

1.7 Energy, work and power continued

1.7.4 Power

Core

- 1 Define power as work done per unit time and also as energy transferred per unit time; recall and use the equations

$$(a) P = \frac{W}{t}$$

$$(b) P = \frac{\Delta E}{t}$$

Supplement

1.8 Pressure

Core

- 1 Define pressure as force per unit area; recall and use the equation

$$p = \frac{F}{A}$$

- 2 Describe how pressure varies with force and area in the context of everyday examples
 3 Describe, qualitatively, how the pressure beneath the surface of a liquid changes with depth and density of the liquid

Supplement

- 4 Recall and use the equation for the change in pressure beneath the surface of a liquid

$$\Delta p = \rho g \Delta h$$

2 Thermal physics

2.1 Kinetic particle model of matter

2.1.1 States of matter

Core

- 1 Know the distinguishing properties of solids, liquids and gases
 2 Know the terms for the changes in state between solids, liquids and gases (gas to solid and solid to gas transfers are **not** required)

Supplement

2.1 Kinetic particle model of matter continued

2.1.2 Particle model

Core

- 1 Describe the particle structure of solids, liquids and gases in terms of the arrangement, separation and motion of the particles and represent these states using simple particle diagrams
- 2 Describe the relationship between the motion of particles and temperature, including the idea that there is a lowest possible temperature (-273°C), known as absolute zero, where the particles have least kinetic energy
- 3 Describe the pressure and the changes in pressure of a gas in terms of the motion of its particles and their collisions with a surface
- 4 Know that the random motion of microscopic particles in a suspension is evidence for the kinetic particle model of matter
- 5 Describe and explain this motion (sometimes known as Brownian motion) in terms of random collisions between the microscopic particles in a suspension and the particles of the gas or liquid

Supplement

- 6 Know that the forces and distances between particles (atoms, molecules, ions and electrons) and the motion of the particles affects the properties of solids, liquids and gases
- 7 Describe the pressure and the changes in pressure of a gas in terms of the forces exerted by particles colliding with surfaces, creating a force per unit area
- 8 Know that microscopic particles may be moved by collisions with light fast-moving molecules and correctly use the terms atoms or molecules as distinct from microscopic particles

2.1.3 Gases and the absolute scale of temperature

Core

- 1 Describe qualitatively, in terms of particles, the effect on the pressure of a fixed mass of gas of:
 - (a) a change of temperature at constant volume
 - (b) a change of volume at constant temperature
- 2 Convert temperatures between kelvin and degrees Celsius; recall and use the equation

$$T \text{ (in K)} = \theta \text{ (in }^{\circ}\text{C)} + 273$$

Supplement

- 3 Recall and use the equation

$$\rho V = \text{constant}$$
 for a fixed mass of gas at constant temperature, including a graphical representation of this relationship

2.2 Thermal properties and temperature

2.2.1 Thermal expansion of solids, liquids and gases

Core

- 1 Describe, qualitatively, the thermal expansion of solids, liquids and gases at constant pressure
- 2 Describe some of the everyday applications and consequences of thermal expansion

Supplement

- 3 Explain, in terms of the motion and arrangement of particles, the relative order of magnitudes of the expansion of solids, liquids and gases as their temperatures rise

2.2.2 Specific heat capacity

Core

- 1 Know that a rise in the temperature of an object increases its internal energy

Supplement

- 2 Describe an increase in temperature of an object in terms of an increase in the average kinetic energies of all of the particles in the object
- 3 Define specific heat capacity as the energy required per unit mass per unit temperature increase; recall and use the equation

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

- 4 Describe experiments to measure the specific heat capacity of a solid and a liquid

2.2.3 Melting, boiling and evaporation

Core

- 1 Describe melting and boiling in terms of energy input without a change in temperature
- 2 Know the melting and boiling temperatures for water at standard atmospheric pressure
- 3 Describe condensation and solidification in terms of particles
- 4 Describe evaporation in terms of the escape of more-energetic particles from the surface of a liquid
- 5 Know that evaporation causes cooling of a liquid

Supplement

- 6 Describe the differences between boiling and evaporation
- 7 Describe how temperature, surface area and air movement over a surface affect evaporation
- 8 Explain the cooling of an object in contact with an evaporating liquid

2.3 Transfer of thermal energy

2.3.1 Conduction

Core

- Describe experiments to demonstrate the properties of good thermal conductors and bad thermal conductors (thermal insulators)

Supplement

- Describe thermal conduction in all solids in terms of atomic or molecular lattice vibrations and also in terms of the movement of free (delocalised) electrons in metallic conductors
- Describe, in terms of particles, why thermal conduction is bad in gases and most liquids
- Know that there are many solids that conduct thermal energy better than thermal insulators but do so less well than good thermal conductors

2.3.2 Convection

Core

- Know that convection is an important method of thermal energy transfer in liquids and gases
- Explain convection in liquids and gases in terms of density changes and describe experiments to illustrate convection

Supplement

2.3.3 Radiation

Core

- Know that thermal radiation is infrared radiation and that all objects emit this radiation
- Know that thermal energy transfer by thermal radiation does not require a medium
- Describe the effect of surface colour (black or white) and texture (dull or shiny) on the emission, absorption and reflection of infrared radiation

Supplement

- Know that for an object to be at a constant temperature it needs to transfer energy away from the object at the same rate that it receives energy
- Know what happens to an object if the rate at which it receives energy is less or more than the rate at which it transfers energy away from the object
- Know how the temperature of the Earth is affected by factors controlling the balance between incoming radiation and radiation emitted from the Earth's surface

continued

2.3 Transfer of thermal energy continued

2.3.3 Radiation continued

Core

Supplement

- 7 Describe experiments to distinguish between good and bad emitters of infrared radiation
- 8 Describe experiments to distinguish between good and bad absorbers of infrared radiation
- 9 Describe how the rate of emission of radiation depends on the surface temperature and surface area of an object

2.3.4 Consequences of thermal energy transfer

Core

- 1 Explain some of the basic everyday applications and consequences of conduction, convection and radiation, including:
 - (a) heating objects such as kitchen pans
 - (b) heating a room by convection

Supplement

- 2 Explain some of the complex applications and consequences of conduction, convection and radiation where more than one type of thermal energy transfer is significant, including:
 - (a) a fire burning wood or coal
 - (b) a radiator in a car

3 Waves

3.1 General properties of waves

Core

Supplement

- 1 Know that waves transfer energy without transferring matter
- 2 Describe what is meant by wave motion as illustrated by vibrations in ropes and springs, and by experiments using water waves
- 3 Describe the features of a wave in terms of wavefront, wavelength, frequency, crest (peak), trough, amplitude and wave speed
- 4 Recall and use the equation for wave speed

$$v = f\lambda$$
- 5 Know that for a transverse wave, the direction of vibration is at right angles to the direction of propagation and understand that electromagnetic radiation, water waves and seismic S-waves (secondary) can be modelled as transverse

continued

3.1 General properties of waves continued

Core

- 6 Know that for a longitudinal wave, the direction of vibration is parallel to the direction of propagation and understand that sound waves and seismic P-waves (primary) can be modelled as longitudinal
- 7 Describe how waves can undergo:
 - (a) reflection at a plane surface
 - (b) refraction due to a change of speed
 - (c) diffraction through a narrow gap
- 8 Describe the use of a ripple tank to show:
 - (a) reflection at a plane surface
 - (b) refraction due to a change in speed caused by a change in depth
 - (c) diffraction due to a gap
 - (d) diffraction due to an edge

Supplement

- 9 Describe how wavelength and gap size affects diffraction through a gap
- 10 Describe how wavelength affects diffraction at an edge

3.2 Light

3.2.1 Reflection of light

Core

- 1 Define and use the terms normal, angle of incidence and angle of reflection
- 2 Describe the formation of an optical image by a plane mirror and give its characteristics, i.e. same size, same distance from mirror, virtual
- 3 State that for reflection, the angle of incidence is equal to the angle of reflection; recall and use this relationship

Supplement

- 4 Use simple constructions, measurements and calculations for reflection by plane mirrors