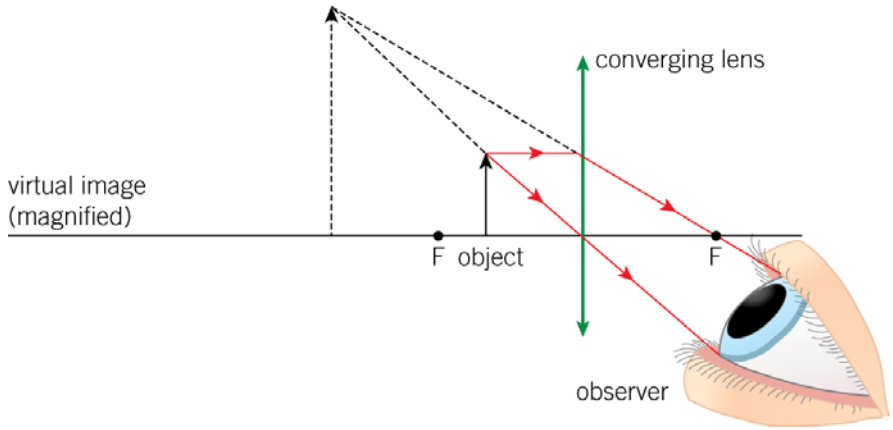
Answers

1.1

1 a The top ray should refract at the lens and pass through F; the bottom ray should refract at the lens and then become parallel to the principal axis; the image should be formed at 1.4(3)*f* on the right-hand side of the lens.

b real, inverted, diminished

2 a



b virtual, magnified, upright

3 a Image distance is 0.240 m from the lens on the opposite side to the object.

b i real

ii inverted

4 a Image distance is −0.300 m from the lens on the same side as the object.

b i virtual

ii upright

1.2

2 b i 7.5

ii 1.13° (1.125° to 4 s.f.)

4 a i 640 mm

ii 680 mm

b i 0.3°

ii $1.4(3) \times 10^4$ m

1.3

4 a 100

b 40

1.4

3 **a** 0.06(3) m

4 **b** 80 m

1.5

2 **a** **i** 2×10^{-5} degree

ii 3×10^{-6} degree

4 **a** 4, 1, $\frac{2}{3}$, 5

2.1

2 **b** **ii** +11.63

3 **b** +5.9 4

4 **b** −23.2

2.2

2 **b** 4700 K

4 **b** 2.0×10^{9} m

2.3

4 **a** Z, Y, X

b X giant; Y main sequence; Z white dwarf,

c $\frac{X}{YZ} = 6300$; $\frac{Y}{Z} = 100$

2.4

4 **b** **i** 3.0 km

ii 1.8×10^{19} kg m^{-3}

c 1.8×10^{5}

3.1

2 1.6×10^4 m s^{-1}

4 **a** 4.0×10^4 m s^{-1}

b 5.0×10^{11} m

3.2

2 **a** 3.9×10^6 m s^{-1}

b 59 Mpc

4 **a** 2500 Mpc

3.3

2 **b** 3.3×10^7 m s^{-1}

3.4

1 An exoplanet is too faint to be seen directly; they are hidden by the glare of light from the parent star.

2 $\frac{\text{depth of the dip}}{\text{maximum intensity}} = 0.25$. Therefore the area of the planet disc $= 0.25 \times$ the area of the star's disc. Because the area of a disc is proportional to the square of its radius, the radius of the planet $= 0.50$ $(= 0.25^{\frac{1}{2}}) \times$ the radius of the star.

3 Radial velocity $= \frac{\Delta\lambda}{\lambda} \times c = \frac{0.033}{550} \times 3.0 \times 10^8 = 1.8 \times 10^4$ m s^{-1}

4 Many rocky planets will not be in the habitable zone around the parent star. This is the zone in which liquid water could exist on the exoplanet. This can happen only if the surface temperature is between the freezing point and the boiling point of water. Outside this temperature range, surface conditions are likely to be very different to the conditions on Earth (apart from Antarctica).