P1 : Conservation and dissipation of energy

Energy dissipation/energy and efficiency-

- Useful energy is energy in the place we want it and in the form we need it, wasted energy is energy that is not useful and transferred by an undesired pathway
- Whenever energy is transferred, some is transferred usefully, the rest is dissipated and stored in less useful ways
- Energy becomes more useful the more it spreads out

$$\text{efficiency} = \frac{\text{useful output energy transferred by the device (J)}}{\text{total input energy supplied to the device (J)}}$$

- No energy transfer can't be more than 100% efficient because you can never get more energy from a machine than you put into it
- Efficiency can be increased by reducing the energy they waste, for example lubricating the moving parts to reduce friction, using wires with as little electrical resistance, streamlining the shapes of moving objects to reduce air resistance

Electrical appliances/energy and power-

- The electrical appliances can transfer energy in the form of useful energy, and should waste energy as little as possible
- Light bulb - useful light emitted from the glowing filament - wasted energy transfer from filament heating the surroundings
- Electrical heater - useful energy heating the surroundings - wasteful light emitted from the glowing filament
- The more powerful an appliance is, the faster the rate at which it transfers energy

$$\underset{\text{(watts, W)}}{\text{power, } P} = \frac{\text{energy transferred to appliance, } E \text{ (joules, J)}}{\text{time take for energy to be transferred, } t \text{ (seconds, s)}}$$

$$\text{efficiency} = \frac{\text{useful power out}}{\text{total power in}} (\times 100)$$

Changes in energy stores-

- Chemical energy stores includes fuels, chemicals found in batteries, energy is transferred in chemical reactions
- Kinetic energy stores describes energy an object has when moving
- GPE stores describes the energy stored in an object because of its position, such as an object above the ground
- EPE stores describe energy stored in a springy object when you stretch or squash it
- TE stores describes energy a substance has because of its temp.
- When a kettle is used to boil water, current in kettle heating element transfers energy to te store of water and kettle
- When an object is thrown into the air, object slows down as it goes up, energy is transferred from KE to GPE
- When an object starts to fall freely, speeds up as it falls, energy is transferred from GPE to KE

Gravitational potential energy stores/kinetic energy and elastic stores-

- The GPE store of an object increases when it moves up and decreases when it moves down

$$g.p.e. = mass \times gravitational\ field\ strength \times height$$

$$[E_p = m\,g\,h]$$

$$\underset{\text{(joules, J)}}{\text{change in object's gravitational potential energy store}} = \underset{\text{(newtons, N)}}{\text{weight}} \times \underset{\text{(metres, m)}}{\text{change of height}}$$

- The energy in the KE store of a moving object depends on its mass and speed

$$\underset{\text{(joules, J)}}{\text{kinetic energy, } E_k} = \frac{1}{2} \times \underset{\text{(kilograms, kg)}}{\text{mass, } m} \times \underset{\text{(metres per second, m/s)}^2}{\text{speed}^2, v^2}$$

- Elastic potential energy is the energy stored in an elastic object when work is done on the object

$$\underset{\text{(joules, J)}}{\text{elastic potential energy, } E_e} = \frac{1}{2} \times \underset{\text{(newtons per metre, N/m)}}{\text{spring constant, } k} \times \underset{\text{(metres, m)}}{\text{extension}^2, e^2}$$

Conservation of energy/energy and work-

- A pendulum is an example of a closed system because no energy transfer takes place out of or into the energy stores of the system
- Principle of conservation of energy says that no energy can be created or destroyed
- Energy can be transferred between energy stores of closed system, the total energy of a system is always the same, before or after any transfers
- Work is done on an object when a force makes the object move

$$\underset{\text{(joules, J)}}{\text{work done, } W} = \underset{\text{(newtons, N)}}{\text{force applied, } F} \times \underset{\text{(metres, m)}}{\text{distance moved along the line of action of the force, } s}$$

- Work done to overcome friction is transferred to thermal energy stored by heating

P2 : Energy transfer by heating

Heating and insulating buildings-

- Measures can be taken to reduce the rate of energy transfer from a home, and so reduce heating bills
- Loft insulation - uses fibreglass to reduce rate of energy transfer through the roof, and reduces rate of energy transfer by conduction
- Cavity wall insulation - reduces rate of energy transfer through outer walls, space between two layers of brick that make up the wall
- Aluminium foil between radiator panel and wall reflects radiation away from wall, reduces rate of energy transfer by radiation
- Double-glazed windows - two glass panels with dry air or vacuum between panes, thicker the glass, lower its thermal conductivity, slower rate of energy transfer by conduction
- If external walls of a building have thicker bricks and lower thermal conductivity,rate of energy transfer from inside of building to outside will be lower

Specific heat capacity-

- The SHC of a substance is the amount of energy needed to change the temperature of 1kg of the substance by 1˚c

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

$$[\Delta E = m\,c\,\Delta\theta]$$

- The greater the mass of an object, the more slowly its temperature increases when it is heated
- To find the SHC of an object, use a joule meter and thermometer to find change in thermal energy and temperature change, then use the equation

$$c = \frac{\Delta E}{m\,\Delta\theta}$$

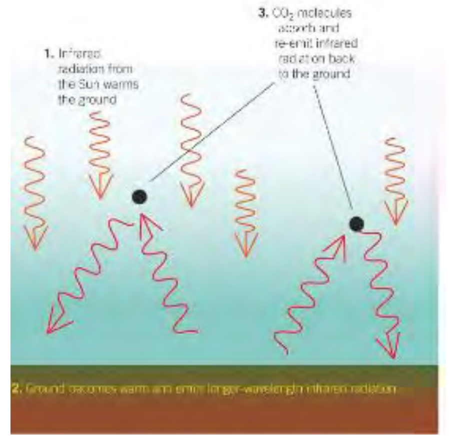
- Measuring specific heat capacity required practical

Energy transfer by conduction-

- Metals are the best conductors of energy and non-metal materials such as wool and fibreglass are the best insulators
- The energy transfer by conduction through a material depends on its thermal conductivity
- The greater the thermal conductivity of a material, the more energy per second it transfers by conduction
- Testing sheets of materials as insulators required practical
- Good insulators need to be materials that have low thermal conductivity
- Energy transfer per s through insulating material depends on the temp. Difference across the material, thickness, thermal conductivity
- To reduce the energy transfer as much as possible, thermal conductivity should be as low as possible, thickness should be as thick as practically possible

Infrared radiation-

- All objects emit and absorb infrared radiation
- The higher the temperature of the object,the more infrared radiation it emits in a given time
- Blackbody radiation is radiation emitted by a body that absorbs all the radiation incident on it
- An object that has constant temperature emits radiation across a continuous range of wavelengths
- The temperature of an object increases if it absorbs more radiation than it emits
- The Earth's temperature depends on a lot of factors, including the absorption of infrared radiation from the sun, and emission of radiation from the Earth's surface and atmosphere



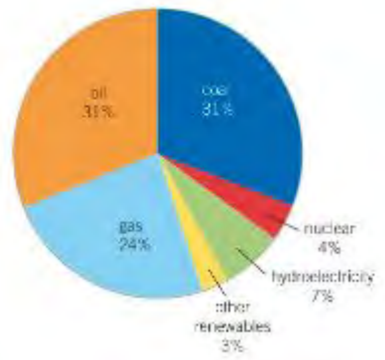
P3 : Energy resources

Big energy issues-

- Gas-fired power stations and pumped-storage situations can meet variations in demand
- Nuclear power stations are expensive to build, run, and decommission
- Carbon capture of fossil fuel emissions is likely to be very expensive, and renewable resources are cheap to run but expensive to install
- Nuclear power stations, fossil-fuel power stations that use carbon capture technology and renewable energy resources are likely to be needed for future energy supplies

Energy demands-

- The main energy resources available for use on Earth include: fossil fuels, nuclear fuels, biofuels, wind, hydroelectricity, geothermal, tides, sun, water waves
- In coal or oil-fired power stations, burning fuel heats water in a boiler, produces steam, this drives a turbine that turns an electricity generator
- A biofuel is any fuel taken from living or recently living organisms, examples are ethanol, straw, nutshells, and woodchip
- A biofuel is renewable because its biological source regrows or continually produced, and carbon-neutral because it releases the same amount of C02 into the atmosphere as the crops absorbed for photosynthesis when they were growing
- Nuclear fuel takes energy from atoms
- Uranium or plutonium is used as the fuel in a nuclear power station, more energy is released per kg from uranium or plutonium than from fossil fuels



Energy and the environment-

- Burning of fossil fuels produce increased levels of greenhouse gases, causing global warming
- Nuclear fuels produce radioactive waste
- Advantages - no greenhouse gases, more energy is transferred than ff
- Disadvantages - contains radioactive waste so has to be stored safely for centuries, nuclear reactor may cause an explosion
- Renewable energy sources and the environment
- Advantages - will never run out as replenished by natural processes, don't produce greenhouse gases or acid rain, don't create radioactive waste
- Disadvantages - not able to meet the world demand, tidal barrages affect habitats, hydroelectric schemes need large reservoirs of water and can flood habitats, some renewable energy resources are not available all the time and unreliable

Energy from wind and water/power from the Sun and Earth-

- Wind power - force of the wind drives the turbine blades around, this turns a generator so generates electricity, power increases as wind speed increases
- Wave power - wave generator uses waves to make a floating generator move up and down, motion turns generator so generates electricity
- Hydroelectric power - generated when rainwater that's collected in a reservoir flows downhill, flowing water drives turbines that turn electricity generators
- Tidal power - traps water from each high tide behind a barrage, high tide released into the sea through the turbines, these drive generators in the barrage
- Solar cells are flat solid cells and use the sun's energy to generate electricity directly, solar heating panels use sun's energy to heat water directly
- Solar cells - useful when small amounts of electricity are needed, expensive to buy, lots of them are needed and plenty of sunshine
- Geothermal energy comes from energy released by radioactive substances deep within the Earth, energy transferred from the substances heats the surrounding rock