Solutions to 2023 Measurement Self-Review Questions

S1.

Density, $\rho = \dfrac{1.00 \times 10^{-3}}{1.00 \times 10^{-6}} = 1.00 \times 10^{3}$ kg m^{-3}

S2.

(A) ohm, newton and volt are not base units.

S3.

Speed of car = $\dfrac{90.0 \times 10^{3}}{60 \times 60} = 25.0$ m s^{-1}

S4.

1 light-year = $3.0 \times 10^{8} \times (365 \times 24 \times 60 \times 60) = 9.46 \times 10^{15}$ m

Distance to star = $\dfrac{4.0 \times 10^{16}}{9.46 \times 10^{15}} = 4.2$ light-years

S5.

(C). Stopping the stopwatch requires judging the correct timing of the end of the sprint. The stopwatch may be stopped too early or too late by the timekeeper (due to the fast speed). The other options constitute systematic errors.

S6.

Graph	A	B	C	D
Precise	✓	✓		
Not precise			✓	✓
Accurate	✓			✓
Not accurate		✓	✓	

S7.

$$F = \frac{1}{2} C_D \rho A v^2$$

$$v = \sqrt{\frac{2F}{C_D \rho A}} = \sqrt{\frac{2(22)}{(0.88)(1.2)(0.32)}} = 11.411 \text{ m s}^{-1}$$

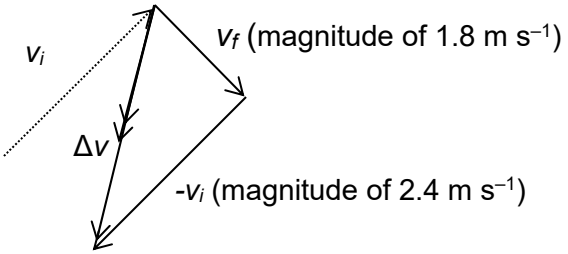
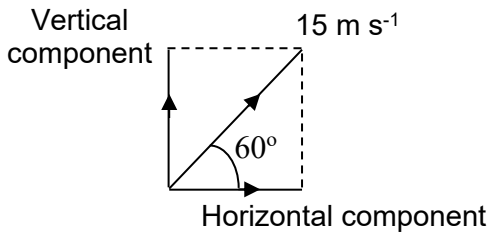
$$\frac{\Delta v}{v} = \frac{1}{2}\frac{\Delta F}{F} + \frac{1}{2}\frac{\Delta C_D}{C_D} + \frac{1}{2}\frac{\Delta \rho}{\rho} + \frac{1}{2}\frac{\Delta A}{A}$$

$$\frac{\Delta v}{11.411} = \frac{1}{2}\left(\frac{2}{22} + \frac{0.01}{0.88} + \frac{0.1}{1.2} + \frac{0.02}{0.32}\right)$$

$$\Delta v = 1.416$$

$$v = 11 \pm 1 \text{ m s}^{-1}$$

The uncertainty must be expressed to 1 sf, which is in the ones place. Hence the value is expressed to the ones place too.

S8.	$\Delta v = v_f - v_i$ (note that this is a vector operation) 
S9.	(a) (i) The velocity is at an angle to the horizontal. The diagram indicates it has both magnitude and direction.
	(ii) Less. All components of a vector are of a smaller magnitude than its original vector (the hypotenuse).
	
	(c) (i) $V_h = 15 cos 60^0 = 7.5 \text{m s}^{-1}$
	(ii) $V_v = 15 sin 60^0 = 13 \text{m s}^{-1}$