

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 = $\frac{\text{image size}}{\text{actual size}}$

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

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)

- $8 \times 10\ \mu\text{m} = \mathbf{80}\ \mu\text{m}$

3.1 B

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

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

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

3.2 D

- a ribosome ($\approx 25\ \text{nm}$) is far below the $\approx 200\ \text{nm}$ 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)

- $2 \times 5 \text{ }\mu\text{m} = \mathbf{10 \text{ }\mu\text{m}}$

3.4

(a)

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

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

(b)

- the ring cell (2 μm) and its detail are near or below the light microscope's resolution ($\approx 200 \text{ nm} = 0.2 \text{ }\mu\text{m}$)
- 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