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**Year 10 – Teacher Booklet (TRIPLE & TRILOGY)**

Key Stage 4 Science:

**Energy**

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**Ensure that your booklet is returned to your class book box at the end of the lesson.**

**Lesson Breakdown**

Lesson 1: Energy stores and energy changes within systems (by heating, forces and current) **& power**. Conservation of energy.

Lesson 2: Kinetic energy and associated changes to energy stores **& power**.

Lesson 3: Elastic potential energy and associated changes to energy stores.

Lesson 4: Gravitational potential energy and associated energy changes **& power**.

Lesson 5: Energy changes in systems – specific heat capacity **& power**.

**Lesson 6: Required Practical – specific heat capacity.**

Lesson 7: Efficiency & energy dissipation.

**Lesson 8: PHYSICS ONLY – Required practical – thermal insulators**

Lesson 9: Energy sources.

Lesson 10: Energy sources – patterns / trends and wider issues.

**Keystone words**

**Dissipate**

**Efficiency**

**Transfer**

**Power**

**Store**

**Conductivity**

**Conserved**

**Lesson 1: Teacher notes**

**KS3 Programme of Study:**

**Energy changes and transfers**

* heating and thermal equilibrium: temperature difference between two objects leading to energy transfer from the hotter to the cooler one, through contact (conduction) or radiation; such transfers tending to reduce the temperature difference: use of insulators
* other processes that involve energy transfer: changing motion, dropping an object, completing an electrical circuit, stretching a spring, metabolism of food, burning fuels.

**Changes in systems**

* energy as a quantity that can be quantified and calculated; the total energy has the same value before and after a change
* comparing the starting with the final conditions of a system and describing increases and decreases in the amounts of energy associated with movements, temperatures, changes in positions in a field, in elastic distortions and in chemical compositions
* using physical processes and mechanisms, rather than energy, to explain the intermediate steps that bring about such changes.

**AQA content**

**4.1.1.1** A system is an object or group of objects. There are changes in the way energy is stored when a system changes.

**Students should be able to** describe all the changes involved in the way energy is stored when a system changes, for common situations. For example:

• an object projected upwards

• a moving object hitting an obstacle

• an object accelerated by a constant force

• a vehicle slowing down

• bringing water to a boil in an electric kettle.

Throughout this section on Energy students should be able to calculate the changes in energy involved when a system is changed by:

• heating

• work done by forces

• work done when a current flows.

Use calculations to show on a common scale how the overall energy in a system is redistributed when the system is changed.

**4.1.2.1** Energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed.

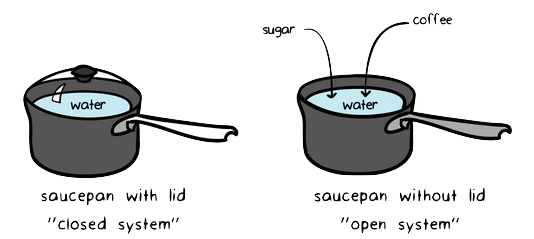
**Students should be able to** describe with examples where there are energy transfers in a closed system, that there is no net change to the total energy.

**Students should be able to** describe, with examples, how in all system changes energy is dissipated, so that it is stored in less useful ways. This energy is often described as being ‘wasted’.

**Key direct and explicit teacher explanations:**

Energy is a concept that can be difficult to understand. It is a model that we use to explain why anything happens. For example, boiling a pan of water, an aeroplane taking off, and a light bulb lighting up. However, it is a mathematical model and so is abstract. We can use other models to help us make sense of energy. We will do this in this topic.

1. In Physics we use closed systems to simplify situations; this makes them easier to think about. A closed system is one in which matter (particles) is not exchanged with the surroundings. For example, if we boil a pan of water with the lid on, steam will not escape; this is a closed system. If we take the lid off, the system is not closed; steam (particles) can escape.



1. Scientists imagine energy as being stored in objects. There are eight stores each of which has its own properties:

* Thermal store – in a warm object.
* Kinetic store – in a moving object.
* Gravitational store – due to the position of an object in a gravitational field.
* Elastic store – in an object that is stretched or compressed.
* Chemical store – in an object, e.g. fossil fuels, that contain chemicals.
* Magnetic store – when two magnets are attracting or repelling.
* Electrostatic store – when two separated charges attract or repel.
* Nuclear store – released through radioactive decay, fission or fusion.

1. The energy can move from one store to another; scientists say that the energy is transferred from one store to another. The total amount of energy must always stay the same; it is conserved.

**Chunking**

* Closed systems.
* Energy stores in systems (emphasis on closed systems).
* Transfer of energy from one store to another (including dissipation).
* Power – the rate of transfer of energy from one store to another.

For example, when the ball is compressed by a person, energy is transferred from the energy store of the person to the elastic store of the ball. However, the total amount of energy in the chemical store and elastic store combined remains the same.

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Scientists say that ‘energy can not be crated or destroyed’. Energy can be stored usefully or it can be wasted. For example, a car moving at speed has a lot of energy in its kinetic energy store; this is useful energy. However, the engine of the car also gets hot; some of the energy from the chemical energy store (the fuel) is transferred to the thermal energy store of the car; this is wasted energy. Wasted energy is also called dissipated energy.

d. Energy can be transferred from one store to another at different rates. For example, a formula 1 car transfers energy from its chemical store (the fuel) to its kinetic store very quickly. This happens when it accelerates quickly.

Compare this to a Ford Fiesta; the car transfers energy from its chemical energy store to its kinetic energy store much more slowly. This causes its acceleration to be relatively low.

Scientists would say that the formula 1 car is more powerful. Power is the rate at which energy is transferred from one store to another.

**Teacher notes (e.g. key questions, examples, non-examples, explanations)**

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**Lesson 1: Energy stores, energy changes within systems and power.**

**Objective: You are learning to describe how energy is distributed in a system and how it moves from one store to another.**

**Skills Drill / Retrieval**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**Catch-up**

This is the first lesson in the topic; catch up work has not be set for this lesson.

**Connect**

At KS3 you learnt that there are different energy stores. Energy can be transferred between the energy stores.

Some of the energy stores are:

1. Chemical store
2. Kinetic store
3. Thermal store
4. Gravitational store
5. Elastic store

Give an example of an object that contains a lot of energy in the following stores:

1. Chemical store

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1. Kinetic store

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1. Thermal store

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1. Gravitational store

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1. Elastic store

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50% of the energy transfers into the gravitational store of the person as they move uphill. This is through the mechanical pathway as a force is used.

The remaining 50% of energy transfers in the thermal store of the persons body gets warmer. This uses the heating pathway.

Thermal store

Gravitational store

Chemical store

All of the energy transferred moves from the persons chemical store into the books gravitational store.

The pathway is the mechanical pathway because the exerts a force to move the book.

**Question 1:** A person walks up a hill. The energy in their chemical store is transferred to their gravitational store and thermal store (an equal amount is transferred to each).

Table

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Energy can not be created or destroyed. It can only be transferred from one store into another.

We can show this in an accounting chart.

**Worked Example:** A person lifts a book up and puts it on a bookshelf.

Table

Description automatically generated

* The person’s body has energy in the chemical store. When they lift the book up and put it on the shelf, energy is transferred from the persons chemical store into the books gravitational store (because the book is higher up).
* So, at the start all of the energy is in the person’s chemical store.
* At the end, it is shown in the books gravitational store.

Gravitational store

Chemical store

Electrical work

Radiation

**Question 2:** For each energy transfer:

* Identify which store the energy is in at the start.
* Identify which store the energy was in at the end.
* Identify the pathway (mechanical work; electrical work; heating; radiation).
* Calculate any missing energy values (assume energy is conserved).

1. A rocket taking off.

c. Boiling an electric kettle.

Output energy:

5,000J thermal store

(in the water)

Output energy:

800J \_\_\_\_\_\_\_\_\_\_\_\_\_ store

(in the car)

**Output energy:**

600J gravitational store

(in rocket)

**Output energy:**

400J thermal store

(in surroundings)

Input energy (from power station):

10,000J \_\_\_\_\_\_\_\_\_\_\_\_\_ store

Output energy:

\_\_\_\_\_\_\_\_\_\_\_\_J \_\_\_\_\_\_\_\_\_\_\_ store (particles in environment)

b. A car accelerated by a constant force from its engine.

Mechanical pathway

Heating pathway

Mechanical pathway

Input energy:

800J chemical store

Input energy:

1000J chemical store

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When work is done on an object, energy is transferred. Power is the rate at which the energy is transferred from one store into another. In other words, power is the amount of energy transferred per second.

Power is calculated using the following equation:

**Power = work done / time**

Power is measured in Watts. Work done is measured in joules. Time is measured in seconds.

a. When a car stops, 40,000J of work is done by the brakes in a time of 5s.

What is the power of the brakes?

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b. When a fan starts moving, 30J of work is done by the motor in a time of 3s.

What is the power of the motor?

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c. When an arm lifts a weight, 4,500J of work is done in 4s.

What is the power of the muscles in the arm?

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d. What is the power of a toaster that is able to toast bread in 20s by doing 40J of work. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

e. A rollercoaster life is able to move car up the lift in 50s by doing 5,000J of work.

What is the power of the lift’s motor?

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f. A television does 6,000J of work in 1 minute to create an image of television programme.

What is the power of the television?

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**\*Resource purchased from Simple Science (TEs resources).**

**Lesson 2: Teacher notes**

**AQA Content**

Students should be able to calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level.

The kinetic energy of a moving object can be calculated using the equation:

kinetic energy = 0.5 × mass × speed2

Ek = 1/2  m v2

* kinetic energy, Ek , in joules, J
* mass, m, in kilograms, kg
* speed, v, in metres per second, m/s

Power is defined as the rate at which energy is transferred or the rate at which work is done.

power = energy transferred / time

P  = E/ t

power = work done / time

P  = W/ t

* power, P, in watts, W
* energy transferred, E, in joules, J
* time, t, in seconds, s
* work done, W, in joules, J

An energy transfer of 1 joule per second is equal to a power of 1 watt. Students should be able to give examples that illustrate the definition of power eg comparing two electric motors that both lift the same weight through the same height but one does it faster than the other.

**Chunking**

* Quantifying energy.
* Calculating kinetic energy.
* Power associated with changes in kinetic energy.

**Key direct and explicit teacher explanations:**

1. In the last lesson we learnt about the energy stores and how energy can move from one store to others. However, it can not be created or destroyed; the total amount of energy always stays the same.

Sometimes scientists want to say how much energy there is in a store, or how much is transferred from one store to another. There are equations that allow them to do this using the position, movement and properties of an object. For example, we can calculate the amount of energy in the kinetic energy store of a car if we know its mass and speed / velocity.

1. The amount of energy in the kinetic energy store of an object can be calculated using the equation:

Ek = 1/2  m v2

This equation tells us that the amount of energy in the kinetic energy store is directly proportional to the

mass of the object. This means that if the mass doubles, the amount of energy in the kinetic energy store

also doubles.

It also tells us the if the speed of the object doubles, the amount of energy in the kinetic energy store

quadruples.

1. The speed or rate at which energy is transferred from one store into another is called power. It can be calculated using two equations:

P  = E/ t

P  = W/ t

The units for power are Watts. One watt is equivalent to one joule of energy being transferred per second.

**Teacher notes (e.g. key questions, examples, non-examples, explanations)**

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**Lesson 2: Kinetic energy**

**Objective: You are learning to calculate the amount of energy in kinetic energy stores and the rate at which it is transferred to other stores (power).**

**Skills Drill / Retrieval**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**Catch-up – If you were absent last lesson, use your knowledge booklet to complete the following questions.**

1. What do we mean when we say the amount of energy is conserved?

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1. Name three energy stores.

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1. A sky diver jumps out of a plane.

Which store is full of energy just before he jumps out?

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Which store is the energy transferred into as he falls towards the Earth?

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Which pathway is used to transfer the energy?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The hare because it accelerated at a faster rate (energy entered the kinetic store at a faster rate).

Chemical energy store.

The heavier tortoise had more energy in their kinetic store as they were moving more mass.

Students might answer in terms of work done.

The hare. It accelerated more quickly and reached a higher top speed.

\*Power can be introduced here.

Chemical store

**Connect**

Objects that are moving have energy in their kinetic energy stores.

In the parable ‘The Hare and the Tortoise’, the hare and the tortoise had a race. The hare accelerated very quickly and reached a high top speed in the time that it took the tortoise to accelerate to a slow speed.

When the hare and the tortoise moved, energy was transferred into their kinetic energy stores.

1. Which energy store was the energy in before it was transferred into the kinetic energy store?

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1. Which animal transferred energy into their kinetic energy store the fastest? How can you tell?

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1. The tortoise had a much heavier sibling. However, they both moved at exactly the same speed.

Which tortoise would have the most energy in their kinetic store if they moved at the same speed?

Explain your answer.

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Diagram, schematic

Description automatically generated

Diagram, schematic

Description automatically generated

Table

Description automatically generated

Table

Description automatically generated

**ANSWERS**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**ANSWERS**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

12100 x 0.7 = 8470K in kinetic energy store

8470 = 0.5 x 100 x v2

V2 = 8470 / 50 = 169.4

V = 13.01 m/s

6050 / 0.25 = 12100J

6050 – 0 / 0.4 = 15125W

KE = 0.5 x 100 x 112

= 6050J

Kinetic energy = 0.5mv2

V = 0 so KE = 0J

Linford Christie was a British sprinter. He held the world record for running 100m in 9.87 seconds.

He could accelerate from 0m/ (stationary) to 11m/s in 0.4 seconds.

Linford had a mass of 100kg.

1. Calculate the amount of energy in Linford’s kinetic energy store when he was in the blocks (stationary).

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1. Calculate the amount of energy in Linford’s kinetic energy store when he was sprinting at 11m/s.

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1. Calculate his power if he accelerated from 0m/s to 11m/s in the first 0.4 seconds.

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1. The human body is about 25% efficient. How much energy was transferred from Linford’s chemical energy store if only 25% of it was transferred to the kinetic energy store?

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1. If Linford’s body had an efficiency of 70%, what would be his velocity after 0.4 seconds? Assume that the amount of energy transferred from is chemical energy store is the same as your answer to question d.

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**Lesson 3: Teacher notes**

**AQA Content**

Students should be able to calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level.

elastic potential energy = 0.5 × spring constant × (extension)2

Ee    = 1/2  k e2

* (assuming the limit of proportionality has not been exceeded) elastic potential energy, Ee, in joules, J
* spring constant, k, in newtons per metre, N/m
* extension, e, in metres, m

**Chunking**

* The elastic potential energy store.
* Calculating the amount of energy in the elastic energy store.

**Key direct and explicit teacher explanations:**

1. The elastic energy store of any object fills up if the object is stretched or compressed. For example, when a person stretches an elastic band, energy is transferred from the chemical energy store of the person into the elastic energy store of the elastic band.
2. You may recall that work is done when energy is transferred using a force. In a stretched spring the energy transferred is equal to the work done to stretch the spring.
3. The amount of energy in the elastic energy store can be calculated using the equation:

Ee = 1/2 k e2

This equation tells us that the amount of energy in the store is quadruples if the extension doubles. The amount of energy in the elastic energy store is also directly proportional to the spring constant.

**Teacher notes (e.g. key questions, examples, non-examples, explanations)**

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**Lesson 3: Elastic potential energy**

**Objective: You are learning to calculate the amount of energy in the elastic energy store of an object that has been stretched or compressed.**

**Skills Drill / Retrieval**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

Power = 50000 / 5 = 10000W

Ek = 0.5 x 1000 x 102

Ek = 50000J

Ek = 0.5 x m x v2

**Catch-up**

1. Which equation is used to calculate the amount of energy in a kinetic energy store?

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1. If a car has a mass of 1000kg and is moving at 10m/s, how much energy is in its kinetic energy store?

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1. If the car took 5s to accelerate from 0m/s to 10m/s, what would its power be?

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**Connect**

In the **KS3 Energy** topic you learnt that the elastic energy store is filled when an object is compressed or stretched. For example, it fills when a spring is stretched and when a rubber ball is compressed.

A person stretches a spring by transferring 100J of energy from their chemical energy store. 40J of the energy is transferred into the spring’s elastic energy store. The rest enters the thermal energy store of the surroundings.

Complete the energy accounts diagram below to show these energy transfers.

Table

Description automatically generated

40% of the energy moves to the elastic store using the mechanical pathway (a force is exerted on the spring).

60% transfers to the thermal energy store of the surroundings using the radiation pathway.

Thermal store of the surroundings

Elastic store of the spring

Persons chemical store

Ee = 0.5 x k x e2

Ee = 0.5 x 200 x 0.0009

Ee = 0.09J

Ee = 0.5 x k x e2

Ee = 0.5 x 120 x 0.0004

Ee = 0.024J

Obtained from Astrea Academy Sheffield.

Table

Description automatically generated with medium confidence

= 10 / (0.022 x 0.5)

= 50,000 N/m

= 96 / (0.052 x 0.5)

= 76,800 N/m

= 68 / (0.062 x 0.5)

= 37,778N/m

= 45 / (0.022 x 0.5)

= 225,000N/m

**Task 3: Calculations - rearranging**

Ee = ½ k e2

**Worked example**

A spring stores 30 J of elastic potential energy when it is stretched by 10 cm. What is the spring constant?

Step 1 – write the equation - Ee = ½ k e2

Step 2 – Fill in the known values/substitute – 30 = 0.5 x k x 0.12 (the extension has to be in meters so convert cm to metres first)

Step 3 – remember opposite function from maths – 30 = 0.5 x k

0.12

30 = k

(0.12 x 0.5)

Step 4 – complete the calculation - 6000N/m

2. An elastic spring stores 45 J of elastic potential energy when it is stretched by 2 cm. What is the spring constant?

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3. A spring stores 68 J of elastic potential energy when it is stretched by 6 cm. What is the spring constant?

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4. A spring stores 96 J of elastic potential energy when it is stretched by 5 cm. What is the spring constant?

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5. An elastic spring stores 10J of elastic potential energy when it is stretched by 2 cm. What is the spring constant?

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Obtained from Astrea Academy Sheffield.

**Lesson 4: Teacher notes**

**AQA Content**

Students should be able to calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level.

g . p . e . = mass × gravitational field strength × height

Ep = m g h

* gravitational potential energy, Ep, in joules, J
* mass, m, in kilograms, kg
* gravitational field strength, g, in newtons per kilogram, N/kg (In any calculation the value of the gravitational field strength (g) will be given).
* height, h, in metres, m

An energy transfer of 1 joule per second is equal to a power of 1 watt. Students should be able to give examples that illustrate the definition of power eg comparing two electric motors that both lift the same weight through the same height but one does it faster than the other.

**Chunking**

* The gravitational store.
* Calculating the amount of energy in the gravitational store.
* Transfer of energy between the gravitational and kinetic stores.

**Key direct and explicit teacher explanations:**

When objects are raised up the gravitational energy store is filled. For example, a helicopter that is hovering above a landing pad has more energy in the gravitational store than one that has landed on the landing pad.

When objects are raised up in the air, work is done against gravity. So, the gravitational energy store fills. The higher the object is raised, the more work is done against gravity. So, the gravitational store fills as the object goes higher.

More work must be done to lift a heavier object to the same height as a lighter object. So, more energy is transferred to the gravitational energy store for relatively heavy objects.

These relationships are represented by the following equation:

g . p . e . = mass × gravitational field strength × height

Ep = m g h

When objects fall, for example a skydiver jumping from a plane, energy is transferred from the gravitational store of the skydiver to the kinetic store of the sky diver. If we only needed to think about the gravitational store and the kinetic store, all of the energy in the gravitational store would be transferred to the kinetic store; it would be 100% efficient.

Equations used in interleaved questions:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| Ek = kinetic energy (J)  m = mass (kg)  v = velocity (m/s) | Ee = elastic potential energy (J)  k = spring constant (N/m)  e = extension (m) | Ep = gravitational potential energy (J)  m = mass (kg)  g = gravitational field strength (N/kg)  h = height (m) | P = power (W)  E = Energy transferred (J)  t = time (s) |

**Teacher notes (e.g. key questions, examples, non-examples, explanations)**

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**Lesson 4: Gravitational potential energy**

**Objective: You are learning to calculate the amount of energy in an objects gravitational potential energy store.**

**Skills Drill / Retrieval**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

Text

Description automatically generated

= 68 / (0.062 x 0.5)

= 37,778N/m

= 45 / (0.022 x 0.5)

= 225,000N/m

**Catch-up**

1. Which equation is used to calculate the amount of energy in a elastic energy store?

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2. An elastic spring stores 45 J of elastic potential energy when it is stretched by 2 cm. What is the spring constant?

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3. A spring stores 68 J of elastic potential energy when it is stretched by 6 cm. What is the spring constant?

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The second balloon.

The second balloon.

Chemical energy store of the fuel in the burner.

Gravitational energy store.

**Connect**

Work is done when forces act on objects. If the force raises an object up in the air, work is done and energy is transferred into the gravitational energy store.

If a person is in a hot air balloon, and they turn the burner on, the balloon moves higher.

1. Which energy store starts to fill up?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Which energy store starts to empty?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. A second balloon floats exactly level with the first one. The second balloon contains two people (the mass of people is exactly double that of the person in the first balloon).

If both balloons need to rise by 20m, which balloon would you need to do more work on?

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1. Which balloon would contain more energy in its gravitational store once the balloons are level?

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**GRAVITATIONAL POTENTIAL ENERGY STORE**

1. Use the following equation to help you complete the questions on this worksheet:

**Gravitational Potential Energy = Mass x Gravitational Field Strength x Height**

**(J) (kg) (N/kg) (m)**

Gravitational field strength of Earth = 10N/kg

a. A man holds a bag 2m off the ground with a weight of 4kg.

Calculate the amount of energy in the gravitational store.

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b. A ball with a mass of 2kg is thrown 15m into the air.

Calculate the amount of energy in the gravitational store at the top of the throw.

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c. A roller coaster has come to the top of the first hill which is 190m high. The mass of the car is around 1500kg

Calculate the amount of energy in the gravitational store.

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Graphical user interface, text, application

Description automatically generated

d. A bird with a mass of 0.5kg jumps off the roof of a house that is 10m high.

Calculate the amount of energy in the gravitational store.

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e. A spoon with a mass of 0.4kg falls off a kitchen side that is 2.5m high.

Calculate the amount of energy in the gravitational store.

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f. A leaf with a mass of 0.05kg drops from a tree that is 15m high.

Calculate the amount of energy in the gravitational store.

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Purchased from Simple Science (TES Resources)

**Energy calculations – interleaved**

**Complete the questions on the notes page.**

|  |  |  |  |
| --- | --- | --- | --- |
| Find the kinetic store of energy of a 1500 kg car travelling at 25 m/s.  **468,750 J** | Find the energy stored in an elastic band with a spring constant of 27 N/m and an extension of 1.2m.  **19.44 J** | Calculate the energy in the gravitational store gained by a 5 kg mass when lifted 0.7m in the air by a bodybuilder (g =10 N/kg).  **34.4 J** | Calculate the power output of a bodybuilder when 10J of energy is transferred from their muscles in 3 seconds.  **3.33 W** |
| Find the kinetic store of energy of a ball with a mass of 100 g as it flies through the air at 3 m/s.  **0.45 J** | Find the energy stored in a spring which is stretched to an extension of 0.58m. The spring constant of the spring is 30 N/m.  **5J** | Find the height gained by a 4.2 kg exercise ball that is lifted to gain 340 J of energy in the gravitational store (g = 10 N/kg).  **8.25 m** | A 3W mechanical device transfers energy over 30 s. How much energy is transferred?  **90 J** |
| Find the mass of a rocket travelling at 30m/s that has a kinetic store of energy of 150J.  **0.33 kg** | A spring stores 180 J of energy when extended by 1.8 m. Calculate the spring constant.  **111.1 N/m** | A box of unknown mass gains 300J of energy by being raised 0.5m. What is the mass of the box?  (g = 10 N/kg).  **61.2 kg** | How long would a 2 kw heater take to transfer 500 J to the thermal store of the air around it?  **0.25 s** |
| A 200 g ball is dropped from a height where is has 1.20 J of energy in it’s gravitational store. Calculate the speed of the ball just before it lands (ignore the effects of air resistance).  **3.46 m/s** | How long would a bungee rope be extended by if it stored 450 J of energy in its elastic store and it had a spring constant of 62 N/m?  **3.81 m** | A 100g ball is thrown upwards with an initial speed of 3m/s. Calculate the maximum height reached. Ignore the effects of air resistance. (g=10N/kg)  **0.45 m** | A bodybuilder lifts a 5kg mass repeatedly from the ground to a height of 1.2m. If it is lifted up 10 times in 1 minute, calculate the power output of the weightlifter.  **10 W** |

A plane carrying a parachutist remains at a height of 300m above the Earth. The parachutist has a mass of 90kg.

1. Calculate the amount of energy in the parachutist’s gravitational store. Assume gravitational field strength = 10N/kg.

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1. The parachutist jumps from the plane and descends 40m in the first 8 seconds of his descent.

Calculate the amount of energy in the parachutists gravitational store after they have descended by 40m.

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1. Calculate the rate of energy transfer (power) for the first 8 seconds of the parachutist’s descent.

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1. The parachutist took 5 seconds to fall the next 40m.

Calculate the total amount of energy transferred from the parachutist’s gravitational store in the first 13 seconds of their descent.

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1. Calculate the average rate of energy transfer (power) for the first 13 seconds of their descent.

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72,000 / 13 = 5538 W

260m – 40m = 220m

90 x 10 x 220 = 198,000 J

270,000 – 198,000 = 72,000 J or 72kJ

270,000 – 234,000 = 36,000 J

36,000 / 8 = 4,500 W

90 x 10 x 260 = 234,000 J or 234kJ

90 x 10 x 300 = 270,000 J or 270 kJ

**Lesson 5: Teacher notes**

**AQA Content**

The amount of energy stored in or released from a system as its temperature changes can be calculated using the equation:

change in thermal energy = mass × specific heat capacity × temperature change

* ∆ E  = m c  ∆θ
* change in thermal energy, ∆E, in joules, J
* mass, m, in kilograms, kg
* specific heat capacity, c, in joules per kilogram per degree Celsius, J/kg °C
* temperature change, ∆θ, in degrees Celsius, °C

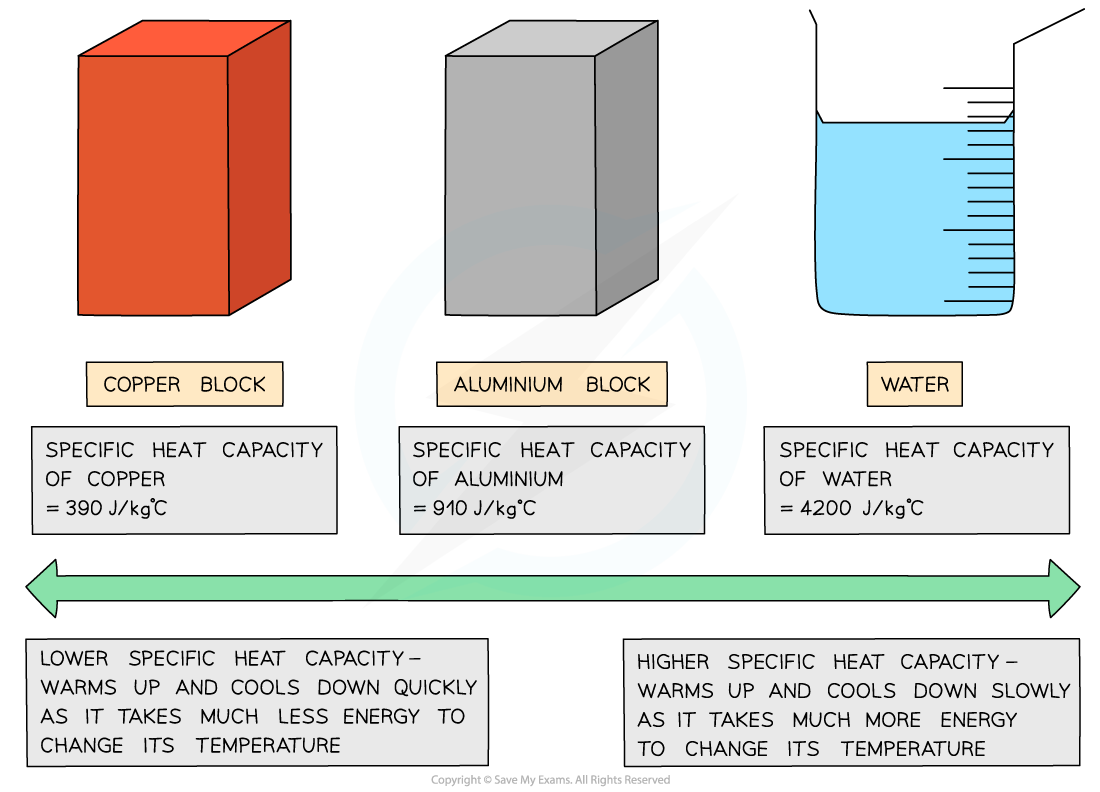
The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.

**Chunking**

* Transfer of thermal energy.
* Specific heat capacity.
* Calculating specific heat capacity.

**Key direct and explicit teacher explanations:**

* Thermal energy is also called heat. Thermal energy is transferred from relatively hot areas to relatively cold areas. This occurs by conduction, convection and radiation. Energy is transferred from the thermal store of the object to the thermal store of the surroundings.
* When energy is transferred out of the thermal energy store of an object, it becomes cooler. If energy moves into an objects thermal energy store it becomes hotter (higher temperature). However, if we transferred the same amount of energy into the thermal energy store of two different materials, the temperature doesn’t change by the same amount. The change in temperature depends on a materials specific heat capacity. Thermal conductors, like metals, have a relatively low specific heat capacity; the transfer of small amounts of energy into I a metals thermal store increases the temperature by a relatively large amount. Water, an insulator, is the opposite.



* The relationship between the amount of energy transferred into an objects thermal store and its temperature are given in the following equation:

∆ E  = m c  ∆θ

This equation shows that:

The amount of energy transferred into the thermal store is directly proportional to the temperature change.

It also shows that the temperature change depends on mass and specific heat capacity.

**Teacher notes (e.g. key questions, examples, non-examples, explanations)**

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**Lesson 5: Specific heat capacity**

**Objective: You are learning to calculate temperature changes associated with energy transfers.**

**Skills Drill / Retrieval**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

Graphical user interface, text

Description automatically generated

**Catch-up**

Objects that are raised up in the air have energy transferred into heir gravitational energy store.

The equation for calculating the amount of energy in the gravitational store is:

**Gravitational Potential Energy = Mass x Gravitational Field Strength x Height**

**(J) (kg) (N/kg) (m)**

a. A man holds a bag 2m off the ground with a weight of 4kg.

Calculate the amount of energy in the gravitational store (assume gravitational

field strength = 10 N/m).

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b. A ball with a mass of 2kg is thrown 15m into the air.

Calculate the amount of energy in the gravitational store at the top of the throw.

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The temperature change would decrease because some energy is transferred to the surroundings.

So that energy from the thermal energy store doesn’t get transferred into the thermal store of the surroundings.

**Connect**

When scientists want to measure temperature changes during reactions, they often use an insulated container with a lid.

1. Why might they use an insulated container with a lid?

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1. If they didn’t use an insulated container, would the temperature change that they measured be too low or too high? Explain your answer.

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Diagram

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Text, email, timeline

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