Power: the same lift in different times

Student activity • investigation and reasoning

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The question

How can two lifts transfer the same useful energy at different powers?

Raise a small mass through a fixed height in different times. Calculate useful mechanical power, not the body's total metabolic power.

Equipment

- Small secure load carrier, balance, ruler, stopwatch and padded tray
- Booklet and calculator

Stay seated and lift only the small approved load over the tray. Do not climb, race, use heavy weights or compare physical performance. Anyone may choose timing or calculation instead of lifting.

Course coverage: Shared Physics / Double Award: 4.16–4.17. Rate of energy transfer.

Plan, model or apparatus sketch

Draw a labelled setup or force diagram; include the measured quantities.

Method and reasoning

Read the whole sequence before starting

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1. Work seated with a small mass in a secure carrier above a padded tray. Staff set a vertical lifting height of 0.20 m and approve the total moving mass.

2. Measure the carrier-plus-load mass. Lift steadily from the lower mark to the upper mark in about two seconds, then hold it safely. A partner times only the upward movement.

3. Lower the mass gently without timing that motion. Repeat three upward lifts, then repeat at a slower pace of about four seconds. Do not race.

4. Calculate useful energy per lift using mgh with g = 9.8 N kg^{-1}. Use the same mass and height for both pace conditions.

5. For each measured upward time, calculate useful power mgh/t and compare the means. Note the effect of reaction-time uncertainty on such short intervals.

6. Explain why useful mechanical power differs from total energy use, and why the timing result is not a measure of personal fitness.

Cleanup

- Lower loads gently into trays, count carriers and return stopwatches.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Power is energy transferred per unit time, measured in watts (J s^{-1}). Practice example: lifting 0.10 kg through 0.20 m transfers 0.196 J of gravitational energy. If it takes 2.0 s, useful power is 0.098 W. Starting and stopping motion and the person's other energy transfers are omitted from this simple model.

Pace / trial	Time / s	Useful energy / J	Useful power / W
Faster / 1			
Faster / 2			
Faster / 3			
Slower / 1			
Slower / 2			
Slower / 3			

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. What is the unit of power?

2. Find energy for the practice lift.

3. Find useful power for that lift in 4.0 s.

4. Does a slower lift necessarily transfer less gravitational energy?

5. Why keep height and mass fixed?

6. What is a major uncertainty here?