

Following energy through devices and chains

Grade 7 science (Year 8 · Class 7) · Worksheet answers

Each answer shows the formula, the substitution and the final result in bold with its unit. Check that useful plus wasted energy always equals the input, and remember that efficiency has no unit apart from the percentage sign.

Level: Grade 7 science (Year 8 · Class 7) · **Curriculum:** MS-PS3-5

Problem 1 Name the transfer

1. Toaster: electrical in, **thermal (and a little light)** out.
2. Loudspeaker: electrical in, **sound** out.
3. Solar cell: light in, **electrical** out.
4. Candle: chemical in, **light and thermal** out.

Problem 2 The conservation law

Energy cannot be **created** or **destroyed**. It can only be **transferred** from one store to another.

Problem 3 Phone in a pocket

1. **Thermal energy**.
2. It is **wasted**, because the aim is to show video and play sound, not to heat the phone.

Problem 4 Efficiency of a lamp

1. **Efficiency = (useful energy output ÷ total energy input) × 100 %**.
2. $40 \div 100 \times 100 = \mathbf{40\%}$.

Problem 5 Complete the energy chain

1. The first arrow carries **light** energy.
2. The second arrow carries **electrical** energy.
3. The fan produces **kinetic energy** in the moving air.

Problem 6 Kilojoules and joules

1. $18 \times 1000 = \mathbf{18\,000\,J}$.
2. $240\,000 \div 1000 = \mathbf{240\,kJ}$.
3. $3.5 \times 1000 = \mathbf{3500\,J}$.

Problem 7 Wasted energy of a bulb

1. Wasted = $50 - 8 = \mathbf{42\,J}$.
2. It is mostly **thermal energy**.

Problem 8 Reading a Sankey diagram

1. **56 J** of kinetic energy.
2. **24 J** (thermal and sound).
3. Efficiency = $56 \div 80 \times 100 = \mathbf{70\%}$.

Problem 9 Two kettles

1. X wastes $150 - 132 = \mathbf{18\,kJ}$. Y wastes $150 - 120 = \mathbf{30\,kJ}$.
2. X: $132 \div 150 \times 100 = \mathbf{88\%}$. Y: $120 \div 150 \times 100 = \mathbf{80\%}$.
3. **Kettle X** is better because it wastes less energy for the same input.

Problem 10 Complete the table

Fan: wasted $200 - 120 = \mathbf{80\,J}$; efficiency $120 \div 200 \times 100 = \mathbf{60\%}$.

Drill: useful $500 - 150 = \mathbf{350\,J}$; efficiency $350 \div 500 \times 100 = \mathbf{70\%}$.

Heater: wasted $1000 - 950 = \mathbf{50\,J}$; efficiency $950 \div 1000 \times 100 = \mathbf{95\%}$.

Problem 11 A warm charger

1. Electrical energy from the socket is transferred to **chemical energy** stored in the battery.
2. Some of the electrical energy is transferred to thermal energy in the charger, because no device is perfectly efficient.
3. It spreads into the **surrounding air**, where it cannot be used again.

Problem 12 Solar panel on a roof

1. Useful = $20\% \text{ of } 5000 = 0.20 \times 5000 = \mathbf{1000\,J}$.

2. Wasted = $5000 - 1000 = 4000 \text{ J}$.

Problem 13 Bicycle lamp chain

Chemical energy (in her muscles) → **kinetic energy** (pedals and wheel) → **electrical energy** (dynamo) → **light energy** (lamp). Thermal energy is wasted in the muscles, the bearings, the dynamo and the lamp.

Problem 14 Which lamp is better?

1. Lamp P: $6 \div 40 \times 100 = 15 \%$. Lamp Q: $6 \div 12 \times 100 = 50 \%$.

2. **Lamp Q**: it needs only 12 J for the same light, so it takes less electrical energy from the supply.

Problem 15 Find the errors

1. Energy cannot be created, so a device can never give out more energy than it takes in.

Efficiency can never exceed 100 %.

2. Possibly the input was measured wrongly, or the water was already warm, or the output included heat from the surroundings.

Problem 16 Wind turbine in two stages

1. $0.40 \times 50 = 20 \text{ kJ}$.

2. $0.90 \times 20 = 18 \text{ kJ}$.

3. Overall efficiency = $18 \div 50 \times 100 = 36 \%$ (also $0.40 \times 0.90 = 0.36$).

Problem 17 Replacing school lamps

1. $3 \div 60 \times 100 = 5 \%$.

2. Input = $3 \div 0.30 = 10 \text{ J every second}$.

3. Saving per lamp = $60 - 10 = 50 \text{ J every second}$. For 20 lamps: $20 \times 50 = 1000 \text{ J every second}$. In 8 hours: $8 \times 3600 = 28\,800 \text{ s}$, so $1000 \times 28\,800 = 28\,800\,000 \text{ J} = 28.8 \text{ MJ}$.

Problem 18 Diesel water pump

1. $2.4 \div 12 \times 100 = 20 \%$.

2. Input = $2.4 \div 0.30 = 8 \text{ MJ}$.

3. Saved = $12 - 8 = 4 \text{ MJ}$.

Problem 19 Battery toy car

1. Thermal = $900 - 540 - 90 = \mathbf{270 \text{ J}}$.
2. Efficiency = $540 \div 900 \times 100 = \mathbf{60 \%}$.
3. $270 \div 900 \times 100 = \mathbf{30 \%}$.

Problem 20 Is a heater wasteful?

1. $1000 \div 1000 \times 100 = \mathbf{100 \%}$ as a heater, because all the thermal energy is useful.
2. Whether energy is wasted depends on the purpose: thermal energy is the aim for a radiator but an unwanted by-product for a lamp.
3. Once the room warms, the thermal energy leaks to the outside air and spreads out, so it cannot be gathered and used again.