**7.3 – Energy**

Heating a substance increases the internal energy store of the object – the particles are moving with more kinetic energy

**Conduction**

Particles transfer energy by **colliding** with adjacent particles when they vibrate and making them vibrate also.

Heat transfer occurs until all particles have the **same amount of kinetic energy** – all areas are at the **same temperature**

**Convection – in fluids**

**2. Conservation of Energy**

**What do I need to be able to do?**

•Describing changes in the amounts of energy in stores during processes that involve energy transfer.

•Understand internal energy stored in materials.

•Describe the intermediate pathways that bring about energy changes in systems

•Describe the energy transfer from hotter to cooler objects, via conduction, convection or radiation; to reduce the temperature difference until equilibrium

•Explain the use of insulators to reduce the rate of thermal energy transfer

•Calculate work done & energy changes, including on deformation of an object

•Evaluate fuels and renewable energy resources.

•Describe simple machines as giving a bigger force as the result of a smaller movement

•Describe the energy changes in changes of state; motion & arrangement of particles

•Describe the cycles of materials and energy

• Understand energy as a quantity that can be quantified, calculated, and is conserved

•Calculate fuel costs in a domestic context

•Compare power ratings of appliances in W & kW

•Comparing amounts of energy transferred (J, kJ, kWh)

**3. Methods of Heat Transfer**

**1. Energy Stores**

Energy cannot be created or destroyed, only transferred from one store to another

**The total amount of energy before and after a transfer remains constant**

e.g.

Energy is measured in **Joules (J)**

There are different types of energy stores:

|  |  |  |
| --- | --- | --- |
| **Name** | **Energy stored…**  | **Example**  |
| Magnetic | *When repelling poles are pushed closer or attracting poles pulled apart* | Fridge magnets, compasses  |
| Electrostatic  | *When repelling charges are moved closer/ attracting charges pulled apart* | Thunder and lightening  |
| Internal (thermal) | *In the total potential and kinetic energy of the particles in an object* | Hot drinks, ice cubes  |
| Chemical potential | *In chemical bonds*  | Food, fuels |
| Gravitational potential | *In objects at height*  | Kite, aeroplane |
| Elastic potential  | *When an object is stretched or squashed* | Stretched spring,  |
| Kinetic  | *In moving objects*  | Car, comet |
| Nuclear  | *In the nucleus of an atom* | Uranium  |



The gravitational potential energy store decreases and the kinetic energy store increases. Mechanical work is done





The internal energy store of the surroundings decreases, and the internal energy store of the ice cube increases. Work is done via heating



1. Particles at the bottom gain **kinetic energy** and move faster

2. They spread out and the substance becomes **less dense.** Less dense substances rise

**5. Efficiency**



3. As they rise, they lose kinetic energy and move closer together. The substance becomes denser and sinks

4. The process repeats, a **convection current** is created

The elastic potential energy store decreases and the kinetic energy store increases. Mechanical work is done

**4. Renewable & Non-renewable Resources**



A doctor weighs **600 N.** A lift moves her **40 m** to the top floor of a hospital. Calculate the work done on the doctor by the lift.

**work done** = force × distance

**work done** = 600 N × 40 m

**work done** = 24,000 J

Work is done when energy is transferred from one store to another. Work is also done when a force causes an object to move.

**Work done = force x distance**

**(J) (N) (m)**

 Work done is equal to the energy transferred and so is also measure in Joules

***Worked example:***

Efficiency is the measure of the proportion of input energy to a system that is transferred usefully

**Efficiency = useful output energy ÷ total input energy**

**Efficiency = useful output power ÷ total input power**

 **(J or W) (J or W)**

***Hint – no system is 100% effective and will waste some energy – so you will always be dividing a smaller number by a larger one***

Efficiency can be expressed as a decimal or x 100 for a percentage

***Worked example:***

The energy supplied to a light bulb is 200 J. A total of 28 J of this is usefully transferred. How efficient is the light bulb?

**Efficiency** = useful output ÷ total input

**Efficiency** = 28 J ÷ 200 J

**Efficiency** = 0.14 or (0.14 x 100 = 14%)

**To calculate the cost of energy transfer:**

**Total cost** = power (W) x time (h) x cost per unit

Power is the rate at which energy is transferred or work is done

**Power = energy transferred (work done) ÷ time**

 **(W) (J) (s)**

 Power is measured in Watts (W)

1 W = 1J per second

***Worked example:***

An oven transfers 36000 J of energy in 3 seconds. Calculate the power of the oven.

**power** = energy ÷ time

**power** = 36 000 J ÷ 3 s

**power** = 12 000 J

**To calculate the cost of energy transfer:**

**Total cost** = power (W) x time (h) x cost per unit

**7. Work Done**

**6. Power & Energy Costs**

|  |  |
| --- | --- |
| **Non-renewable resources** | **Fossil fuels**  |
| **Coal, oil and natural gas** |
| ✔cheap and easy to obtainInfrastructure already in place  | ✖finite resource Contributes to global warming and acid rain |
| **Nuclear**  |
| **Uranium, plutonium** |
| ✔≈ 165 years left Doesn’t contribute to global warming Large amounts of energy released per gram  | ✖slow start up timeRadioactive waste High decommissioning costs Risk of catastrophic accidents  |

|  |
| --- |
| **Renewable energy resources**  |
| **Solar, wind, tidal, H.E.P, wave, geothermal, biomass** |
| ✔infinite do not contribute to global warming  | ✖construction is costly *some are*; unreliable, can only be used in certain locations, have major ecological impacts |

|  |  |
| --- | --- |
| **Key term** | **Definition**  |
| Renewable | Replenished as we are using it  |
| Non-renewable | Using it faster than it can be replenished  |
| Finite | Will run out  |
| Infinite | Will not run out  |
| Power | Rate of energy transfer |
| Efficiency | Proportion of input energy that is transferred usefully |
| Work done  | Work is done when energy is transferred from one store to another |
| Newton  | The unit of measurement of forces |
| Joule  | The unit of measurement of energy  |
| Fluid | Gas or liquid |
| Density  | Mass per unit volume of nay object. Mass ÷ volume |
| Solar  | Energy that comes from radiation from the Sun |
| H.E.P | Energy transferred from the gravitational potential energy store of water to the kinetic store  |
| Geothermal | Energy transferred from the internal (thermal) energy store of the Earth  |
| Tidal  | Harnessing the kinetic energy of moving water in the tides |
| Wind  | Energy transferred as a result of convection currents in the atmosphere  |
| Biomass  | Energy transferred from the chemical energy store of biological material e.g. wood  |

**Know it**

**Energy Stores**

1. Name the energy store of moving objects

2. Name the energy store of food, batteries and fuels

3. Name the energy store of objects at a height

4. What unit is energy measured in?

5. State the ‘law of the conservation of energy’

**Methods of Heat Transfer**

6. Name the method of heat transfer that occurs in fluids

7. Define the term conduction

8. What do we call a poor conductor?

9. Give an example of a material that is a good conductor

10. What happens to air molecules as their kinetic energy store increases?

**Work done/Power/Efficiency**

11. State the units of Power

12. State the equation to calculate efficiency

13. Sate the units of work done

14. State the equation to calculate power

15. State the equation to calculate work done

**Renewable & Non-renewable resources**

16. Define the term renewable resource

17. Define the term non-renewable resource

18. Which renewable energy resources are dependent on the weather?

18. Describe an advantage of renewable resources

19. Describe a disadvantage of solar energy

20. Describe a disadvantage of H.E.P

21. Describe a disadvantage of wind farms

22. Describe a disadvantage of geothermal energy

23. Why is wood considered a renewable resource?

24. Why do nuclear energy power stations have high decommissioning costs?

25. Why is nuclear not a fossil fuel, but is non-renewable?

26. Describe the changes in energy stores and pathways in H.E.P

**Link it**

**1.** Calculate the power of a crane that lifts a 50 kN load by 5m in 3 minutes.

**(hint – you need to use two equations)**

**2**. Explain how each of the following features of the vacuum flask reduce heat transfer to surroundings by conduction, convection or radiation

**3**. Use the particle diagrams below to suggest why a wooden spoon would be better to stir soup in a pan on the hob, than a metal spoon.



**4.** Plan an investigation to determine which of the following materials is the best insulator: ***cardboard or bubble wrap***

Include details of your independent, dependent and control variables.

**Grasp it**

**Energy Stores**

1. Describe the changes in energy stores and pathways in a battery-operated torch

2. Describe the changes in energy stores and pathways in a disposable hand warmer

3. Describe the changes in energy stores and pathways in a slingshot

4. If a ball has 50 J in its gravitational potential energy store as it is raised in the air, how much energy increases in the kinetic energy store as it falls?

5. Describe the changes in energy stores and pathways as water is heated on a stove.

**Methods of Heat Transfer**

6. Draw a series of diagrams to show what happens to particles during convection

7. Explain how the whole room becomes warm when a radiator is put on

8. Why doesn’t convection occur in solids?

9. Does convection happen fastest in gases or liquids? Explain your answer

10. Which paper clip would fall first? Explain your answer

**Work done/Power/Efficiency**

11. Calculate the power of a motor that uses 800J of electrical energy in 20 seconds.

12. Calculate the power of a person who does 24000J of work in 2 minutes

13. Calculate the work done when a force of 8N moves by 0.4m.

14. Calculate the work done when a force of 30N moves by 50cm.

**Renewable & Non-renewable resources**

15. Why are fossil fuels non-renewable?

16. Why is tidal energy more reliable than wind energy?

