KESTEVEN AND SLEAFORD HIGH SCHOOL

Physics Scheme of Learning

P2: Energy Transfer by Heating

Intent – Rationale

This topic takes a more in depth look at heat energy. Properties of conducting and insulating materials are examined and students gain an appreciation for why different materials have differing conductivities. Students learn to link thermal conductivity with rate of heat transfer, and how this can be used to our advantage in many real-life applications, e.g. insulating housing. Students examine infrared radiation, discussing that all objects can emit and absorb infrared radiation, and that we associate infrared radiation with the temperature of an object. Students complete a practical in which they predict the best absorber and emitter in order to learn about black body radiators. Students are shown that infrared radiation is a key part in maintaining the temperature of the Earth.
Students complete a practical to measure the specific heat capacity of a block of aluminium metal, to demonstrate to them how we can quantify and experimentally determine how much energy we need to add to a material in order to raise its temperature.

Sequencing – what prior learning does this topic build upon?	Sequencing – what subsequent learning does this topic feed into?
KS3 Topic 1 Energy transfers **KS3 Topic 3 Energy resources** **KS3 Topic 8 Waves and sound** **KS3 Topic 11 Heat transfer** **KS4 P1 Conservation and dissipation of energy**	• P3 Energy resources • P6 Molecules and matter • P7 Radioactivity • P12 Wave properties • P13 Electromagnetic waves
What are the links with other subjects in the curriculum?	**What are the links to SMSC, British Values and Careers?**
• Base the content here on what you already know but there will be time in future to liaise further as part of our collaborative work	• Use the coded help guides to complete this section
What are the opportunities for developing literacy skills and developing learner confidence and enjoyment in reading?	**What are the opportunities for developing mathematical skills?**
FROM THE LIBRARY *A Dictionary of Physics*-530.03 *Energy From Fossil Fuels*-620 *Energy*; Louise Spilsbury-530 *Energy*; Chris oxlade-531 *Energy and Chemical Change*; Brian Knapp-531 *Energy and Cells*; C Gayford-571.6 *Energy Alternatives*; Robert Sneddon-620	• Calculation of specific heat capacity • Unit prefixes • Rearranging equations • Calculating costs versus savings of home improvements (e.g. insulation)

Physics Scheme of Learning

P2: Energy Transfer by Heating

Intent – Concepts

What knowledge will students gain and what skills will they develop as a consequence of this topic?

Know

- Describe materials as good or poor thermal conductors
- Compare the thermal conductivities of materials in simple terms.
- Relate thermal conductivities of a material to its uses in familiar contexts.
- State that an object cools by emitting IR radiation and heats by absorbing IR radiation.
- Measure the difference in cooling of objects of different colours.
- Describe the cooling of objects in terms of the rate of emission of radiation.
- Describe the heating of objects in terms of the rate of absorption of radiation.
- Describe the cooling of an object over a period of time.
- State that infrared radiation is electromagnetic radiation with a wavelength shorter than red light.
- State that an object cools by emitting infrared radiation and heats by absorbing infrared radiation.
- Describe materials in terms of being difficult or easy to heat up (increase the temperature of).
- State the factors that affect the amount of energy required to increase the temperature of an object.
- State some design features used to prevent energy transfer to the surroundings in the home.
- Calculate the payback time of a simple home improvement feature.

Apply

- Analyse temperature change data to compare the thermal conductivity of materials.
- Describe the changes in behaviour of the particles in a material as the temperature of the material increases.
- Apply understanding of thermal conductivity in reducing energy dissipation through the choice of appropriate insulating materials.
- Compare the cooling and heating of different coloured surfaces.
- Apply the concepts of absorption and emission of IR radiation to explain why an object maintains a constant temperature.
- Compare the emission of infrared radiation with a wavelength shorter than red light.
- Outline the evidence that changes in the concentration of atmospheric gases are the likely cause of global warming.
- Describe the greenhouse effect in terms of absorption and emission of radiation.
- Calculate the energy required to change the temperature of an object.

- Measure the specific heat capacity of a material and find a mean value.
- Describe how some design features used to reduce energy dissipation from a home work.
- Compare home improvement features in terms of payback time.

Extend

- Explain the different thermal conductivities of materials using the free electron and lattice vibration explanations of conduction.
- Evaluate the results of an experiment into thermal conductivity in terms of repeatability and reproducibility of data, and the validity of conclusions drawn from the data.
- Justify the choices of material involved in insulation or conduction using the concept of thermal conductivity and other data.
- Explain why objects stop cooling in terms of the rate of absorption and emission of radiation.
- Describe the changes in the rate of cooling of objects of different colours and temperatures.
- Describe factors that affect the rate of emission of infrared radiation, including temperature and surface area.
- Apply the concepts of absorption and emission of infrared radiation to explain why an object maintains a constant temperature.
- Explain the greenhouse effect in terms of absorption, emission, and wavelengths of electromagnetic radiation.
- Evaluate materials used for transferring energy in terms of their specific heat capacity.
- Use the specific heat capacity equation to perform a wide range of calculations in unfamiliar contexts.
- Evaluate in detail the results of an experiment to measure specific heat capacity.
- Evaluate in detail design features used to reduce energy loss from the home.
- Choose home improvement features using payback time and savings beyond the payback time.

What subject specific language will be used and developed in this topic?	What opportunities are available for assessing the progress of students?
• **Black body radiation** The radiation emitted by a perfect black body (a body that absorbs all radiation that hits it). • **Boiling point** The temperature at which a pure substance boils or condenses. • **Density** Mass per unit volume of a substance. • **Dissipation of energy** The energy that is not usefully transferred and stores in less useful ways. • **Errors** Sometimes called uncertainties**.** • **Freezing point** The temperature at which a pure substance freezes or melts. • **Frequency** The number of wave crests passing a fixed point every second. • **Infrared radiation** Electromagnetic waves between visible light and microwaves in the electromagnetic spectrum • **Microwaves** Electromagnetic waves between infrared radiation and radio waves in the electromagnetic spectrum. • **Specific heat capacity** Energy needed to raise the temperature of 1kg of a substance by 1°C. • **Systematic errors** Cause readings to be spread around a value other than the true value, due to results differing from the true value by a consistent amount each time the measurement is made. • **Transmission** A wave passing through a substance. • **Wave speed** The distance travelled per second by a wave crest or trough. • **Wavelength** The distance from one wave crest to the next.	• Assessed homework 1 (Home insulation) - assesses students' ability to: o Perform energy calculations o Compare different insulation methods o Make a judgement about the best way to insulate a building in terms of cost effectiveness • Assessed homework 2 (Vacuum flask) – assess students' ability to: o Explain physics concepts using key terminology (e.g. radiation, transmission, etc) and good prose o Explain how the transmission rate of infrared radiation is affected by (a) different coloured surfaces and (b) a vacuum.

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Intent – Concepts

Lesson title	Learning challenge	Higher level challenge	Suggested activities and resources
P2.1 Insulated materials (Core Practical)	• Can I describe materials as good or poor thermal conductors? • Can I compare thermal conductivities of materials?	• Can I investigate which materials make the best insulators? • Can I evaluate the results of an experiment into thermal conductivity in terms of repeatability and reproducibility of data, and the validity of conclusions drawn from the data?	
P2.2 Heat, temperature and conduction	• Can I compare the heating and cooling of different coloured surfaces? • Can I describe the cooling of objects in terms of the rate of emission of radiation?	• Can I justify the choices of material involved in insulation or conduction using the concept of thermal conductivity and other data?	
P2.3a Radiation and the greenhouse effect	• Can I state that infrared radiation is electromagnetic radiation with a wavelength shorter than red light? • Can I state that an object cools by emitting infrared radiation and heats by absorbing infrared radiation?	• Can I describe factors that affect the rate of emission of infrared radiation, including temperature and surface area?	
P2.4 Radiation and the greenhouse effect (Part 2)	• Can I describe the greenhouse effect in simple terms? • Can I outline evidence that changes in the concentration of atmospheric gases are the likely cause of global warming?	• Can I fully explain the greenhouse effect in terms of absorption, emission and wavelengths of electromagnetic radiation?	
P2.5 Specific heat capacity	• Can I calculate the energy required to change the temperature of an object? • Can I describe the effects of changing the different factors involved in the specific heat capacity equation?	• Can I evaluate materials used for transferring energy in terms of their specific heat capacity? • Can I use the specific heat capacity equation to perform a wide range of calculations in unfamiliar contexts?	
P2.6 Specific heat capacity (Core Practical)	• Can I measure the specific heat capacity of a material and find a mean value?	• Can I evaluate in detail the results of an experiment to measure specific heat capacity?	
P2.7 Insulated buildings	• Can I describe how some design features help to reduce the energy dissipation from a home? • Can I compare home improvement features in terms of payback time?	• Can I evaluate in detail design features used to reduce energy loss from the home? • Can I decide on home improvement features using payback time and savings beyond the payback time?	
Revision			
Assessment			