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AQA Physics

Energy

Energy stores and systems

A system is an object or a group of objects.

These systems have energy.

Energy can be transferred between these stores of energy.

The energy stores are:

- Kinetic - Movement
- Gravitational potential – When an object is lifted up
- Thermal – Stored as heat
- Vibrational – Particles moving to and fro
- Electric and magnetic – Stored when a charged particle is moved within an electric or magnetic field
- Nuclear – Stored within the nucleus of an atom
- Chemical – Stored within the bonds of atoms
- Elastic potential – When an object is stretched

Examples

A ball thrown in the air

System – the ball

Energy stores - Kinetic energy → Gravitational potential energy → Kinetic energy

A car slowing down

System – The car

Energy stores - Kinetic energy → Thermal energy (in the brakes)

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Changes in energy

Energy can never be created or destroyed, only transferred.

Kinetic energy

[You need to remember this equation for the exam!]

Kinetic energy = 0.5 × mass × (speed)^2

($E_k = \frac{1}{2}mv^2$)

Kinetic energy - E_k - measured in Joules (J)

Mass - m - measured in kilograms (kg)

Speed - v - measures in meters per second (m/s)

Example

The mass of the cyclist is 80 kg. The speed of the cyclist is 12 m/s.

Calculate the kinetic energy of the cyclist.

Step 1 - Write out the equation

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

Step 2 - Write down what you know

E_k = ?

m = 80kg

v = 10m/s

Step 3 - Put the numbers into the equation

$$E_k = \frac{1}{2} \times 80 \times 10^2$$

Step 4 - Solve for E_k

$$E_k = \frac{1}{2} \times 80 \times 10^2$$

$$E_k = \frac{1}{2} \times 80 \times 100$$

$$E_k = \frac{1}{2} \times 8000$$

$$E_k = 4000J$$

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Elastic potential energy

[This equation is given in the exam]

Elastic potential energy = 0.5 × spring constant × (extension)^2

$(E_e = \frac{1}{2}ke^2)$

Elastic potential energy – E_e – measured in Joules (J)

Spring constant – k – measured in newtons per meter (N/m)

Extension – e – measured in meters (m)

Example

At the lowest point in a jump when the student is stationary, the extension of the bungee cord is 35 metres.

The bungee cord behaves like a spring with a spring constant of 40 N / m.

Calculate the energy stored in the stretched bungee cord.

Use the correct equation from the Physics Equations Sheet.

Step 1 - Write out the equation

$$E_e = \frac{1}{2}ke^2$$

Step 2 - Write down what you know

E_e = ?

k = 40N/m

e = 35m

Step 3 - Put the numbers into the equation

$$E_e = \frac{1}{2} \times 40 \times 35^2$$

Step 4 - Solve for E_e

$$E_e = \frac{1}{2} \times 40 \times 35^2$$

$$E_e = \frac{1}{2} \times 40 \times 1225$$

$$E_e = \frac{1}{2} \times 49000$$

$$E_e = 24500J$$

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Gravitational potential energy

[You need to remember this equation for the exam!]

Gravitational potential energy = mass × gravitational field strength × height

$(E_g = mgh)$

Gravitational potential energy - E_g - measured in Joules (J)

Mass - m - measured in kilograms (kg)

Gravitational field strength - g - measured in newtons per kilogram (N/kg)

Height - h - measured in meters (m)

Example

A basket of apples with a mass of 9kg is lifted 1.2m off the ground onto a bench. What is the change in gravitational potential energy?

Assume gravity to be 9.8 N/kg

Step 1 - Write out the equation

$E_g = mgh$

Step 2 - Write down what you know

E_g = ?

m = 9kg

g = 9.8N/kg

h = 1.2m

Step 3 - Put the numbers into the equation

$E_g = 9 \times 9.8 \times 1.2$

Step 4 - Solve for E_g

$E_g = 9 \times 9.8 \times 1.2$

$E_g = 9 \times 11.76$

$E_g = 105.84\text{J}$

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Energy changes in systems

Specific Heat Capacity (SHC)

[This equation is given in the exam]

Change in thermal energy store = mass × Specific heat capacity × temperature change

$(\Delta E = mc\Delta\theta)$

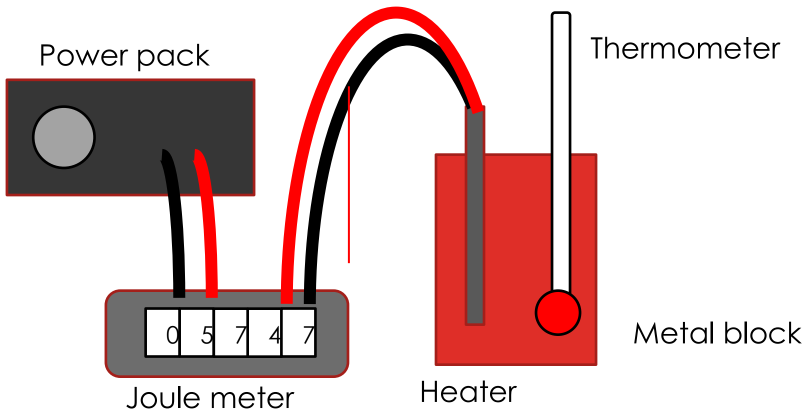
Change in thermal energy store - ΔE - measured in Joules (J)

Mass - m - measured in kilograms (kg)

Specific heat capacity - c - measured in Joules per kilogram per degree Celsius (J/kg^{o}C)

Temperature change - Δθ - measured in Degrees Celsius (^{o}C)

Required Practical



1. Connect the equipment as shown in the diagram
2. Record the mass of the metal block
3. Take the initial temperature of the metal block
4. Ensure the Joule meter is on zero
5. Turn the power pack on for 10 minutes
6. Record the final temperature of the metal block
7. Calculate the change in temperature by taking the final temperature away from the initial temperature
8. Record the energy used on the Joule meter
9. Use the equation $c = \frac{\Delta E}{m\Delta\theta}$ to calculate the specific heat capacity of the metal

Example

The electric kettle shown below is used to boil water.

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After the water has boiled, the temperature of the water decreases by 22 °C.

The mass of water in the kettle is 0.50 kg.

The specific heat capacity of water is 4200 J/kg °C.

Calculate the energy transferred to the surroundings from the water.

Step 1 - Write out the equation

$\Delta E = mc\Delta\theta$

Step 2 - Write down what you know

ΔE = ?

m = 0.50kg

c = 4200J/kg°C

Δθ = 22°C

Step 3 - Put the numbers into the equation

$\Delta E = 0.50 \times 4200 \times 22$

Step 4 - Solve for ΔE

$\Delta E = 0.50 \times 4200 \times 22$

$\Delta E = 2100 \times 22$

$\Delta E = 46200J$

Power

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

Power

[You need to remember these equations for the exam!]

$$power = \frac{energy\ transferred}{time}$$

$$P = \frac{E}{t}$$

Power - P - measured in watts (W)

Energy transferred - E - measured in Joules (J)

Time - t - measured in seconds (s)

$$power = \frac{work\ done}{time}$$

$$P = \frac{W}{t}$$

Power - P - measured in watts (W)

Work done - W - measured in Joules (J)

Time - t - measured in seconds (s)

An energy transfer of 1 Joule per second is equal to 1 watt.

Example

The motor in a lift does 120 000 J of work in 8.0 seconds.

Calculate the power output of the motor in the lift.

Step 1 - Write out the equation

$$P = \frac{W}{t}$$

Step 2 - Write down what you know

P = ?

W = 120000J

T = 8.0s

Step 3 - Put the numbers into the equation

$$P = \frac{120000}{8.0}$$

Step 4 - Solve for P

$$P = \frac{120000}{8.0}$$

$$P = 15000w$$

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