Solutions

Each answer shows the steps, then the **result**.

2.1

- nuclear fusion (of hydrogen nuclei into helium)

2.2

- distance (the distance light travels in one year)

2.3

- a galaxy is a very large group of (billions of) stars held together by gravity
- the Milky Way

2.4

- distance = speed × time, $d = vt$

$$d = vt = (3.0 \times 10^8 \text{ m/s})(500 \text{ s}) = \mathbf{1.5 \times 10^{11}} \text{ m}$$

3.1 B

- redshift shows galaxies are receding – the Universe is expanding

3.2

(a) it swells into a red giant

- throws off its outer layers as a planetary nebula
- leaving a white dwarf

(b) a white dwarf

3.3

(a) age $\approx 1/H_0$

$$\text{age} = \frac{1}{2.2 \times 10^{-18} \text{ s}^{-1}} = \mathbf{4.5 \times 10^{17}} \text{ s}$$

(b) the cosmic microwave background radiation (CMBR)

3.4

- it explodes as a supernova
- forming a nebula containing hydrogen and new, heavier elements
- leaving a neutron star or, for the most massive stars, a black hole

3.5

(a) $H_0 = v/d$

$$H_0 = \frac{v}{d} = \frac{3.1 \times 10^6 \text{ m/s}}{1.4 \times 10^{24} \text{ m}} = \mathbf{2.2 \times 10^{-18}} \text{ s}^{-1}$$

(b) the light from distant galaxies is redshifted, so they are moving away from us

- the further away the galaxy, the greater the redshift and the faster it recedes, so the Universe is expanding from a single starting point