

REIES – Lesson 1: What is Energy?

Section A – Knowledge Questions

Exercise 1

Knowledge

Energy can be found in many different forms. List all nine energy forms discussed in the lesson and give a real-life example for each one.

Exercise 2

Knowledge

State the Law of Conservation of Energy (also known as the First Law of Thermodynamics) in your own words. Then explain, using one example, the difference between energy transfer and energy conversion.

Exercise 3

Knowledge

Below is a list of energy converters. For each one, identify the energy input and the useful energy output, and give the approximate average efficiency.

Energy Converter	Input → Output (Efficiency)
Human Body	
Combustion Engine	
Gas Boiler	
Electric Boiler	
Wind Turbine	
PV Panel	

Exercise 4

Knowledge

What are the four primary energy sources that exist on Earth? For each one, briefly explain its origin. Then explain why wind, biomass, and fossil fuels are all ultimately derived from sunlight.

Section B – Calculation Questions

Exercise 5

Calculation

A person consumes a meal containing 800 kcal (kilocalories).

- Convert 800 kcal into Joules.
- Convert the result into kWh.
- The human body has an average efficiency of 25 % when converting food into movement. How much energy (in kJ) is available as useful mechanical work?

Exercise 6

Calculation

A household electric kettle has a power rating of 2000 W and is used for 5 minutes.

- How much energy (in Joules) does the kettle consume?
- Convert this to kWh.
- If the electric boiler efficiency is 99 %, how much heat energy (in Joules) is delivered to the water?

Exercise 7

Calculation

A car with a combustion engine has a power output of 75 kW (at the wheels) and an engine efficiency of 20 %.

- What is the total chemical energy input (in kJ) required to drive for 30 minutes?
- How much energy (in kJ) is wasted as heat?

Exercise 8

Calculation

A house is heated with a gas boiler. In one winter month, the boiler burns 120 m³ of natural gas.

- Convert 120 m³ of gas into MJ and into kWh. (Use: 1 m³ gas = 35.17 MJ)
- The gas boiler has an efficiency of 92 %. How much useful heat energy (in kWh) is delivered to the house?
- If the same house were heated with an electric boiler (99 % efficient) using the same amount of input energy (in kWh), how much more useful heat would be delivered?

Section C – Internet Exploration Questions

Exercise 9

Internet Exploration

Visit the U.S. Energy Information Administration (EIA) website (www.eia.gov) and find the 'Energy Explained' section.

- Find the page about energy units and calculators. List three energy units that are NOT mentioned in the lesson slides.
- Write 3–5 sentences summarising one thing you found interesting or surprising on the EIA website.

Section D – Home Experiments

Exercise 10

Home Experiment – Measure Your Own Power Output

Power is the rate at which energy is used or converted. In this experiment you will calculate your own mechanical power output by climbing a staircase as quickly as possible. You will need a friend or family member to time you, or you can use the timer on your phone.

Materials needed (no purchase required):

- A staircase of at least 8–10 steps
- A measuring tape or ruler
- A stopwatch or phone timer
- A bathroom scale (to find your body mass in kg)

Procedure:

1. Measure the height of one step (in metres). Count the number of steps you will climb and calculate the total vertical height H (m).
2. Weigh yourself on the bathroom scale and record your mass m (kg).
3. Start the timer and walk up the stairs at a normal pace. Record the time t_1 (s).
4. Rest for 2 minutes. Then run up the stairs as fast as safely possible. Record the time t_2 (s).
5. Calculate the gravitational potential energy gained each time: $E = m \cdot g \cdot H$, where $g = 9.81 \text{ m/s}^2$.
6. Calculate your mechanical power output for each attempt: $P = E / t$ (in Watts).
7. Convert your maximum power output to horsepower (hp). Use: $1 \text{ hp} = 745.7 \text{ W}$.

Record your results here:

Measurement	Your Value
Step height (m)	
Number of steps	
Total height H (m)	
Body mass m (kg)	
Gravitational PE gained E (J)	
Time walking t_1 (s)	
Power walking P_1 (W)	
Time running t_2 (s)	
Power running P_2 (W)	
Maximum power in hp	

Reflection questions:

- How does your power output compare to a 100 W light bulb? And to a car engine (typically 75–150 kW)?
- The human body efficiency is about 25 %. What does that mean for the total chemical energy (from food) your body had to burn to climb the stairs?
- If you could maintain your maximum running power for one hour, how many kWh of energy would you produce? What does that tell you about the energy content of food?