Solutions

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

2.1

- 1 mm = 1000 µm and 1 µm = 1000 nm
- 0.005 mm = **5** µm
- 2 µm = **2000** nm
- 1.5 mm = **1500** µm

2.2

- put both sizes in µm: image = 100 mm = 100 000 µm
- magnification $= \dfrac{\text{image size}}{\text{actual size}}$

$$\frac{100\,000\ \mu\text{m}}{50\ \mu\text{m}} = \times\mathbf{2000}$$

2.3

(a)

- 100 divisions line up with 1.0 mm

$$\frac{1.0\ \text{mm}}{100} = 0.010\ \text{mm} = \mathbf{10}\ \mu\text{m}$$

(b)

- 8 × 10 µm = **80** µm

3.1 B

- actual size $= \dfrac{\text{image size}}{\text{magnification}}$

$$\frac{36\ \text{mm}}{12\,000} = 0.003\ \text{mm} = \mathbf{3}\ \mu\text{m}$$

- D multiplies by the magnification instead of dividing; A is 10× too small; C is 10× too large

3.2 D

- a ribosome (≈ 25 nm) is far below the ≈ 200 nm resolution of a light microscope
- A, B and C are large enough to see with a high-power light microscope

3.3

(a)

- 40 divisions = 0.20 mm

$$\frac{0.20\ \text{mm}}{40} = 0.005\ \text{mm} = \mathbf{5}\ \mu\text{m}$$

(b)

- 2 × 5 µm = **10** µm

3.4

(a)

- put both sizes in µm: image = 80 mm = 80 000 µm

$$\frac{80\,000\ \mu\text{m}}{2.0\ \mu\text{m}} = 40\,000 = \times\mathbf{4.00 \times 10^4}$$

(b)

- the ring cell (2 µm) and its detail are near or below the light microscope's resolution (≈ 200 nm = 0.2 µm)
- the electron microscope has far higher resolution, so it shows the ring cell as a separate, detailed structure

3.5

(a)

- **magnification** is how many times larger the image is than the actual object

(b)

- **resolution** is the smallest distance between two points that can still be seen as two separate points