Year 3 Physics Half-Term 1

HT1 **Energy – Energy Stores and Transfers; Kinetic and Potential Energy; Specific Heat Capacity; Power**

4.1 Energy

The concept of energy emerged in the 19th century. The idea was used to explain the work output of steam engines and then generalised to understand other heat engines. It also became a key tool for understanding chemical reactions and biological systems.

Limits to the use of fossil fuels and global warming are critical problems for this century. Physicists and engineers are working hard to identify ways to reduce our energy usage.

4.1.1.1 Energy stores and systems

Content
A system is an object or group of objects. There are changes in the way energy is stored when a system changes. Students should be able to describe all the changes involved in the way energy is stored when a system changes, for common situations. For example: • an object projected upwards • a moving object hitting an obstacle • an object accelerated by a constant force • a vehicle slowing down • bringing water to a boil in an electric kettle. Throughout this section on Energy students should be able to calculate the changes in energy involved when a system is changed by: • heating • work done by forces • work done when a current flows
• use calculations to show on a common scale how the overall energy in a system is redistributed when the system is changed.

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4.1.1.2 Changes in energy

Content
Students should be able to calculate the amount of energy associated with a moving object, a stretched spring and an object raised above ground level.
The kinetic energy of a moving object can be calculated using the equation:

$kinetic\ energy = 0.5 \times mass \times (speed)^2$

$[E_k = \frac{1}{2} m v^2]$

kinetic energy, E_k, in joules, J

mass, m, in kilograms, kg

speed, v, in metres per second, m/s

The amount of elastic potential energy stored in a stretched spring can be calculated using the equation:

$elastic\ potential\ energy = 0.5 \times spring\ constant \times (extension)^2$

$[E_e = \frac{1}{2} k e^2]$

(assuming the limit of proportionality has not been exceeded)

elastic potential energy, E_e, in joules, J

spring constant, k, in newtons per metre, N/m

extension, e, in metres, m

The amount of gravitational potential energy gained by an object raised above ground level can be calculated using the equation:

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

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

gravitational potential energy, E_p, in joules, J

mass, m, in kilograms, kg

gravitational field strength, g, in newtons per kilogram, N/kg (In any calculation the value of the gravitational field strength (g) will be given.)

height, h, in metres, m

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4.1.1.3 Energy changes in systems

Content
The amount of energy stored in or released from a system as its temperature changes can be calculated using the equation:
$change\ in\ thermal\ energy = mass \times specific\ heat\ capacity \times temperature\ change$ $[\Delta E = m\ c\ \Delta\theta]$ change in thermal energy, ΔE, in joules, J mass, m, in kilograms, kg specific heat capacity, c, in joules per kilogram per degree Celsius, J/kg °C temperature change, $\Delta\theta$, in degrees Celsius, °C The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.

Required practical activity 1: investigation to determine the specific heat capacity of one or more materials. The investigation will involve linking the decrease of one energy store (or work done) to the increase in temperature and subsequent increase in thermal energy stored.

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4.1.1.4 Power

Content
Power is defined as the rate at which energy is transferred or the rate at which work is done. $power = \frac{energy\ transferred}{time}$ $\left[P = \frac{E}{t}\right]$ $power = \frac{work\ done}{time}$ $\left[P = \frac{W}{t}\right]$ power, P, in watts, W energy transferred, E, in joules, J time, t, in seconds, s work done, W, in joules, J An energy transfer of 1 joule per second is equal to a power of 1 watt. Students should be able to give examples that illustrate the definition of power eg comparing two electric motors that both lift the same weight through the same height but one does it faster than the other.

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