# Chapter 3
## Answers to Questions

1. Accuracy indicates how close measured values are to the true value and precision is how close the measurements are to each other.

2. A random error is a statistical variation in measurements and a systematic error is a consistent factor affecting all measurements equally.

3. (a) metre (b) second (c) candela.

4. (a) kilogram (b) Kelvin (c) Pascal.

5. (a) Mega (b) deci (c) nano

6. (a) $10^3$ (b) $10^{-6}$ (c) $10^{-12}$

7. Precise, because they are consistent among themselves, but not accurate as they are not close to the known value.

8. Accurate, because they average to the known value, but not precise as they are not consistent among themselves.

9. (a) 3 (b) 4 (c) 3 (d) 1

10. (a) 5 (b) 2 (c) 3 (d) 1

11. (a) $8.10\times10^{-4}$ (b) $5.836\times10^{1}$ (c) $1.0000\times10^{2}$

12. (a) $2.0000\times10^{3}$ (b) $4.0\times10^{-1}$ (c) $8.1\times10^{-8}$

13. (a) negative (b) positive

14. (a) right (b) left

15. (a) 0.04030 (b) 162.4 (c) 0.0000398

16. (a) 5987 (b) 0.000006 (c) 0.8112

17. (a) 2.8 (b) 1.5

18. (a) 0.260 (b) 87.4

19. (a) As prefixes come in multiples of $10^3$, the first thing is to "take out" exponents:
$4.28\times10^{-11}$ g = $(4.28\times10^1)\times10^{-12}$ g = $(42.8)\times10^{-12}$ g = 42.8 pg

(b) This exponent is already a multiple of $10^3$:
$2.5\times10^{-6}$ L = $(2.5)\times10^{-6}$ L = 2.5 μL

(c) Again, one power of ten has to be "taken out":
$5.101\times10^4$ m = $(5.101\times10^1)\times10^3$ m = $(51.01)\times10^3$ m = 51.01 km

20. (a) As prefixes come in multiples of $10^3$, the first thing is to "take out" exponents:
$9.27\times10^7$ g = $(9.27\times10^1)\times10^6$ g = $(92.7)\times10^6$ g = 92.7 Mg

(b) Here $10^1$ must be "taken out" to give an exponent which is a multiple of $10^3$:
$6.62\times10^{-8}$ L = $(6.62\times10^1)\times10^{-9}$ L = $(66.2)\times10^{-9}$ L = 66.2 nL

(c) Here $10^2$ must be "taken out" to give an exponent which is a multiple of $10^3$
$9.002\times10^{-7}$ m = $(9.002\times10^2)\times10^{-9}$ m = $(900.2)\times10^{-9}$ m = 900.2 nm
(always "take out" a positive exponent – if you had "taken out" $10^{-2}$, it would have given 0.9002 μm and for prefixes, the numerical value must be greater than one.)

21. (a) $2.17\times10^{-2}$ (b) $1.2\times10^{-1}$ (c) $1.37\times10^1$ (d) $4.4\times10^{-3}$

22. (a) $1.7\times10^{-1}$ (b) $7.7\times10^{-2}$ (c) $3.3\times10^2$ (d) $7.19\times10^4$

23. (a) 15.1 (b) 0.60 (c) 11.30

24. (a) 4.55 (b) 124 (c) 17.08

25. 145.42 g

26. 38.1 g

27. (a)

| Strategy | Relationship |
|---|---|
| vol (mL) → vol (L) | 1 L = 1000 mL |

$$\text{Vol}\ \ \text{mL}\ = 154\ \text{mL} \times \frac{1\ \text{L}}{1000\ \text{mL}} = 0.154\ \text{L}$$

(b)

| Strategy | Relationship |
|---|---|
| mass (kg) → mass (g) | 1 kg = 1000 g |

$$\text{Mass}\ \ \text{g}\ = 0.0680\ \text{kg} \times \frac{1000\ \text{g}}{1\ \text{kg}} = 68.0\ \text{g}$$

28. (a)

| Strategy | Relationship |
|---|---|
| mass (g) → mass (ng) | 1 g = $10^9$ ng |

$$\text{Mass}\ \ \text{ng}\ = 5.47 \times 10^{-8}\ \text{g} \times \frac{10^9\ \text{ng}}{1\ \text{g}} = 54.7\ \text{ng}$$

(b)

| Strategy | Relationship |
|---|---|
| vol (L) → vol (μL) | 1 L = $10^6$ μL |

$$\text{Vol}\ \ \mu\text{L}\ = 4.971 \times 10^{-5}\ \text{L} \times \frac{10^6\ \mu\text{L}}{1\ \text{L}} = 49.71\ \mu\text{L}$$

29. (a) The mass of the water will be unchanged. As water is a liquid, its volume will be unchanged. Thus its density will be unchanged;

(b) The mass of the air will be unchanged. As air is a gas, it will expand to fill the available space. Thus its volume will increase and so the density will decrease.

30. The density would be the same on Earth and on the Moon. The mass (but not the weight) would be the same, as would be the volume, therefore the density would be the same.

31.

| Strategy | Relationship |
|---|---|
| lengths (cm) → vol ($cm^3$) | v = l × w × h |
| vol, density → m (g) | mass = density × volume |
| mass (g) → mass (kg) | 1 kg = 1000 g |

$$\text{Volume} = 10.0\ \text{cm} \times 5.0\ \text{cm} \times 2.0\ \text{cm} = 1.0 \times 10^2\ \text{cm}^3$$

$$\text{Mass (g)} = 19.3\ \text{g} \cdot \text{cm}^{-3} \times 1.0 \times 10^2\ \text{cm}^3 = 1.93 \times 10^3\ \text{g}$$

$$\text{Mass}\ \ \text{kg} = 1.93 \times 10^3\ \text{g} \times \frac{1\ \text{kg}}{1000\ \text{g}} = 1.93\ \text{kg}$$

32.

| Strategy | Relationship |
|---|---|
| lengths (m) → vol ($m^3$) | v = l × w × h |
| vol, density → m (kg) | m = d × v |
| mass (kg) → mass (tonne) | 1 tonne = 1000 kg |

$$\text{Volume} = 1.83\ \text{m} \times 1.83\ \text{m} \times 0.305\ \text{m} = 1.02\ \text{m}^3$$

$$\text{Mass (kg)} = 1.00 \times 10^3\ \text{kg} \cdot \text{m}^{-3} \times 1.02\ \text{m}^3 = 1.02 \times 10^3\ \text{kg}$$

$$\text{Mass}\ \ \text{tonne} = 1.02 \times 10^3\ \text{kg} \times \frac{1\ \text{tonne}}{1000\ \text{kg}} = 1.02\ \text{tonne}$$

(it was the over one tonne mass of water in a water bed which sometimes caused bedroom floors to collapse)

33. Mass of liquid = (187.95 g) – (124.60 g) = 63.35 g

| Strategy | Relationship |
|---|---|
| mass, vol → density | d = m/v |

$$\text{Density} = \frac{63.35\ \text{g}}{50.0\ \text{mL}} = 1.27\ \text{g} \cdot \text{mL}^{-1}$$

34. Volume of solid = (88.7 mL) – (50.0 mL) = 38.7 mL

| Strategy | Relationship |
|---|---|
| vol (mL) → vol ($cm^3$) | 1 mL = 1 $cm^3$ |
| mass, vol → density | d = m/v |

$$\text{Volume}\ \ \text{cm}^3 = 38.7\ \text{mL} \times \frac{1\ \text{cm}^3}{1\ \text{mL}} = 38.7\ \text{cm}^3$$

$$\text{Density} = \frac{93.86\ \text{g}}{38.7\ \text{cm}^3} = 2.43\ \text{g} \cdot \text{cm}^{-3}$$