DYNAMO TORCH

A. OVERVIEW

Subject	Green Science
Age	6-10
Duration	60 Minutes
Content	Energy cannot be made or destroyed only converted from one form to another. Motors can be used to convert kinetic energy to electric energy and thus power useful tools. This is the principle behind the dynamo torch.
Goals	Students will: 1. Understand motors such as in dynamos can be used as generators. 2. Define energy transfer. 3. Explain electromagnetic induction. 4. Explain the phrase 'energy conservation'. 5. Explain what happens when energy is transformed into another form and give everyday examples.
Objectives	After completing this section, the student will explain the principle of generating electricity via a dynamo. They will use the first law of thermodynamics to explain the energy transfers involved in a simple dynamo.
Materials	Green Science – Dynamo Torch kit and lesson plan, Clean plastic drink bottle, Small cross-head screwdriver
Introduction	Background reading – First law of thermodynamics/ electromagnetic induction Class discussion – Energy transfer in daily life
Practical	Students will assemble dynamo torches.
Extensions	Open ended discussion/investigation

B. BACKGROUND READING

Set the background reading as a homework assignment the day before the planned dynamo torch lesson. The reading covers the first law of thermodynamics and its application to dynmo generators via electromagnetic induction.

Review

Start the lesson by reviewing the reading.
Points to ensure are understood:

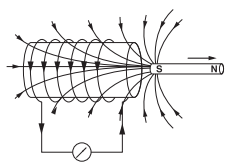
- First law of thermodynamics – Energy conservation
- Electromagnetic induction – Movement of a magnet within a wire coil induces an electrical current to flow

Reading material

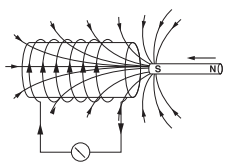
The laws of thermodynamics help to explain the relationships between heat, work and energy.

The first law of thermodynamics – $\Delta U = Q + W$

This means – the change in the internal energy of a closed system is equal to the sum of the amount of heat energy supplied to or removed from the system and the work done on or by the system. This is essentially a principle about the conservation of energy. Energy cannot be made or destroyed only converted from one form to another. Remember no energy transfer is perfectly efficient. For example, energy is 'lost' as heat or light energy due to friction in dynamo motors.



A moving magnet induces current in the coiled wire. Electricity flows from the coiled wire towards the meter causing the arrow to move.



A change in direction of the magnet causes a change in the direction of the current – as indicated by the arrow of the meter.

All electricity generators use the principle of electromagnetic induction. They turn movement into electricity. This is an example of the first law of thermodynamics in action – conservation of energy – kinetic (movement) energy converted into electrical energy.

Dynamos can be used practically to generate power. Commercially available dynamo-powered appliances include emergency torches, radios and bicycle lights.

C. CLASS DISCUSSION

How is electricity generated?

• Energy conversion – e.g. in a wind turbine movement(kinetic) energy via electromagnetic induction to electrical energy, many forms of electricity generation rely on turbine movement and electromagnetic induction.
• Apply first law of thermodynamics – Where are the energy transfers happening – make sure to include friction 'losses' heat/light.
• What electricity generation methods are used near you?
• What energy transfers are involved in these electricity generators?

Generation method	Original energy form	Energy transfers
Coal power station	Fossil fuel – chemical energy	Combustion to release heat (heat energy) Heat turns water into steam (movement and heat energy). Steam pressure drives turbines (movement energy).
Nuclear power	Radioactivity	Nuclear fission is the splitting of one atom into smaller atoms. The energy arises from the equation E=mc2. The original atom ways more than its fission products. The rest of the mass is converted into energy mostly as heat. Heat turns water into steam (movement and heat energy). Steam pressure drives turbines (movement energy).
Geo-thermal power	Heat/movement	Heat turns water into steam (movement and heat energy). Steam pressure drives turbines (movement energy).
Hydro-electric power	Movement	Movement of water drives turbines (movement energy).
Wind power	Movement	Movement of wind drives turbines (movement energy).
Solar power	Light	Light energy is converted to electrical energy via photovoltaic cells.
Wave power	Movement	Movement energy of waves drives turbines.

• Advantages/disadvantages of each?
• Focus on green energy vs greenhouse gas producing

D. PRACTICAL

Each group of students requires 1 kit, 1 instruction sheet, 1 clean plastic drink bottle and 1 small crosshead screwdriver. Select the relevant information from the instructions if necessary.
Go through the safety warnings advised in the instructions with the class before assembly.
Check each group's finished model and supervise the class' test runs.
Encourage the students to read the information sheet completely.

E. EXTENSIONS

• Use word equations to illustrate the energy transfers necessary in the following situations:
- Power generation at a hydroelectric plant
- Boiling water in a kettle
- Petrol powering a car engine causing the car to move (Do not forget to include 'lost' energy e.g. friction induced losses)
• Where would dynamo appliances be most helpful?
• What other dynamo appliances can you think of?
• Dynamo torches are just one example of practical use of the first law of thermodynamics. They exploit the principle of energy conservation in energy transfer to convert kinetic energy to light energy via electromagnetic induction.
• Can you think of a situation around the house where the principles of energy transfer/conservation could be used to improve your household environment?
• HINT
- Where is energy currently being transferred to a 'wasted form' heat/light?
- Where could this be useful?
- How would you harness the energy for transfer/use?
• Could there be a patent and riches in your future?

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