

Solutions

2.1 It emits more infrared in a given time.

2.2 An object that absorbs all the radiation incident on it, reflecting and transmitting none.

2.3 The temperature rises: the energy arriving exceeds the energy leaving, so the internal energy of the body increases.

3.1 (a) The black cube: it absorbs the radiation better than the white surface, which reflects more. (b) Each cube now absorbs at the same rate as it emits; constant temperature means the two rates balance. (c) A good absorber is a good emitter: the black cube emits infrared faster, so it loses energy faster and cools quicker.

3.2 (a) The Earth absorbs radiation at (nearly) the same average rate as it emits infrared; the balance keeps the average temperature steady. (b) Ice reflects much of the incoming radiation; dark ocean absorbs it. Absorption rises, so the temperature rises until emission balances again at a higher level – a feedback that amplifies warming. (c) Any one: cloud cover; atmospheric gases (aerosols/particles).

3.3 (a) Intensity increased (doubled); peak wavelength halved. (b) The distribution of wavelengths shifts towards shorter wavelengths: the same total shape moves, so more of the radiation is emitted at shorter wavelength when hotter. (c) A mirror surface is a poor absorber and therefore a poor emitter; it emits much less infrared than the matt black plate, which is close to a perfect black body.