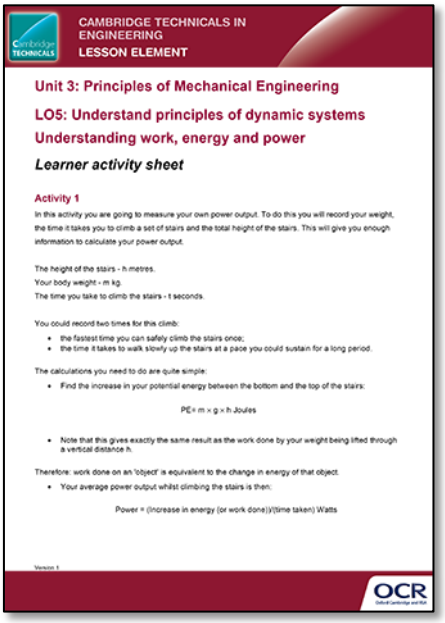
Unit 3: Principles of Mechanical Engineering

LO5: Understand principles of dynamic systems

Understanding work, energy and power

Instructions and answers for teachers

These instructions should accompany the OCR resource 'Understand principles of dynamic systems – Understanding work, energy and power' *activity which supports Cambridge Technicals in Engineering Level 3.*


CAMBRIDGE TECHNICALS IN ENGINEERING
LESSON ELEMENT

Unit 3: Principles of Mechanical Engineering

LO5: Understand principles of dynamic systems

Understanding work, energy and power

Learner activity sheet

Activity 1

In this activity you are going to measure your own power output. To do this you will record your weight, the time it takes you to climb a set of stairs and the total height of the stairs. This will give you enough information to calculate your power output.

The height of the stairs - h metres.
Your body weight - m kg.
The time you take to climb the stairs - t seconds.

You could record two times for this climb:

- the fastest time you can safely climb the stairs once;
- the time it takes to walk slowly up the stairs at a pace you could sustain for a long period.

The calculations you need to do are quite simple:

- Find the increase in your potential energy between the bottom and the top of the stairs:

PE= m × g × h Joules

- Note that this gives exactly the same result as the work done by your weight being lifted through a vertical distance h.

Therefore: work done on an 'object' is equivalent to the change in energy of that object.

- Your average power output whilst climbing the stairs is then:

Power = (increase in energy (or work done))/(time taken) Watts

Version 1

OCR

The Activity:

In this Lesson Element, learners are going to calculate their own power output by climbing stairs.

This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Suggested timings:

Activity 1 15+ minutes (depending on class size)

Activity 2 Flexible

Activity 3 Flexible

Activity 1

Learners will need to measure the height of a convenient set of stairs and, individually, their mass and the time it takes them to climb the stairs. The aims of the lesson are:

- to demonstrate the relationship between energy, work and power;
- to develop a feeling for the magnitude of the power output of many of the machines that we use in everyday life.

Learners will record:

The height of the stairs - h metres.

Their body weight - m kg.

The time they take to climb the stairs - t s. [It might be interesting to record their (sensible) minimum time, and the time it takes them to WALK up the stairs].

The calculations are relatively simple:

- Increase in potential energy by climbing the stairs:

$$PE = m \times g \times h \text{ Joules}$$

- Note that this gives exactly the same result as the work done by their weight being lifted through a vertical distance h

Therefore: work done on an 'object' is equivalent to the change in energy of that object.

- Their average power output whilst climbing the stairs:

$$\text{Power} = (\text{Increase in energy (or work done)})/(\text{time taken}) \text{ Watts}$$

It is important to stress that the calculation of the increase in PE is independent of time, and the value is the same no matter how quickly or slowly they climb the stairs.

Activity 2

The results of Actvity 1 could form the basis for an investigation of many human powered machines and devices. See http://en.wikipedia.org/wiki/Bicycle_performance

or http://en.wikipedia.org/wiki/Human_power

Activity 3

It would be useful for learners to have an understanding of the power of common machines that they use in everyday life. This could be set as a research activity, easily completed with access to the internet.

Learners will find alternative units used to measure power (h.p., bhp., etc). They should understand that work in this qualification will always refer to power in Watts (W).

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