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| THe mandatory practical book  Challenging the NORM – Part 2 – Physics (Mechanics) | Abstract  This book is a tribute to the lifelong journey of curiosity and scientific discovery that began in the rainy backyards of Palmerston North. From mixing childhood “potions” in old jars to inspiring students in the classroom, the author reflects on a deep-rooted passion for science nurtured by open-minded parents and later shaped by the wisdom and mentorship of educators like George Osborne, Duncan Nielson, Chris Currie, and Daryl Smith. These pages offer a curated collection of science experiments—some classic, some new—designed not merely to teach, but to spark curiosity, joy, and exploration. The work serves as both a celebration of science and a gift to future learners, continuing the cycle of inspiration passed from one generation to the next.  Jason Morgan  Educator |

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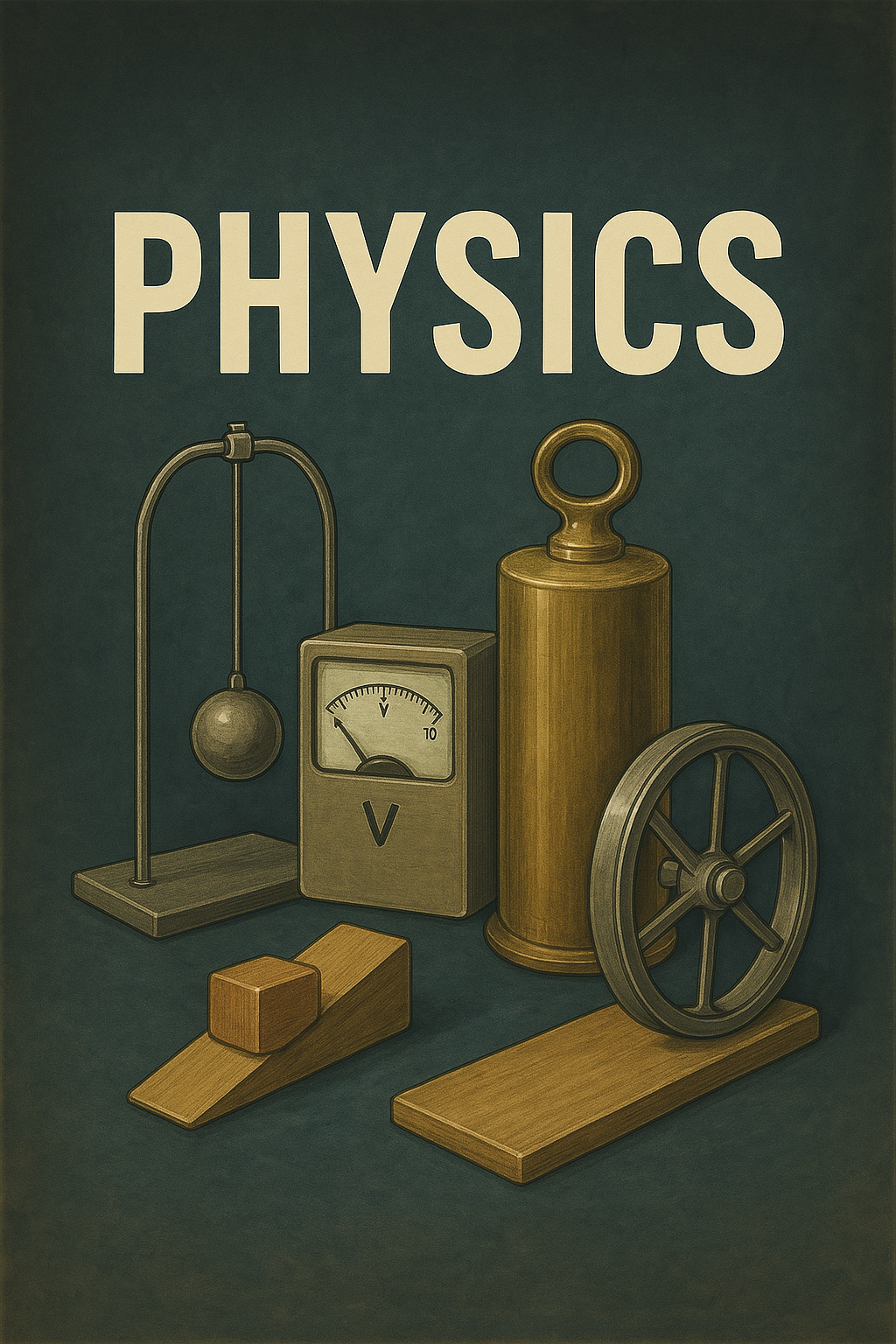
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# Physics

**🔬 Experiment Title: Investigating Inertia – How Mass Affects Motion**

**🧪 Aim:**

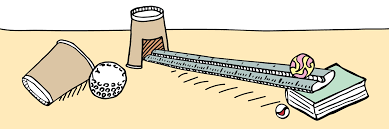
To investigate how **mass affects inertia** by observing how far a paper cup moves when struck by a rolling marble, and how increasing the cup's mass changes the result.

**🎒 You Will Need:**

* 1 small **marble** or metal ball
* 2 identical **paper or plastic cups**
* **Ramp** (ruler, cardboard, or plastic channel)
* Stack of books (to raise ramp)
* Measuring tape or ruler
* Stopwatch or timer (optional)
* Safety glasses
* Flat tabletop or floor space

**🧪 Method:**

1. Set up the **ramp** by placing one end on a stack of books and the other on the table.
2. Place **one paper cup** at the bottom of the ramp, standing upright. With a gap cu
3. Release a **marble from the same height** on the ramp so it rolls down and strikes the cup.
4. Measure how far the cup moves after impact.
5. Repeat this setup **three times** and record each distance.
6. Now place a **second cup inside the first one** to double the mass.
7. Repeat the same three trials and record how far the heavier cup moves.
8. Calculate and record the **average distance** for each setup.



**📊 Results Table:**

| **Number of Cups** | **Trial 1 (cm)** | **Trial 2 (cm)** | **Trial 3 (cm)** | **Average Distance (cm)** |
| --- | --- | --- | --- | --- |
| 1 Cup |  |  |  |  |
| 2 Cups |  |  |  |  |

**📉 Graph Instructions:**

* Draw a **bar graph**.
* **X-axis**: Number of Cups (1 Cup, 2 Cups)
* **Y-axis**: Average Distance Moved (cm)
* Use a separate bar for each cup setup.
* Label clearly. Add a title: *“Effect of Mass on Distance Moved”*.

**👀 Making Observations (Sentence Starters):**

* When the marble hit the cup, it...
* The single cup moved...
* The two stacked cups moved...
* I noticed that heavier cups...

**🧠 Conclusion Scaffold:**

* The marble caused the cup to move because...
* The cup with two cups moved... than the single cup.
* This shows that objects with more mass...
* The experiment demonstrates inertia because...

**🧠 Explanation:**

This experiment shows **Newton’s First Law of Motion** — an object at rest will stay at rest unless acted upon by a force.

* The **marble transfers energy** to the cup when it hits it.
* A **lighter cup** has **less inertia**, so it moves further when struck.
* A **heavier cup** resists motion more due to **greater inertia**, so it moves less.
* This illustrates that **more mass = more resistance to change in motion**.

**❓ Differentiated Questions:**

**🔹 Level 1 – Recall & Observation**

* What happened to the cup when the marble hit it?
* Which cup setup moved further?

**🔸 Level 2 – Understanding & Explanation**

* What is inertia?
* Why did the heavier cup move less than the lighter one?

**🔺 Level 3 – Analysis & Application**

* How does this experiment relate to Newton’s First Law of Motion?
* What would happen if you increased the mass of the marble instead?
* How is this similar to how seatbelts help keep passengers safe in a moving vehicle?

**🏷️ Tags:**

*#Physics*  
*#Inertia*  
*#ForcesAndMotion*  
*#NewtonFirstLaw*  
*#MomentumTransfer*  
*#MassAndMotion*  
*#JuniorPhysics*  
*#ObservationSkills*  
*#StudentExperiment*  
*#Year8Science*

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**Note:**

How to make the car <https://www.youtube.com/watch?v=LHmWG1k2v6U>

**🔬 Experiment Title: How Many Turns? Investigating Friction and inertia in a Rubber Band Car**

**🧪 Aim:**

To determine the **minimum number of propeller turns** required to overcome the **inertia** of a stationary car and cause it to start moving.

**🎒 You Will Need:**

* Rubber band–powered **propeller car** (like image)
* Smooth flat surface (desk or hallway floor)
* Ruler or measuring tape
* Notebook or data table
* Safety glasses (for propeller safety)
* Optional: stopwatch

**🧪 Method:**

1. Place the car on a **flat, level surface**.
2. Wind the propeller **1 full turn** and let go.
   * Observe: Did the car move? Record result.
3. Repeat by increasing the number of turns by **one each time** (e.g. 2 turns, 3 turns...).
4. Continue until the car **clearly moves forward** on its own.
5. Record the **minimum number of turns** that produced consistent movement.
6. Optionally: measure how far the car moves at 5, 10, and 15 turns for extended learning.

**📊 Results Table:**

| **Number of Turns** | **Did the Car Move? (Yes/No)** | **Notes (e.g. jumpy, smooth, rolling)** |
| --- | --- | --- |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**👀 Making Observations (Sentence Starters):**

* The car stayed still until I reached...
* When the car finally moved, it...
* With more turns, the car...
* The rubber band stored...

**🧠 Conclusion Scaffold:**

* The car didn’t move until...
* This shows that the car’s inertia...
* More energy had to be stored in the rubber band to...
* This experiment links to inertia because...

**🧠 Explanation:**

Inertia is the **resistance of an object to change its motion**. The car stays still (inertia at rest) until enough **force from the propeller** is applied to overcome **friction and mass**.

* Fewer turns = not enough energy stored
* More turns = greater force as the rubber band unwinds
* Once the **unbalanced force** overcomes inertia, the car moves  
  This is an application of **Newton’s First Law of Motion**.

**❓ Differentiated Questions:**

**🔹 Level 1 – Recall & Observation**

* What happened when the car was only wound 1–2 turns?
* What was the minimum number of turns that moved the car?

**🔸 Level 2 – Understanding & Explanation**

* Why didn’t the car move right away with only 1 turn?
* What is inertia, and how did the car demonstrate it?

**🔺 Level 3 – Analysis & Application**

* If you used a heavier car, would it need more or fewer turns to move? Why?
* How is this similar to starting a real vehicle, like a bike or car?
* How could this experiment relate to engineering design?

**🏷️**

**Tags:**

*#Physics*  
*#Inertia*  
*#ForcesAndMotion*  
*#NewtonFirstLaw*  
*#RubberBandEnergy*  
*#EnergyToMotion*  
*#StudentExperiment*  
*#Year8Physics*  
*#PropellerCar*

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**Note:**

How to make the car <https://www.youtube.com/watch?v=LHmWG1k2v6U>

**🔬 Experiment Title: Falling Tins – Does Mass Affect Time?**

**🧪 Aim:**

To investigate whether the **number of muffin tins** affects the **time taken to fall**, and observe how mass influences **vertical and horizontal motion**.

**🎒 You Will Need:**

* 1 to 6 identical **metal muffin tins**
* Stopwatch (or video with slow-motion review)
* Measuring tape or marked height (e.g. 1 metre)
* Soft landing surface (e.g. carpet or towel)
* Safety glasses
* Notebook or recording sheet
* Optional: helper to time and observe

**🧪 Method:**

1. Drop **1 muffin tin** from a height of 1 metre.
2. Use a stopwatch to measure the **time it takes to fall**.
3. Repeat 3 times and calculate the **average**.
4. Add another muffin tin to the stack and repeat the drops.
5. Continue up to **6 stacked tins**, recording all times.
6. Watch for any **sideways or spinning motion** and note your observations.
7. Plot your results on a graph.



**📊 Results Table:**

| **Number of Tins** | **Trial 1 (s)** | **Trial 2 (s)** | **Trial 3 (s)** | **Average Time (s)** |
| --- | --- | --- | --- | --- |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |
| 6 |  |  |  |  |

**📉 Graph Instructions:**

* **X-axis**: Number of Tins
* **Y-axis**: Average Time to Fall (seconds)
* Plot your data points and draw a **smooth curve** or line.
* Title your graph: *“Effect of Mass on Fall Time”*

**👀 Making Observations (Sentence Starters):**

* I noticed the tin...
* With more tins, the drop felt...
* The first few tins fell...
* As the stack grew heavier, the motion...

**🧠 Conclusion Scaffold:**

* The tins took about the same time to fall because...
* I observed that increasing the number of tins...
* This supports the idea that...
* The graph shows a small increase, then...

**🧠 Explanation:**

This experiment demonstrates **gravity’s effect on motion**.

* In theory, **mass does not affect fall time**. All objects should accelerate at **9.8 m/s²** regardless of weight.
* But with 1 or 2 tins, you may see a **slightly longer time**. This is because:
  + Light objects experience **more air resistance** compared to their weight.
  + The wide, flat shape of a single tin **increases drag**.
* As you stack more tins, the **mass increases**, and gravity has a **greater net effect** than air resistance.
* Eventually, the mass is high enough that air resistance has **little impact**, and the fall time becomes **stable**.

This is why the graph may show a **slight rise in fall time**, then **level off** as the object behaves more like a classic free-falling body.

**❓ Differentiated Questions:**

**🔹 Level 1 – Recall & Observation**

* How did the time change as more tins were added?
* Did the stack fall straight down or tip?

**🔸 Level 2 – Understanding & Explanation**

* Why do the tins fall at nearly the same speed?
* Why does the graph level off after a few tins?

**🔺 Level 3 – Analysis & Application**

* What forces are acting on the tins as they fall?
* How does this experiment relate to falling objects in real life (e.g. a parachute)?
* What would happen on the Moon, where there is no air resistance?

**🏷️ Tags:**

*#Physics*  
*#FreeFall*  
*#Gravity*  
*#MassAndMotion*  
*#AirResistance*  
*#GalileosPrinciple*  
*#Year9Science*  
*#FallingObjects*  
*#AccelerationDueToGravity*  
*#ScienceGraphing*

**🔬 Experiment Title: Rolling Down the Ramp – How Height Affects Distance**

**🧪 Aim:**

To investigate how changing the **height of a ramp** affects the **horizontal distance** a marble travels after rolling off a table.

**🎒 You Will Need:**

* 1 marble or small ball
* Ramp (ruler, foam channel, or cardboard)
* Stack of books (to change ramp height)
* Table or desk
* Measuring tape or ruler
* Marker or tape (to mark where the marble lands)
* Stopwatch (optional for further investigation)
* Safety glasses

**🧪 Method:**

1. Place one end of the **ramp on a book**, with the other end at the edge of a table.
2. Place a marble at the **top of the ramp** and release (do not push).
3. Observe and **measure the horizontal distance** from the edge of the table to where the marble first lands.
4. Record this distance.
5. Repeat 3 times for accuracy.
6. **Increase the ramp height** by adding more books and repeat the experiment.
7. Try at least **three different ramp heights** and compare the results.

**📊 Results Table:**

| **Ramp Height (cm)** | **Trial 1 (cm)** | **Trial 2 (cm)** | **Trial 3 (cm)** | **Average Distance (cm)** |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**📉 Graph Instructions:**

* **X-axis**: Ramp Height (cm)
* **Y-axis**: Average Horizontal Distance (cm)
* Plot your results and draw a **smooth curve**
* Title: *“Effect of Ramp Height on Distance Travelled”*

**👀 Making Observations (Sentence Starters):**

* The marble moved furthest when...
* As I increased the ramp height, the marble...
* The marble travelled in a...
* I noticed the speed after the ramp was...

**🧠 Conclusion Scaffold:**

* Increasing the ramp height caused...
* This is because the marble gained more...
* The further the marble fell, the...
* This experiment shows the relationship between...

**🧠 Explanation:**

This experiment demonstrates the conversion of **gravitational potential energy (GPE)** into **kinetic energy (KE)**.

* The **higher the ramp**, the **more GPE** the marble has at the top:

GPE=m×g×h

* As the marble rolls down, that energy is converted to **kinetic energy**:

KE=1/2mv2

* A steeper ramp means the marble travels **faster** when it leaves the ramp.
* Once in the air, the marble moves at **constant horizontal speed** (no friction or pushing forces), so it travels **further** before hitting the ground.

✅ **Key Idea**: More height → more speed → greater horizontal distance.

**❓ Differentiated Questions:**

**🔹 Level 1 – Recall & Observation**

* What happened to the distance when the ramp was made higher?
* What did the marble do once it left the ramp?

**🔸 Level 2 – Understanding & Explanation**

* Why did increasing the ramp height make the marble go further?
* What energy changes took place in the marble?

**🔺 Level 3 – Analysis & Application**

* How does this relate to roller coasters or launching objects off ramps?
* What would happen if you changed the mass of the marble?
* How would air resistance affect the results?

**🏷️ Tags:**

*#Physics*  
*#KineticEnergy*  
*#PotentialEnergy*  
*#MotionAndForces*  
*#ProjectileMotion*  
*#Gravity*  
*#EnergyConversion*  
*#Year9Science*  
*#StudentInvestigation*  
*#ConstantSpeed*

**🔬 Experiment Title: Rolling Race – Do Heavier Balls Roll Faster?**

**🧪 Aim:**

To investigate whether the **mass of an object** affects how fast it rolls down a ramp under gravity.

**🎒 You Will Need:**

* A **ramp** (e.g. ruler, foam channel, cardboard)
* Books or blocks to raise the ramp
* **Two or more balls of the same size** but different masses (e.g. rubber ball vs metal ball)
* Stopwatch or video recording (optional for precision)
* Measuring tape or marked ramp length
* Safety glasses
* Helper (recommended)

**🧪 Method:**

1. Set up the ramp at a fixed height (e.g. 20 cm from the table).
2. Mark a **release point** and a **finish line** (e.g. 50 cm from start).
3. Place the **lighter ball** at the release point and **let it go without pushing**.
4. Time how long it takes to reach the finish line. Record the result.
5. Repeat the trial **3 times** and calculate an average.
6. Repeat steps 3–5 using the **heavier ball**.
7. Make sure the ramp height and angle stay constant throughout.

**📊 Results Table:**

| **Ball Type** | **Mass (g)** | **Trial 1 (s)** | **Trial 2 (s)** | **Trial 3 (s)** | **Average Time (s)** |
| --- | --- | --- | --- | --- | --- |
| Light Ball |  |  |  |  |  |
| Heavy Ball |  |  |  |  |  |

**📉 Graph Instructions:**

* **X-axis**: Ball Type (Label by mass or “Light”/“Heavy”)
* **Y-axis**: Average Time to Reach Bottom (seconds)
* Use a **bar graph** to compare the two results.
* Title: *“Does Mass Affect Rolling Speed?”*

**👀 Making Observations (Sentence Starters):**

* The lighter ball rolled...
* The heavier ball took...
* Both balls travelled...
* I noticed that gravity pulled...

**🧠 Conclusion Scaffold:**

* The time taken was about the same/different for each ball...
* This suggests that mass...
* The ramp height affected the speed because...
* Gravity pulls on all objects...

**🧠 Explanation:**

This experiment tests a key principle of **physics and gravity**.

* According to **Galileo’s discoveries**, **all objects accelerate at the same rate** due to gravity, no matter their mass (if air resistance is ignored).
* So, on the same ramp, balls of different masses should **reach the bottom in the same time**.
* This is because **acceleration due to gravity is constant** (9.8 m/s²), and **mass cancels out** in the motion equations.
* If one ball rolls slower, it might be due to **differences in friction**, **uneven surfaces**, or **air drag**, not mass.

**❓ Differentiated Questions:**

**🔹 Level 1 – Recall & Observation**

* What did you see when both balls rolled down the ramp?
* Which one reached the bottom first?

**🔸 Level 2 – Understanding & Explanation**

* Why does gravity pull objects down at the same rate?
* What does your graph show about how mass affects speed?

**🔺 Level 3 – Analysis & Application**

* Why is this experiment evidence for Newton’s First Law?
* How could you improve the experiment to reduce errors?
* What does this tell us about dropping a hammer and feather on the Moon?

**🏷️ Tags:**

*#Physics*  
*#Gravity*  
*#Acceleration*  
*#MotionDownRamp*  
*#MassAndMotion*  
*#GalileosPrinciple*  
*#NewtonFirstLaw*  
*#StudentInvestigation*

**🔬 Experiment Title: Marble Momentum – Investigating Stopping Distance, Time & Force**

**🧪 Aim:**

To investigate how different surfaces affect the **stopping distance** and **stopping time** of a moving marble, and use data to calculate the **deceleration** and **force** acting on the marble.

**🎒 You Will Need:**

* Ramp (ruler, foam track, or cardboard)
* Marbles (all same size/mass)
* Surfaces: smooth table, sandpaper, carpet, cloth
* Stopwatch or high-speed camera (phone works)
* Measuring tape or ruler
* Scale (to find mass of marble in grams)
* Calculator
* Safety glasses

**🧪 Method:**

1. Set up a **ramp at a fixed height** to ensure all marbles start with the same speed.
2. Place one test surface (e.g. sandpaper) at the end of the ramp.
3. Release the marble from the same height each time.
4. Use a stopwatch or video to measure **stopping time** from when the marble hits the surface to when it stops.
5. Measure the **distance travelled** along the surface before stopping.
6. Repeat 3 times and average the results.
7. Repeat for different surfaces.

**📊 Results Table:**

| **Surface** | **Distance Travelled (cm)** | **Stopping Time (s)** | **Average Speed on Surface (m/s)** | **Deceleration (m/s²)** | **Force (N)** |
| --- | --- | --- | --- | --- | --- |
| Smooth Table |  |  |  |  |  |
| Sandpaper |  |  |  |  |  |
| Carpet |  |  |  |  |  |

**🔢 Calculation Scaffolds:**

**➤ Step 1: Convert units**

* Distance = cm ÷ 100 → m
* Mass = g ÷ 1000 → kg

**➤ Step 2: Find average speed**

Use the formula:

Average speed=distance/time(v=dt)\

**➤ Step 3: Calculate deceleration**

Assume final velocity = 0 (the marble stops), and use:

a=v−ut

(a = acceleration, u = initial speed, v = 0)

So:

a=0−ut=−ut

**➤ Step 4: Find force**

Use Newton’s 2nd Law:

F=m×a

and acceleration is in m/s².

**📉 Graph Instructions:**

**Graph 1:**

* X-axis: Surface Type
* Y-axis: Stopping Distance (cm)

**Graph 2 (Extension):**

* X-axis: Surface Type
* Y-axis: Force (N)

**👀 Making Observations (Sentence Starters):**

* The marble travelled furthest on...
* It stopped quickly on...
* The surface caused it to...
* I noticed the deceleration was greatest on...

**🧠 Conclusion Scaffold:**

* The surface that caused the most friction was...
* The marble slowed down faster when...
* This experiment shows that stopping distance and time are affected by...
* We calculated deceleration and force using...

**🧠 Explanation:**

When a marble rolls onto a surface, it **slows down due to friction**, which creates a **decelerating force** that brings it to rest.

* The **smoother the surface**, the **longer it takes to stop**, because friction is lower.
* On **rougher surfaces**, the marble stops **more quickly**, indicating **greater deceleration**.
* Using physics equations, we calculated:
  + **Average speed**
  + **Deceleration** (rate of slowing down)
  + **Force** (using F=ma)

This shows how **friction converts kinetic energy into heat**, and how force relates to **how fast something stops**.

**❓ Differentiated Questions:**

**🔹 Level 1 – Recall & Observation**

* Which surface had the longest stopping distance?
* Which surface stopped the marble fastest?

**🔸 Level 2 – Understanding & Explanation**

* What caused the marble to stop?
* Why was the deceleration different on each surface?

**🔺 Level 3 – Analysis & Application**

* How would increasing the marble’s mass affect the stopping force?
* How does this experiment help us understand car safety and braking systems?
* What would happen if the surface was tilted slightly?

**🏷️ Tags:**

*#Physics*  
*#Forces*  
*#Deceleration*  
*#Friction*  
*#KineticEnergy*  
*#NewtonSecondLaw*  
*#MassAndMotion*  
*#Year9Science*  
*#StudentExperiment*  
*#MotionAndStopping*

**🔬 Experiment Title: Bounce Back – Investigating Energy Efficiency in a Bouncing Ball**

**🧪 Aim:**

To investigate how the **bounce height** of a ball compares to its **original drop height**, and calculate the **efficiency** of energy transfer.

**🎒 You Will Need:**

* Bouncy ball (e.g. rubber, ping pong, tennis ball)
* Ruler or metre stick
* Smooth hard floor (tile, wood, or concrete)
* Camera/phone (optional for accuracy)
* Marker or tape (to mark drop and bounce heights)
* Calculator
* Safety glasses

**🧪 Method:**

1. Hold the ball at a **measured height** (e.g. 50 cm).
2. Drop the ball (don’t push it) and observe the **maximum bounce height**.
3. Use your eyes or a phone slow-mo to estimate the bounce height.
4. Record your results.
5. Repeat each height **3 times** and calculate an average bounce.
6. Repeat for at least **3 different drop heights** (e.g. 30 cm, 50 cm, 80 cm, 100 cm).
7. Use the data to calculate **efficiency**.

**📊 Results Table:**

| **Drop Height (cm)** | **Bounce Height Trial 1 (cm)** | **Trial 2** | **Trial 3** | **Average Bounce Height (cm)** | **Efficiency (%)** |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

**🔢 Calculation Scaffold:**

**➤ Step 1: Calculate Average Bounce Height**

Average=(Trial 1 + Trial 2 + Trial 3)/3

**➤ Step 2: Calculate Efficiency**

Efficiency (%)=(Bounce Height/mDrop Height)×100

Efficiency shows how much of the ball’s **gravitational potential energy** (GPE) was converted back into **kinetic energy** (and then bounce height), rather than lost to heat, sound, or internal friction.

**📉 Graph Instructions:**

* **X-axis**: Drop Height (cm)
* **Y-axis**: Average Bounce Height (cm)
* Draw a **line graph** to show the relationship.
* Add a second line (optional) for efficiency (%) if plotted on a second Y-axis.

**👀 Making Observations (Sentence Starters):**

* The ball bounced highest when dropped from...
* The bounce height was always less than...
* The amount of energy lost appeared to...
* Some energy was lost as...

**🧠 Conclusion Scaffold:**

* As the drop height increased, the bounce height...
* The ball never bounced back to...
* This shows that some energy was lost as...
* The efficiency of energy transfer was approximately...

**🧠 Explanation:**

When a ball is dropped, it has **gravitational potential energy** (GPE), which is converted into **kinetic energy (KE)** as it falls.  
When the ball hits the ground, some energy is:

* Transferred back into upward motion (bounce)
* Lost as **heat**, **sound**, and **internal deformation**

This is why the **bounce height is always less than the drop height**, and why the **efficiency is never 100%**.

✅ **Key Concept:**

Efficiency = useful energy out / total energy in

The experiment shows **real-world energy loss**, despite conservation of energy in a closed system.

**❓ Differentiated Questions:**

**🔹 Level 1 – Recall & Observation**

* Which height gave the highest bounce?
* Did the ball ever bounce back to the original height?

**🔸 Level 2 – Understanding & Explanation**

* Why was the bounce always lower than the drop?
* What types of energy were lost when the ball hit the floor?

**🔺 Level 3 – Analysis & Application**

* What factors affect how efficient a bounce is (e.g. surface, ball type)?
* How could you improve the experiment’s accuracy?
* How is this experiment useful in sport design or material science?

**🏷️ Tags:**

*#Physics*  
*#EnergyTransfer*  
*#PotentialAndKinetic*  
*#Efficiency*  
*#BounceExperiment*  
*#JuniorPhysics*  
*#GravitationalEnergy*

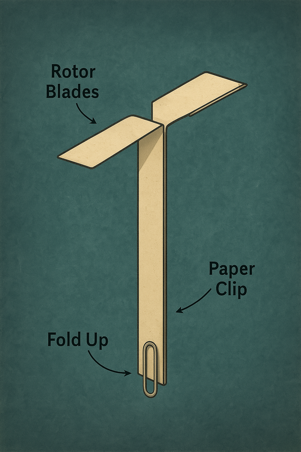
**🔬 Experiment Title: Paper Helicopter Drop – Investigating Air Resistance**

**🧪 Aim:**

To investigate how the **design of a paper helicopter** affects the time it takes to fall, and how **air resistance** influences motion.

**🎒 You Will Need (per person or group):**

* A4 or A5 paper
* Scissors
* Ruler
* Stopwatch
* Paper clips (for added weight)
* Tape measure (optional for consistent height)
* Safety glasses
* Blank wall or door to drop near for observation

**✂️ How to Make a Paper Helicopter:**

1. Cut a strip of paper approximately **15 cm long and 4 cm wide**.
2. Divide the top third of the strip into **two halves** and cut down the centre to make the **rotor blades**.
3. Fold the top flaps in **opposite directions** to form the spinning blades.
4. Fold the **bottom part up** once or twice to create a “stem” and give stability.
5. Add a **paper clip** at the bottom to help it fall straight.
6. Decorate or label your helicopter with a name or version number.

✅ Optional Variations to Test:

* Blade length
* Blade width
* Body length
* Number of paper clips (mass)

**🧪 Method (e.g. testing blade length):**

1. Stand on a chair or next to a ledge (or drop from a fixed height).
2. Drop the helicopter from **the same height** each time.
3. Use a **stopwatch** to measure the time it takes to fall to the floor.
4. Repeat **3 times** per design and calculate an average.
5. Create **3–4 versions** with different **blade lengths** (e.g. 3 cm, 5 cm, 7 cm).
6. Keep other variables (body length, weight) **constant**.

**📊 Results Table (example: Blade Length test):**

| **Blade Length (cm)** | **Trial 1 (s)** | **Trial 2 (s)** | **Trial 3 (s)** | **Average Time (s)** |
| --- | --- | --- | --- | --- |
| 3 |  |  |  |  |
| 5 |  |  |  |  |
| 7 |  |  |  |  |

**📉 Graph Instructions:**

* **X-axis**: Blade Length (cm)
* **Y-axis**: Average Fall Time (s)
* Use a **line graph** or **bar graph**
* Title: *“Effect of Blade Length on Fall Time”*

**👀 Making Observations (Sentence Starters):**

* The helicopter spun faster when...
* The longer blades made the helicopter...
* The shortest design...
* The paper clip helped...

**🧠 Conclusion Scaffold:**

* The helicopter fell slower when...
* This is because the longer blades...
* The air resistance increased due to...
* The experiment shows that falling objects...

**🧠 Explanation:**

As the paper helicopter falls, it spins. This spinning increases **air resistance** (drag), which slows down its fall.

* **Larger blade area** = more air caught = **more resistance**
* A **heavier helicopter** might fall faster, but may spin less or drop more directly
* **Air resistance acts against gravity**, reducing the speed at which the object falls  
  This demonstrates how **shape and surface area** affect how fast things fall — a key concept in **fluid dynamics and motion**.

✅ Key Physics Ideas:

* **Gravity pulls the helicopter downward**
* **Air resistance slows it down**
* The helicopter reaches a **steady speed** called **terminal velocity** when forces balance

**❓ Differentiated Questions:**

**🔹 Level 1 – Recall & Observation**

* Which helicopter design took the longest to fall?
* What happened when you changed the blade length?

**🔸 Level 2 – Understanding & Explanation**

* Why did the helicopter fall slower with longer blades?
* What forces acted on the helicopter as it fell?

**🔺 Level 3 – Analysis & Application**

* How is this experiment similar to how parachutes or seed pods work?
* What would happen if you did the experiment in a vacuum (no air)?
* How could you improve the accuracy of your timing?

**🏷️ Tags:**

*#Physics*  
*#AirResistance*  
*#Gravity*  
*#FallingObjects*  
*#PaperHelicopter*  
*#TerminalVelocity*  
*#StudentInvestigation*  
*#JuniorScience*  
*#Year7Physics*  
*#DesignAndTest*

**🔬 Experiment Title: Finding Gravity – Dropping a Tennis Ball**

**🧪 Aim:**

To measure the **acceleration due to gravity (g)** by timing how long it takes a tennis ball to fall from a known height.

**🎒 You Will Need:**

* **Tennis ball**
* **Measuring tape or metre ruler**
* Stopwatch (or phone with slow-mo/video timer)
* Calculator
* Safety glasses
* Smooth floor space
* Assistant/helper (recommended)

**🧪 Method:**

1. Use a ruler or tape measure to mark a **drop height** (e.g. 1.0 m, 1.5 m, 2.0 m).
2. One person holds the ball **at the marked height**, while another gets ready to time.
3. Drop the ball (do not push it) and **start the timer as the ball is released**.
4. Stop the timer **as soon as the ball hits the floor**.
5. Repeat each height **3 times** and calculate an average fall time.
6. Repeat the experiment for at least **3 different heights**.

**📊 Results Table:**

| **Drop Height (m)** | **Trial 1 (s)** | **Trial 2 (s)** | **Trial 3 (s)** | **Average Time (s)** | **Calculated g (m/s²)** |
| --- | --- | --- | --- | --- | --- |
| 1.0 |  |  |  |  |  |
| 1.5 |  |  |  |  |  |
| 2.0 |  |  |  |  |  |

**🔢 Calculation Scaffold:**

Use the formula for distance fallen under constant acceleration:

s=1/2gt2

Rearranged to solve for **g**:

g=2st2

Where:

* s = drop height (in metres)
* t= average fall time (in seconds)
* g = acceleration due to gravity (m/s²)

**📉 Graph Instructions:**

* **X-axis**: Drop Height (m)
* **Y-axis**: Average Time (s)
* Optionally, plot **g** values as a bar graph to compare consistency

**👀 Making Observations (Sentence Starters):**

* The ball took longer to fall from...
* Timing was hardest when...
* My results for g were close to...
* The fall was faster than I expected because...

**🧠 Conclusion Scaffold:**

* The value I calculated for g was...
* The results were close/not close to 9.8 m/s² because...
* Errors could have come from...
* This experiment shows how falling objects...

**🧠 Explanation:**

All objects on Earth **accelerate downward at approximately 9.8 m/s²** due to gravity. By measuring the time a tennis ball takes to fall a known distance, we can estimate this acceleration using physics formulas.

✅ Key Physics Concept:

Gravity accelerates all objects equally, regardless of mass (ignoring air resistance).

⛔ Small timing errors or ball bounces can affect results, so repeating trials helps improve accuracy.

**❓ Differentiated Questions:**

**🔹 Level 1 – Recall & Observation**

* What happened when the ball was dropped from higher up?
* What did you measure in this experiment?

**🔸 Level 2 – Understanding & Explanation**

* Why do we use the formula g=2st2g = \frac{2s}{t^2}?
* Why should the calculated g value be close to 9.8 m/s²?

**🔺 Level 3 – Analysis & Application**

* What would happen if you did this on the Moon?
* What are some sources of error in your measurements?
* How could you make the experiment more accurate?

**🏷️ Tags:**

*#Physics*  
*#Gravity*  
*#FreeFall*  
*#Acceleration*  
*#NewtonLaws*  
*#ExperimentalScience*  
*#MotionAndForces*  
*#JuniorPhysics*  
*#Year9Science*  
*#ScientificCalculations*

**🔬 Experiment Title: Finding Gravity – Using a Newton Balance and a Spring**

**🔧 Part 1: Measuring g Using a Newton Balance**

**🧪 Aim:**

To calculate the **acceleration due to gravity (g)** using measured **weight (force)** and known **mass** values with a Newton spring balance.

**🎒 You Will Need:**

* Newton spring balance (0–5 N)
* Masses (100 g, 200 g, 500 g, 1 kg)
* Clamp stand
* Ruler (optional)
* Calculator

**🧪 Method:**

1. Attach the Newton balance securely to the clamp stand.
2. Hang a known mass (e.g. 100 g) from the balance.
3. Record the reading in **newtons (N)**.
4. Repeat for at least 4 different masses.
5. Convert all mass values to **kilograms (kg)**.
6. Use the formula:

g=Fm

to calculate gravitational acceleration for each trial.

**📊 Results Table:**

| **Mass (g)** | **Mass (kg)** | **Force (N)** | **Calculated g (m/s²)** |
| --- | --- | --- | --- |
| 100 | 0.1 |  |  |
| 200 | 0.2 |  |  |
| 500 | 0.5 |  |  |
| 1000 | 1.0 |  |  |

**📉 Graph Instructions:**

* **X-axis**: Mass (kg)
* **Y-axis**: Force (N)
* Draw a **line of best fit**
* The **gradient of the line = g**

**👀 Making Observations (Sentence Starters):**

* As the mass increased, the force...
* The force and mass were...
* The graph showed a straight line, meaning...

**🧠 Conclusion Scaffold:**

* I found that as the mass increased, the force...
* The gradient of the graph gave a g value of...
* This supports the idea that...
* The value was close to 9.8 m/s² because...

**🔄 Part 2: Measuring g Using Spring Extension (Hooke’s Law)**

**🧪 Aim:**

To calculate gravitational acceleration by measuring **spring extension** caused by different masses and applying **Hooke’s Law**.

**🎒 You Will Need:**

* Metal spring
* Clamp stand
* Ruler
* Masses (100 g, 200 g, 500 g, 1 kg)
* Calculator

**🧪 Method:**

1. Hang a spring from the clamp stand.
2. Measure and record its **original length** with no mass.
3. Hang a known mass and record the **new length**.
4. Calculate the **extension** = new length – original length (in metres).
5. Use:

F=m×g(use g = 9.8 initially)

1. Apply Hooke’s Law:

F=k×x

where x is extension and k is spring constant.

1. Rearranged to calculate:

g=k×xm

**📊 Results Table:**

| **Mass (g)** | **Mass (kg)** | **Original Length (cm)** | **New Length (cm)** | **Extension (m)** | **Force (N)** | **Calculated g (m/s²)** |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

**📉 Graph Instructions:**

* **X-axis**: Extension (m)
* **Y-axis**: Force (N)
* The gradient of the line = spring constant **k**

**👀 Making Observations (Sentence Starters):**

* The spring stretched more when...
* As the mass increased, the extension...
* The force-extension graph was...

**🧠 Conclusion Scaffold:**

* The spring showed a clear relationship between...
* Hooke’s Law was followed because...
* Using the data, I calculated a g value of...
* This shows that gravity causes...

**🧠 Explanation:**

In both parts of this experiment, we used **Newton’s Second Law**:

F=m×g

* In the **Newton balance**, weight is measured directly and divided by mass to calculate **g**.
* In the **spring method**, we use **Hooke’s Law** to link force and extension, and then rearrange to calculate g indirectly.

**❓ Differentiated Questions:**

**🔹 Level 1 – Recall & Observation**

* What equipment did you use to measure force?
* What happened to the spring when mass was added?

**🔸 Level 2 – Understanding & Explanation**

* What does the graph of mass vs force show?
* Why does a heavier object cause a bigger extension?

**🔺 Level 3 – Analysis & Application**

* How could you use your graph to check if your experiment was accurate?
* What would be different if you did this experiment on the Moon?
* How do these experiments demonstrate Newton’s Second Law?

**🏷️ Tags:**

*#Physics*  
*#Gravity*  
*#AccelerationDueToGravity*  
*#NewtonSecondLaw*  
*#HookesLaw*  
*#ForceAndMass*  
*#SpringExtension*  
*#ExperimentalPhysics*  
*#Year9Science*  
*#StudentPractical*

**🔬 Experiment Title: Magnetic Forces – Measuring Force Using a Balance**

**🔬 Experiment 1: Opposing Poles – Measuring Attraction as Negative Mass**

**🧪 Aim:**

To measure the **attractive magnetic force** between two **opposite poles** of magnets by recording the change in **measured mass** on a digital balance as the distance between them decreases.

**🎒 You Will Need:**

* 2 strong neodymium or bar magnets
* Digital balance (sensitive to 0.01 g or better)
* Clamp stand with boss head
* Ruler or calliper
* Foam pad or non-metallic base
* Safety glasses

**🧪 Method:**

1. Place the **bottom magnet** on the digital balance and **tare** it.
2. Fix the **top magnet** in the clamp stand, directly above it, with **opposite poles facing** (N–S).
3. Reduce the **distance between magnets** step-by-step (e.g. 5 cm → 1 cm).
4. At each distance, record the **mass reading** on the balance.
5. Repeat each reading **3 times** for accuracy.
6. Convert mass change to force:

F=Δm×g

**A diagram of a magnet being measured on a scale

AI-generated content may be incorrect.**

**📊 Results Table:**

| **Distance Between Magnets (cm)** | **Trial 1 (g)** | **Trial 2 (g)** | **Trial 3 (g)** | **Average Mass Change (g)** | **Force (N)** |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |

**📉 Graph Instructions:**

* **X-axis**: Distance Between Magnets (cm)
* **Y-axis**: Mass Change (g) or Force (N)
* Title: *“Magnetic Attraction vs Distance”*

**👀 Making Observations (Sentence Starters):**

* The magnets pulled toward each other as...
* The mass reading became more...
* As the distance decreased, the scale...

**🧠 Conclusion Scaffold:**

* The closer the magnets, the more...
* The balance reading became negative because...
* This experiment shows that attraction...

**🧠 Explanation:**

When **opposite poles attract**, the top magnet **pulls up** on the bottom one.  
This creates an **upward magnetic force**, which **reduces the force pressing down on the balance**, causing the **reading to go negative**.

According to **Newton’s Third Law**:

Every action has an equal and opposite reaction.  
The top magnet pulls up; the bottom magnet feels less weight, which the balance registers as **a drop in measured mass**.

**🔬 Experiment 2: Like Poles – Measuring Repulsion as Positive Mass**

**🧪 Aim:**

To measure the **repelling magnetic force** between two **like poles** of magnets by recording the increase in measured mass as the magnets are brought closer.

**🎒 You Will Need:**

* Same setup as Experiment 1
* Ensure magnets are aligned with **like poles facing** (e.g. N–N or S–S)

**🧪 Method:**

1. Tare the balance with the bottom magnet in place.
2. Suspend the **top magnet above**, with **like poles facing**.
3. Gradually decrease the distance between the magnets.
4. Record the mass reading at each distance.
5. Repeat each distance **3 times** for reliability.
6. Calculate force as:

F=Δm×g

**📊 Results Table:**

| **Distance Between Magnets (cm)** | **Trial 1 (g)** | **Trial 2 (g)** | **Trial 3 (g)** | **Average Mass Increase (g)** | **Force (N)** |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |

**📉 Graph Instructions:**

* **X-axis**: Distance Between Magnets (cm)
* **Y-axis**: Mass Increase (g) or Force (N)
* Title: *“Magnetic Repulsion vs Distance”*

**👀 Making Observations (Sentence Starters):**

* The magnets pushed each other away as...
* The mass reading increased because...
* As the magnets got closer, the repulsion...

**🧠 Conclusion Scaffold:**

* Repulsion increased as the magnets...
* The balance reading went up because...
* This experiment demonstrates magnetic...

**🧠 Explanation:**

When **like poles face**, the magnets **repel**.  
The **top magnet pushes down** on the bottom magnet, adding to its weight, which the balance reads as a **positive increase in mass**.

According to **Newton’s Third Law**:

The top magnet exerts a downward force on the bottom magnet, which pushes back upward with equal strength.

This **added downward force** is recorded by the balance as **increased mass**.

**❓ Differentiated Questions**

**🔹 Level 1 – Recall & Observation**

* What happened to the mass reading in each experiment?
* What kind of poles caused attraction vs repulsion?

**🔸 Level 2 – Understanding & Explanation**

* Why did the mass reading go negative for opposing poles?
* Why did it go positive for like poles?
* What law explains this interaction?

**🔺 Level 3 – Analysis & Application**

* What pattern did you see in the force-distance graph?
* How would stronger magnets change the results?
* How does this experiment relate to magnetic levitation or engineering?

**🏷️ Tags:**

*#Physics*  
*#MagneticForce*  
*#AttractionAndRepulsion*  
*#NewtonThirdLaw*  
*#MassChangeAndForce*  
*#StudentExperiment*  
*#DigitalBalance*  
*#Year10Science*  
*#MagneticFieldInteractions*