Edexcel GCSE Physics

Topic 3: Conservation of Energy

Notes

(Content in bold is for Higher Tier only)

$$\Delta GPE = mg\Delta h$$

- The equation is used to work out the change in GPE as an object is moved from one height to another.
- Change in gravitational potential energy (joule, J) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg) × change in vertical height (metre, m).

$$KE = \frac{1}{2}mv^2$$

- The equation is used to calculate the amounts of energy associated with a moving object.
- Kinetic energy (joule, J) = ½ x mass (kilogram, kg) × (speed)^2 (metre/second^2, m/s^2)

Energy Transfer

- Diagrams show energy input, and the energy output
  - And the forms that the energy takes
  - This includes the waste output energy too
  - Motors also waste energy as heat

Energy Changes

- Object projected upwards
  - KE transferred to GPE, then vice versa as it falls back down
- Object projected up a slope
  - KE transferred to GPE (and also to heat if friction is present)
- Moving object hitting an obstacle
  - KE transferred to sound / KE transferred to obstacle if that moves too
- Object being accelerated by a constant force
  - Object is having work done to it, with it gaining KE
  - Whatever supplies the force is having its energy transferred to KE
- Vehicle slowing down
  - KE transferred to heat (through brakes)
- Boiling water in kettle
  - Electrical energy to thermal

Conservation of Energy

- In physics, conservation of energy means that the total energy of an isolated system remains constant.
- A 'closed system' has no external forces acting on it (e.g. no change in gravitational force, no electrostatic attraction, no external magnetic force etc.)
- In a closed system, the total energy in the system never changes, regardless of the energy transfers that take place
  - In other words, in a closed system no energy is lost
- Once it becomes an open system, energy can be transferred out of the system, and therefore the total energy of the system can change

Mechanical Waste Energy

- In mechanical processes (i.e. where forces are involved on objects)
  - Energy transferred to it can cause a rise in temperature
- So energy is dissipated to surroundings (heat is transferred to air)
  - And this makes the process wasteful

Waste Energy

- Forms: Light, sound, (most commonly) heat
- To reduce waste:
  - Lubricate systems, so less friction and less heat created
  - Thermal insulation, so less heat is lost to surroundings
- Buildings
  - Thicker walls mean greater thermal insulation, so less heat is lost
  - Air cavities between walls causes lots of heat loss by convection - cavity wall insulation fills in this gap and prevents air flow

Efficiency

- Ratio of useful output over total input of energy
- $\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$

Efficiency can be increased by:

- **Reducing waste output (via lubrication/thermal insulation or other methods)**
- **Recycling waste output and using it as input (absorbing heat energy dissipated and used to as input heat energy)**
- **Suitable methods depend on each situation**

Energy Sources

- Fossil Fuels
- Nuclear Fuel
- Bio-Fuel
- Wind
- Hydro-electricity
- Tidal
- Solar

Non-renewable energy is used more for large-scale energy supplies due to the large energy output per kilogram of fuel – renewable resources cannot provide such a large amount of energy as easily

- Renewable energy has become more important due to the finite lifetime of fossil fuels, and so their development has become more important

Patterns and trends in the use of energy resources

- During industrial revolution, fossil fuels became an important source of energy as it was easy to mine, and provided a lot of energy
- Only recently has renewable energy become more suitable – technology has had to develop a lot since industrial revolution to be able to harness such energy sources efficiently