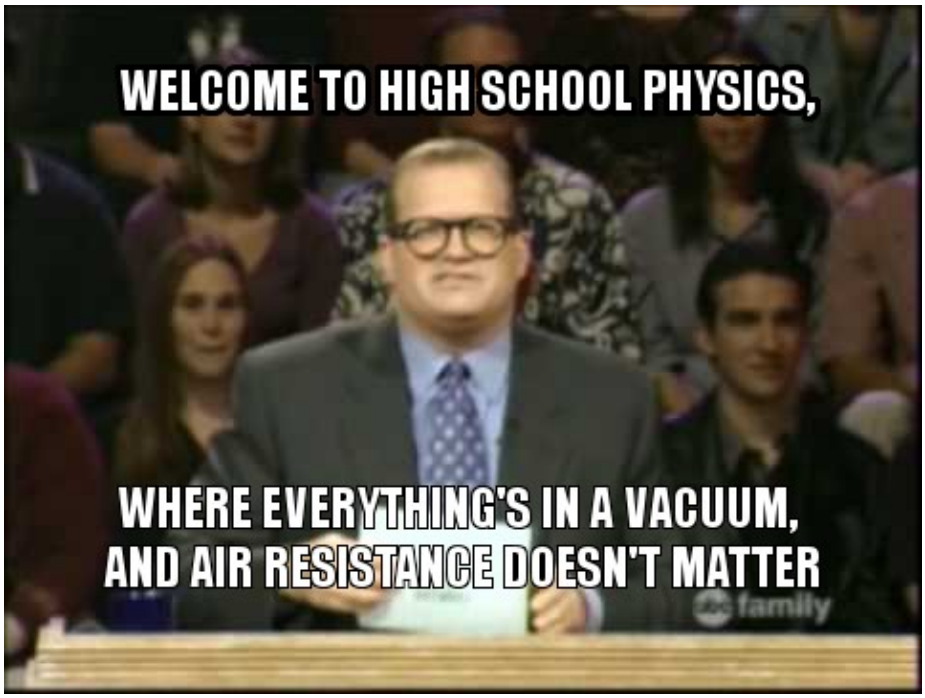
Write the date and te whāinga ako in your book

Whakamātau/Experiment

1. How many seconds was the student in the air for?
2. What is the acceleration due to gravity?
3. What was their velocity at the top of their flight?
4. How far up did Hancock throw them?

Projectile Motion

> Motion under gravity. Friction forces are ignored. Gravity is the only force acting. Motion up and motion down are symmetrical.



Mahi Tuatahi

1. Calculate the height that your ball reached yesterday in your experiment
2. Complete the calculation at the bottom of yesterday's worksheet

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Pātai: Describing Velocity

We first need to correctly describe the *velocity* and *acceleration* of an object in motion.

A ball is thrown vertically upwards. **In pairs on a whiteboard, draw two diagrams and indicate the direction of the ball's velocity and acceleration when:**

1. It is going up,
2. it is going down,
3. it is at the highest point.

Whakatika

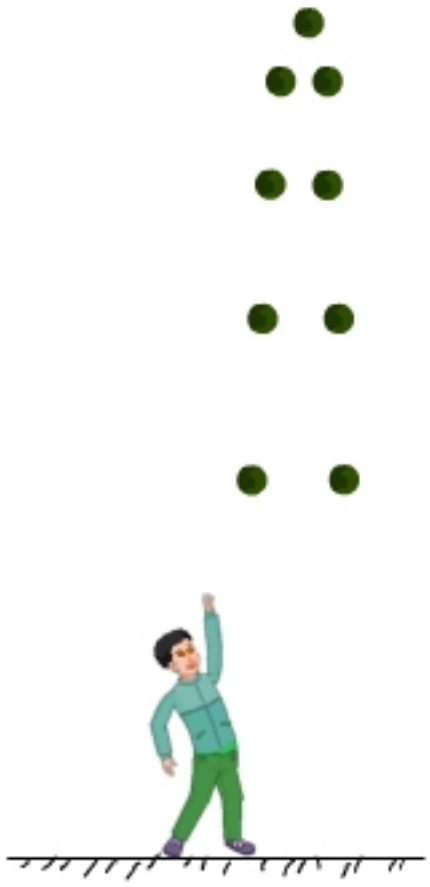

Figure 1: Velocity

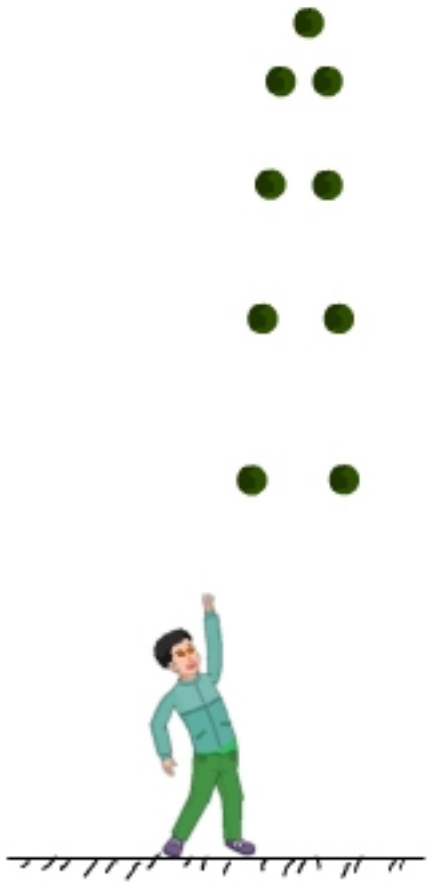

Figure 2: Acceleration

Forces on Projectiles

- We assume that friction force is negligible (we ignore it).
- Therefore, *the only force* acting upon the ball while in the air is the **weight force**.
- Weight force acts in the vertical direction only ($a_y = g = 9.8ms^{-2}, v \neq const.$)
- No forces act in the horizontal ($a_x = 0, v = const.$)

Acceleration Due to Gravity

$a = g = 9.8ms^{-2}$ (down)

The acceleration of any object in the air without any external forces acting on it.

1D Projectile Motion: In Summary

- An object that moves through the air **without its own power source**;
- the only force acting upon it is the **weight force**;
- it is always experiencing **downward acceleration of** $9.8ms^{-2}$;
- motion up/down is symmetrical.

Mahi Tuatahi: Pātai Tahi

A ball is thrown upwards with an initial speed of $161.3kmh^{-1}$ ($44.8ms^{-1}$).

1. How long does it take for the ball to reach its highest point?
2. How high does the ball rise?

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

Pātai Rua

Lachie kicks a rugby ball straight upwards. It is in the air for $10.6s$ before it hits the ground.

1. What is the initial velocity of the ball?
2. If kicked towards some rugby posts, at its highest point, will it go over the crossbar (3m)?

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

Pātai Toru

Angus is going cliff diving. He jumps and falls for $3.4s$ before hitting the water below.

1. What is his **initial velocity**?
2. What is his **acceleration**?
3. What is his **final velocity** (as he hits the water)?
4. How **high** is the cliff?

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

Whakawai/Practise

- Textbook Page 137: Activity 12A Q1, Q3, Q4

2-D Projectile Motion: The Cannon Ball

A cannon ball is fired horizontally from the top of a hill. The velocity of the cannon ball is split into x and y components, which are independent of each other.

1. Weight force is the only force acting.
2. The cannonball accelerates in the y direction ($a_y = g = 9.2ms^{-2}$).
3. No forces are acting in the horizontal direction, so velocity is constant ($a_x = 0$).

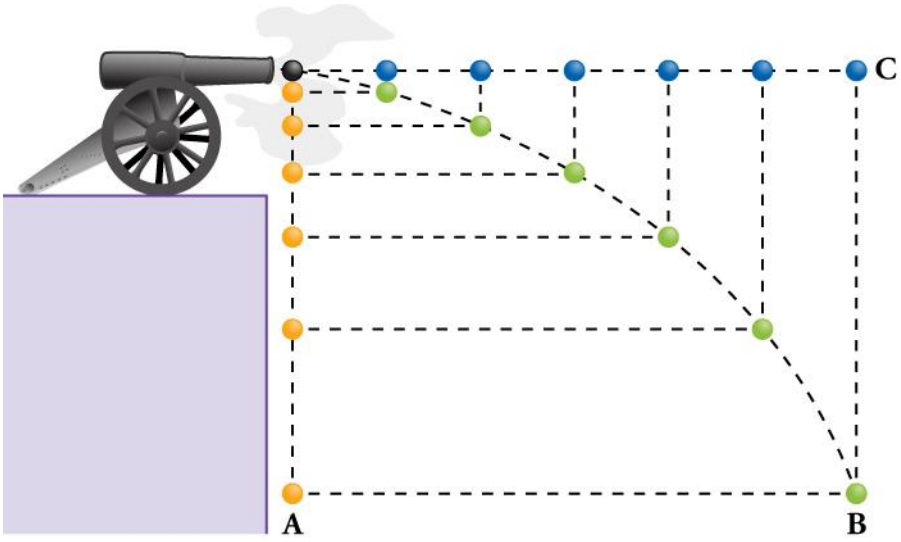

Figure 3: Source

Read page 137-138 in your textbook for extra information. Add any extra information to your notes that you find useful!

Pātai: Hammer Throw

Hume throws a hammer as far as he can during the Highland Games. It has an initial velocity of $12ms^{-1}$ on an angle of 40° to the ground. **How far does it go?**

Steps:

1. Separate the x and y values that you know.
2. Calculate the x and y initial velocities (use a diagram).
3. Calculate how long does it take for the projectile to reach the top of its path?
4. What is the total time of flight?
5. How far can it travel horizontally in that time?

Whakawai/Practise

- Textbook Activity 12B (pg. 140) Q6, Q5