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

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

Supplement

continued

3.1 General properties of waves continued

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

3.2 Light

3.2.1 Reflection of light

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

3.2 Light continued

3.2.2 Refraction of light

Core	Supplement
1 Define and use the terms normal, angle of incidence and angle of refraction	
2 Describe an experiment to show refraction of light by transparent blocks of different shapes	6 Define refractive index, n, as the ratio of the speeds of a wave in two different regions
3 Describe the passage of light through a transparent material (limited to the boundaries between two mediums only)	7 Recall and use the equation $n = \frac{\sin i}{\sin r}$
4 State the meaning of critical angle	8 Recall and use the equation $n = \frac{1}{\sin c}$
5 Describe internal reflection and total internal reflection using both experimental and everyday examples	9 Describe the use of optical fibres, particularly in telecommunications

3.2.3 Thin lenses

Core	Supplement
1 Describe the action of thin converging and thin diverging lenses on a parallel beam of light	
2 Define and use the terms focal length, principal axis and principal focus (focal point)	
3 Draw and use ray diagrams for the formation of a real image by a converging lens	6 Draw and use ray diagrams for the formation of a virtual image by a converging lens
4 Describe the characteristics of an image using the terms enlarged/same size/diminished, upright/inverted and real/virtual	7 Describe the use of a single lens as a magnifying glass
5 Know that a virtual image is formed when diverging rays are extrapolated backwards and does not form a visible projection on a screen	
	8 Describe the use of converging and diverging lenses to correct long-sightedness and short-sightedness

3.2.4 Dispersion of light

Core	Supplement
1 Describe the dispersion of light as illustrated by the refraction of white light by a glass prism	
2 Know the traditional seven colours of the visible spectrum in order of frequency and in order of wavelength	3 Recall that visible light of a single frequency is described as monochromatic

3.3 Electromagnetic spectrum

Core

1 Know the main regions of the electromagnetic spectrum in order of frequency and in order of wavelength

2 Know that all electromagnetic waves travel at the same high speed in a vacuum

3 Describe typical uses of the different regions of the electromagnetic spectrum including:

- (a) radio waves; radio and television transmissions, astronomy, radio frequency identification (RFID)
- (b) microwaves; satellite television, mobile phones (cell phones), microwave ovens
- (c) infrared; electric grills, short range communications such as remote controllers for televisions, intruder alarms, thermal imaging, optical fibres
- (d) visible light; vision, photography, illumination
- (e) ultraviolet; security marking, detecting fake bank notes, sterilising water
- (f) X-rays; medical scanning, security scanners
- (g) gamma rays; sterilising food and medical equipment, detection of cancer and its treatment

4 Describe the harmful effects on people of excessive exposure to electromagnetic radiation, including:

- (a) microwaves; internal heating of body cells
- (b) infrared; skin burns
- (c) ultraviolet; damage to surface cells and eyes, leading to skin cancer and eye conditions
- (d) X-rays and gamma rays; mutation or damage to cells in the body

Supplement

6 Know that the speed of electromagnetic waves in a vacuum is $3.0 \times 10^8 \text{ m/s}$ and is approximately the same in air

continued

3.3 Electromagnetic spectrum continued

Core

5 Know that communication with artificial satellites is mainly by microwaves:
   (a) some satellite phones use low orbit artificial satellites
   (b) some satellite phones and direct broadcast satellite television use geostationary satellites

Supplement

7 Know that many important systems of communications rely on electromagnetic radiation including:
   (a) mobile phones (cell phones) and wireless internet use microwaves because microwaves can penetrate some walls and only require a short aerial for transmission and reception
   (b) Bluetooth uses radio waves because radio waves pass through walls but the signal is weakened on doing so
   (c) optical fibres (visible light or infrared) are used for cable television and high-speed broadband because glass is transparent to visible light and some infrared; visible light and short wavelength infrared can carry high rates of data
8 Know the difference between a digital and analogue signal
9 Know that a sound can be transmitted as a digital or analogue signal
10 Explain the benefits of digital signalling including increased rate of transmission of data and increased range due to accurate signal regeneration

3.4 Sound

Core

1 Describe the production of sound by vibrating sources
2 Describe the longitudinal nature of sound waves
3 State the approximate range of frequencies audible to humans as 20 Hz to 20 000 Hz
4 Know that a medium is needed to transmit sound waves
5 Know that the speed of sound in air is approximately 330–350 m / s

Supplement

10 Describe compression and rarefaction
11 Know that, in general, sound travels faster in solids than in liquids and faster in liquids than in gases

continued

3.4 Sound continued

Core	Supplement
6 Describe a method involving a measurement of distance and time for determining the speed of sound in air	
7 Describe how changes in amplitude and frequency affect the loudness and pitch of sound waves	
8 Describe an echo as the reflection of sound waves	
9 Define ultrasound as sound with a frequency higher than 20 kHz	12 Describe the uses of ultrasound in non-destructive testing of materials, medical scanning of soft tissue and sonar including calculation of depth or distance from time and wave speed

4 Electricity and magnetism

4.1 Simple phenomena of magnetism

Core	Supplement
1 Describe the forces between magnetic poles and between magnets and magnetic materials, including the use of the terms north pole (N pole), south pole (S pole), attraction and repulsion, magnetised and unmagnetised	10 Explain that magnetic forces are due to interactions between magnetic fields
2 Describe induced magnetism	
3 State the differences between the properties of temporary magnets (made of soft iron) and the properties of permanent magnets (made of steel	
4 State the difference between magnetic and non-magnetic materials	
5 Describe a magnetic field as a region in which a magnetic pole experiences a force	
6 Draw the pattern and direction of magnetic field lines around a bar magnet	11 Know that the relative strength of a magnetic field is represented by the spacing of the magnetic field lines
7 State that the direction of a magnetic field at a point is the direction of the force on the N pole of a magnet at that point	
8 Describe the plotting of magnetic field lines with a compass or iron filings and the use of a compass to determine the direction of the magnetic field	
9 Describe the uses of permanent magnets and electromagnets	