**Learning Objectives -**

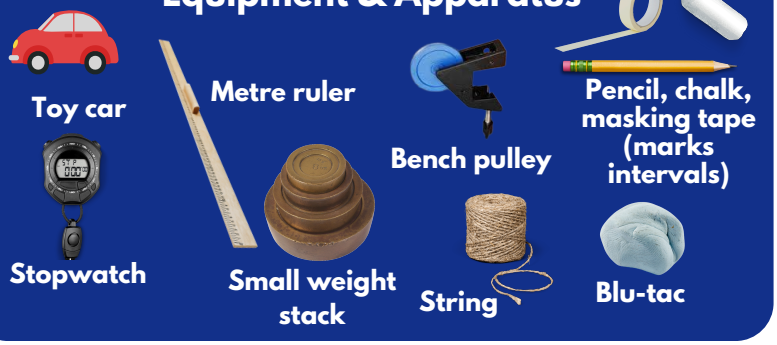
- To determine how the force applied to a trolley affects its acceleration, while keeping the total mass of the system constant.

This links directly to Newton's Second Law of Motion:

**F = ma**

This law tells us that the acceleration of an object is directly proportional to the force applied to it, provided the mass remains unchanged.

## Equipment & Apparatus




# Activity 1:

**1.Marking the bench: Use the ruler to measure 0.2m intervals on the bench and draw straight lines or place tape across the bench at these intervals.**

Make sure it is stable and will not shift during the experiment

**2. Setting Up the Pulley System: Attach the bench pulley to the end of the bench.**

**3. Tie a length of string to the toy car or trolley. Pass the string over the pulley and attach the weight stack to the other end of the string.**

**4. Aligning the System: Make sure the string is taut and runs horizontally and is in line with the toy car or trolley.**

Misalignment can cause extra friction or skew the direction of the force, affecting results.

**5. Preparing for Release: Hold the toy car or trolley at the start point (0cm) and make sure stationary.**

**6. Attach the full weight stack (1.0 N) to the end of the string.**

Recording a video of the sequence will provide more reliable data

**7. Release the toy car or trolley at the same time as you start the stopwatch, press the stop watch (lap mode) at each measured interval on the bench and for the final time at 100 cm.**

**8. Record the results in the table.**

**9. Repeating with Lower Forces: Repeat steps 5–8 for decreasing weights on the stack for example, 0.8 N, 0.6 N, 0.4 N, 0.2 N. Make sure you place the masses that you remove from the weight stack onto the top of the car each time you decrease the weight.**

To keep the mass of the system constant, each time you remove a mass from the hanger, attach it to the car using Blu-tac

For each force level, repeat the entire timing process at least 3 times to reduce the effect of random errors.

**10. Calculate average velocity and acceleration between intervals using the formulas:**

- **Velocity (v) = Distance ÷ Time**
- **Acceleration (a) = (Final velocity - Initial velocity) ÷ Time interval**

**Independent variable**

- Force (N), changed by adjusting the mass hanging from the pulley

**Dependent variable**

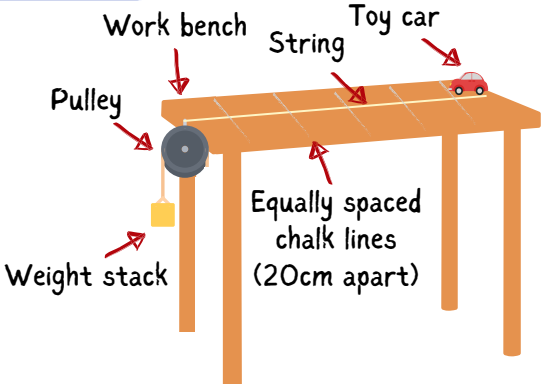
- Acceleration of the trolley

**Control variables:**

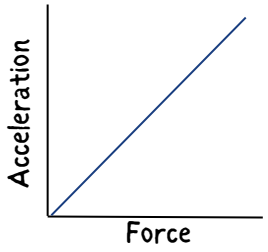
- Mass of the system (trolley + weights)
- Surface of the bench
- Starting position
- String length and alignment
- Method of timing

**Safety Considerations:**

- Secure weights to prevent falls and injuries.
- Stand beside the pulley system, avoiding direct alignment with falling masses.
- Use a soft buffer or sandbag to safely stop the car and prevent damage or injury.




## REQUIRED PRACTICAL 7
# FORCE AND ACCELERATION




**Expected Results**

**You should observe that:**

- **When the force increases, the acceleration of the trolley increases.**
- **A graph of Force (N) on the x-axis and Acceleration (m/s²) on the y-axis should show a straight line through the origin - a linear relationship.**

| Distance (cm) | Time (s) for 1.0 N | Time (s) for 0.8 N | Time (s) for 0.6 N | Time (s) for 0.4 N | Time (s) for 0.2 N |
|---|---|---|---|---|---|
| 20 | | | | | |
| 40 | | | | | |
| 60 | | | | | |
| 80 | | | | | |
| 100 | | | | | |

**This is because: Acceleration ∝ Force (when mass is constant), in line with Newton's Second Law, F = m*a**

# Exam Style Questions - Force and Acceleration

**1. What is the independent variable in this experiment? (1 mark)**

**2. Describe how you would use the setup to determine the acceleration of the trolley. (3 marks)**

**3. A student times the trolley over two 20 cm intervals. The first time is 1.20 s and the second time is 0.80 s. Calculate the change in velocity and the acceleration. (3 marks)**

**4. What relationship should the graph of force against acceleration show? (1 mark)**

**5. Suggest one way to reduce random errors in the timing of the trolley. (1 mark)**

**6. A trolley is pulled with different weights while keeping the total mass constant. What type of graph should be plotted with the results and what does the shape show? (2 marks)**

**7. A student investigates how the force applied to a trolley affects its acceleration.**
**Describe how the student should carry out the experiment and explain how they would use their data to reach a valid conclusion. (6 marks)**

# Exam Style Questions - Force and Acceleration

**1. What is the independent variable in this experiment? (1 mark)**

**Mark One –** The total mass of the system (car + weights)
**Mark Two –** To isolate the effect of force on acceleration

**2. Describe how you would use the setup to determine the acceleration of the trolley. (3 marks)**

**Mark One –** Use a stopwatch to time the trolley as it passes distance markers (e.g. every 20 cm)
**Mark Two –** Calculate velocity at each interval
**Mark Three –** Use acceleration = (final velocity – initial velocity) ÷ time

**3. A student times the trolley over two 20 cm intervals. The first time is 1.20 s and the second time is 0.80 s. Calculate the change in velocity and the acceleration. (3 marks)**

**Mark One –** $v_1 = 0.20 \div 1.20 = 0.167$ m/s; $v_2 = 0.20 \div 0.80 = 0.25$ m/s
**Mark Two –** Change in velocity = 0.25 − 0.167 = 0.083 m/s
**Mark Three –** Acceleration = 0.083 ÷ 0.80 = approx. 0.104 $m/s^2$

**4. What relationship should the graph of force against acceleration show? (1 mark)**

**Mark One –** A directly proportional relationship (straight line through the origin)

**5. Suggest one way to reduce random errors in the timing of the trolley. (1 mark)**

**Mark One -** Use a light gate or motion sensor instead of a manual stopwatch

**6. A trolley is pulled with different weights while keeping the total mass constant. What type of graph should be plotted with the results and what does the shape show? (2 marks)**

**Mark One -** Graph of force vs acceleration
**Mark Two -** The shape is a straight line through the origin (directly proportional)

**7. A student investigates how the force applied to a trolley affects its acceleration.**
**Describe how the student should carry out the experiment and explain how they would use their data to reach a valid conclusion. (6 marks)**

**Level 3 (5–6 marks):**
- Describes full method, including use of pulley, consistent total mass, measuring acceleration, and plotting graph.
- Includes how to control variables and assess relationship.

**Level 2 (3–4 marks):**
- Gives method and mentions a few valid variables/steps.
- Some mention of calculating or using results.

**Level 1 (1–2 marks):**
- Limited or partial method.
- May mention force or acceleration vaguely.