

Work done, power and mechanical energy

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab

Name: _____ Date: _____ Class: _____

How much power can you produce? This lab measures the time taken to climb a flight of stairs at different speeds, then calculates the work done against gravity and the power developed. It shows clearly that work depends on weight and height, while power also depends on time. It works in school or at home.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS3-1

Aim

To measure the work done and the power developed by a student climbing a flight of stairs at different speeds.

Equipment

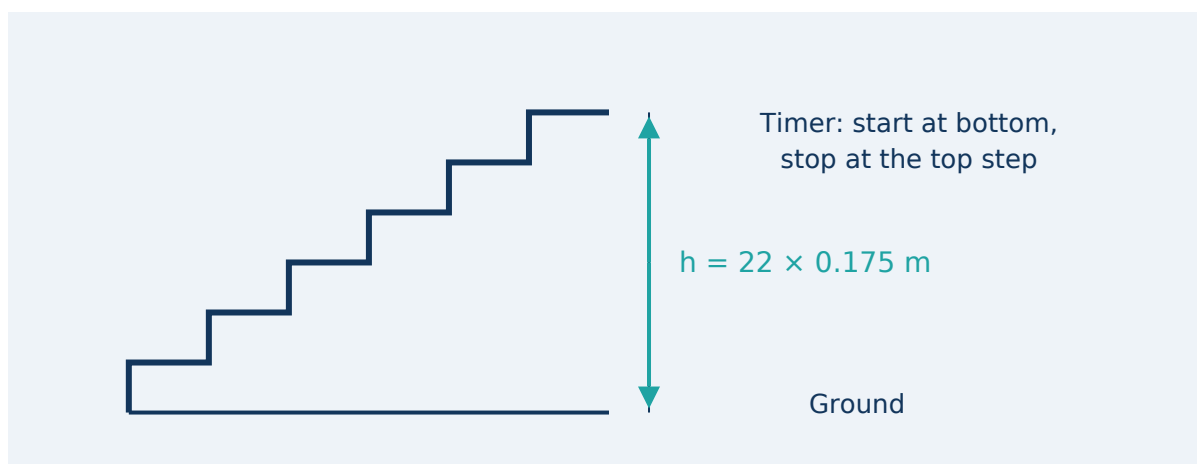
- A flight of stairs with a handrail
- Tape measure
- Stopwatch or phone timer
- Bathroom scales or the student's known mass
- Calculator

Safety

Safety

Use a clear flight of stairs with a handrail and good lighting. Climb only one person at a time. Wear flat shoes with grip. Never run on wet stairs; stop if you feel dizzy or breathless.

Method



A flight of stairs with the total height h marked.

1. Measure the height of one step in metres. Count the steps and calculate the total height h .
2. Find the mass m of the climber in kilograms.
3. Place the timer at the bottom. The climber starts at rest, climbs at a chosen speed, and the timer stops when the climber's foot reaches the top step.
4. Repeat for four speeds: slow walk, normal walk, brisk walk and a fast climb. Rest for one minute between trials.
5. Calculate the work $W = m \times g \times h$ and the power $P = W \div t$ for each trial.

Results

Sample data: mass $m = 48.0$ kg; 22 steps of height 0.175 m, so $h = 3.85$ m; $g = 9.8$ N/kg.

Trial	Time t (s)	Work W (J)	Power P (W)
Slow walk	9.2	1811	197
Normal walk	7.8	1811	232
Brisk walk	5.6	1811	323
Run	3.9	1811	464

Analysis questions

Question 1 Calculate the work

Show that the work done against gravity in the climb is about 1810 J.

Question 2 Calculate a power

Calculate the power for the normal walk and give your answer in watts to three significant figures.

Question 3 Same work, different power

Explain why the work done is the same in every trial but the power is different.

Question 4 Plot and interpret

Calculate $1 \div t$ for each trial and plot power (y-axis) against $1 \div t$ (x-axis). State what the gradient represents and its value.

Question 5 Compare with a lamp

Compare the power in the run with that of a 100 W lamp. State the number of lamps it could run.

Question 6 Uncertainty

The stopwatch uncertainty is ± 0.3 s. Calculate the percentage uncertainty in the time for the run and say how it affects the power.

Question 7 Improve the lab

Suggest two improvements, and state one assumption made about the energy transferred.