

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

Key Stage 4 Science:

**Energy**











**This booklet is for use in your Science lessons. Please look after it in the same way you would your exercise book and ensure that your presentation is always PROUD.**

**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: 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**

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| --- | --- |
| Answer | PA / SA |
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**Catch-up**

This is the first lesson in the topic; catch up work has not been 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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**Notes**

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Thermal store

Gravitational store

Chemical store

**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).



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.



* 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

**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.

Input energy:

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

Input energy:

1000J chemical store

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: 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**

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| --- | --- |
| Answer | PA / SA |
| 1 |  |  |
| 2 |  |  |
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**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?

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**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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**Notes**

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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: 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 |  |  |

**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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Persons chemical store

**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.



Thermal store of the surroundings

Elastic store of the spring

**Notes**

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Obtained from Astrea Academy Sheffield.



**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: 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 |  |  |

**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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**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?

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1. Which energy store starts to empty?

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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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**Notes**

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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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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. | Find the energy stored in an elastic band with a spring constant of 27 N/m and an extension of 1.2m. | 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). | Calculate the power output of a bodybuilder when 10J of energy is transferred from their muscles in 3 seconds. |
| 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. | 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.  | 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). | A 3W mechanical device transfers energy over 30 s. How much energy is transferred? |
| Find the mass of a rocket travelling at 30m/s that has a kinetic store of energy of 150J. | A spring stores 180 J of energy when extended by 1.8 m. Calculate the spring constant. | 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). | How long would a 2 kw heater take to transfer 500 J to the thermal store of the air around it? |
| 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).  | 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? | 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) | 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. |

**ANSWERS**

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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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**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 |  |  |

**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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**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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**Notes**

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