Energy stores and systems

4.1.1.1 · Energy · revision notes

A system is an object or a group of objects, and when a system changes, the way its energy is stored changes too. You need to describe these changes for everyday situations, such as a ball thrown upwards or a kettle boiling water. Expect 1-mark recall questions and 2 to 4 mark 'describe the changes in energy stores' questions on Paper 1, often at the start of a longer calculation question.

Key facts

- System = an object or a group of objects
- Stores: kinetic, gravitational potential, elastic potential, thermal (internal), chemical, magnetic, electrostatic, nuclear
- Transfers: mechanically (force doing work), electrically (current doing work), by heating, by radiation
- Energy is measured in joules (J)
- Ball thrown up: kinetic store → gravitational potential store
- Vehicle braking: kinetic store → thermal store of the brakes → surroundings
- Kettle: electrical work → thermal store of the water (some to the surroundings)
- Grade 5+ only Energy lost from one store = total energy gained by the other stores

Notes

Systems and energy stores

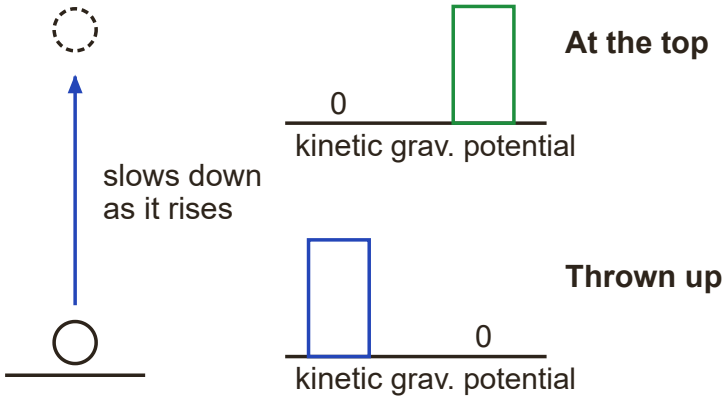
- A **system** is an object or a group of objects. When a system changes, the way its energy is stored changes.
- **Energy stores**: kinetic (moving objects), gravitational potential (raised objects), elastic potential (stretched or squashed objects), thermal or internal (hot objects), chemical (fuels, food, batteries), magnetic, electrostatic and nuclear.
- When a system changes, energy leaves some stores and goes into others. The total amount of energy stays the same.

How energy is transferred

- **Mechanically**: a force does work, e.g. pushing a trolley, or friction.
- **Electrically**: a current does work, e.g. a battery driving a current through a motor.
- **By heating**: energy goes from a hotter object to a cooler one.
- **By radiation**: e.g. light and infrared from the Sun or a lamp. Sound waves also carry energy.
- Light, sound and electricity are ways of transferring energy. They are not energy stores.

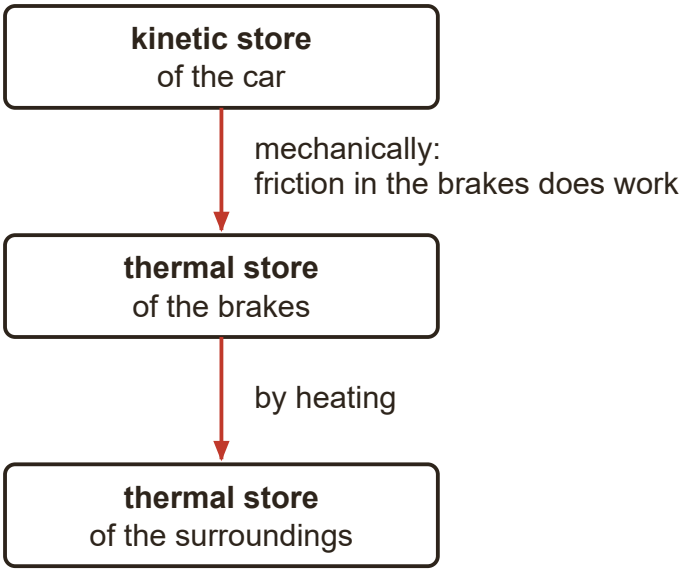
Describing common energy changes

- **Ball thrown upwards**: the kinetic store of the ball decreases and its gravitational potential store increases.



Ball thrown up: the kinetic store empties into the gravitational potential store (ignoring air resistance).

- **Moving object hits an obstacle** (e.g. a car hits a wall): the kinetic store of the car decreases; the thermal stores of the car, the wall and the surroundings increase, and some energy is carried away by sound.
- **Object accelerated by a constant force**: the force does work, so the kinetic store of the object increases. The energy comes from another store, e.g. the chemical store of the person pushing.
- **Vehicle slowing down**: the kinetic store of the vehicle decreases. Friction in the brakes does work, so the thermal store of the brakes increases; this energy then spreads to the surroundings.



A braking car: store, how it is transferred, new store.

- **Electric kettle**: energy is transferred electrically to the heating element, then by heating to the water, so the thermal store of the water increases. Some energy heats the kettle and the air around it.
- **Bungee jump**: while falling, the gravitational potential store decreases and the kinetic store increases; as the cord stretches, the kinetic store falls to zero and the cord's elastic potential store increases.

Showing energy changes with numbers Grade 5+ only

- You can calculate the energy in each store before and after a change, using the equations in 'Changes in energy'. The energy lost from one store equals the total energy gained by the others.
- Example: a falling ball loses 3.0 J from its gravitational potential store. If its kinetic store gains 2.7 J, then 0.3 J has been dissipated by air resistance.

How to answer each type of question

Name the energy store or the energy transfer

1 mark each | Grade 3

1. Use the proper name of the store: kinetic, gravitational potential, elastic potential, thermal, chemical and so on.
2. Say whose store it is if you can (the spring, the water).
3. Remember that light, sound and electricity are ways of transferring energy, not stores.

Example. (a) A student compresses a spring. Name the energy store of the spring that increases.
(b) Name the energy store in the food that a person eats.
(c) A battery is connected to a lamp. State how energy is transferred from the battery to the lamp.

Model answer.

(a) Elastic potential (energy store) (1)
(b) Chemical (energy store) (1)
(c) Electrically / by an electric current doing work (1)

Describe the changes in the way energy is stored

2 to 3 marks | Grade 5

1. Name the object each time, e.g. 'the kinetic store of the car'.
2. Say which store decreases and which store increases.
3. If there is friction, air resistance or heating, add where the wasted energy goes: the thermal store of the surroundings.

Example. A toy car is released from rest at the top of a ramp. It rolls down the ramp.
Describe the changes in the way energy is stored as the car rolls down the ramp.

Model answer. The gravitational potential energy store of the car decreases (1). The kinetic energy store of the car increases (1). Some energy is dissipated to the thermal store of the car and the surroundings because of friction and air resistance (1).

Calculate: show how the energy is redistributed 3 to 4 marks **Grade 7**

1. Calculate the energy in the first store, e.g. $E_p = m\ g\ h$.
2. Calculate the energy in the second store, e.g. $E_k = ½\ m\ v^2$.
3. Subtract: the difference is the energy dissipated (or transferred to another store).
4. Give each answer with its unit, J.

Example. A ball of mass 0.20 kg is dropped from a height of 1.5 m. Just before it hits the ground its speed is 5.2 m/s.
gravitational field strength = 9.8 N/kg
Calculate the energy dissipated by air resistance as the ball falls.

Model answer.

Gravitational potential energy lost = 0.20 × 9.8 × 1.5 = 2.94 J (1)

Kinetic energy gained = 0.5 × 0.20 × 5.2^2 = 2.704 J (1)

Energy dissipated = 2.94 − 2.704 (1)

= 0.24 J (1)

Don’t lose marks

- Using made-up stores such as 'heat energy', 'movement energy' or 'electrical store'. Say thermal and kinetic; electricity is a way of transferring energy.
- Calling light or sound an energy store. They are ways energy is transferred.
- Not saying whose store it is, e.g. writing 'kinetic energy increases' when there are two objects in the question.
- Saying energy is 'used up' or 'lost'. It is transferred or dissipated.
- Missing out a step for a kettle: energy goes electrically to the element, then by heating to the water.

More tips

Memory tricks

- The eight stores: 'Kind Giraffes Eat Tasty Carrots, Munching Every Night': Kinetic, Gravitational potential, Elastic potential, Thermal, Chemical, Magnetic, Electrostatic, Nuclear.
- The four transfers: 'My Energy Has Routes': Mechanically, Electrically, by Heating, by Radiation.
- Every description needs a store that goes down and a store that goes up.
- If anything rubs, moves through air or gets warm, some energy ends up in the thermal store of the surroundings.

Exam technique

- 'Describe the changes in the way energy is stored' wants store names with the words 'decreases' and 'increases'. You don't need equations.
- There is usually one mark for each store named correctly with the right direction of change.
- If the question mentions friction, air resistance or something getting warm, there is usually a mark for saying energy is dissipated to the surroundings.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Define a system**
A system is an object or a group of objects that you choose to study, e.g. a ball and the Earth.

Grade 3 — **Name the main energy stores**
Kinetic, gravitational potential, elastic potential, thermal (internal), chemical, magnetic, electrostatic and nuclear.

Grade 4 — **Name the ways energy is transferred**
Mechanically (a force doing work), electrically (a current doing work), by heating and by radiation such as light.

Grade 5 — **Describe energy changes in common situations**
Say which store decreases and which increases, e.g. a braking car: kinetic store down, thermal store of the brakes up.

Grade 5 — **Include wasted energy in your descriptions**
Say that friction or air resistance dissipates some energy to the thermal store of the surroundings.

Grade 7 — **Use calculations to compare energy stores**
Calculate the energy in each store before and after a change to show how the total energy is shared out.

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