Maths for Science students Solutions

Question 1

Note that $\frac{5}{10}$ is in the same place as $2 \frac{1}{2}$. $\frac{99}{100}$ is just below 1.

Question 2

(a) 1.3  
(b) 1.2  
(c) 0.75  
(d) 0.82  
(e) 0.32  
(f) 3.875

Question 3

0.005, 0.0404, 0.09, 0.404, 0.9

Question 4

(a) 12.7 km  
(b) 5,760,000,000 L  
(c) 0.989 m  
(d) 600 µL  
(e) 0.0000002 ng

Question 5

(a) 0.1 mg  
(b) 40,000 kL  
(c) 2,345.678 mL
**Question 6**

(a) \(2 \times 22.99 + 1.008 + 30.974 + 4 \times 15.999 = 141.96\)

(b) \(2 \times 22.99 + 2 \times 32.06 + 3 \times 15.999 = 158.1\)

**Question 7**

(a) 6 mmol  
(b) 93.606 mg

**Question 8**

Make sure all quantities are in the same sub-units ("milli" seems best since that is how the answer is required.

\(C_1 = 0.05 \text{ M or } 50 \text{ mM}\)

\(V_1 = 500 \mu\text{L or } 0.5 \text{ mL}\)

\(V_2 = 500 \mu\text{L} + 9.5 \text{ mL or } 0.5 \text{ mL} + 9.5 \text{ mL} = 10 \text{ mL}\)

Hence \(C_2 = 2.5 \text{ mM}\)

**Question 9**

\(C_1 = 7.8 \text{ mg/mL} \) needs to be converted to either mM (mmol/L) (or you could go straight to \(\mu\text{M (\mu mol/L)} \) but that can be easily done later).

There are 1000 mL in a litre so

\(C_1 = 7.8 \text{ mg/mL} = 7800 \text{ mg/L}\).

Converting to moles via the atomic mass means we are looking for a number such that

\(7800 \text{ mg/L} = ? \times 156.01 \text{ mg/L}\).

Dividing 7800 by 156.01 gives a number very close to 50 so

\(7800 \text{ mg/L} = 50 \times 156.01 \text{ mg/L} = 50 \text{ mM}\).

From here, it may be obvious that mixing 1 mL of stock solution with 99 mL of water reduces the concentration to a hundredth of it’s original value, so \(C_2 = 0.5 \text{ mM or } 500 \mu\text{M}\) when converted to the required sub-unit. [This rules out options (a) and (b).]
(The formula gives the same answer for $C_2$ using $V_1 = 1$ mL, $C_1 = 50$ mM and $V_2 = 1 + 99 = 100$ mL.)

Finally,

$$500 \, \mu \text{M} = 500 \, \mu \text{mol/L}$$

but we only have 100 mL, or one tenth of this amount. Hence, there must be $50 \, \mu \text{mol}$ of solute in the dilute solution. [This makes (c) the correct answer.]

**Question 10**

Astute readers might spot that option (b) must be incorrect because $10 \, \mu \text{L}$ is only 0.01 mL (decimal point moves back 3 places). If this is added to 9.9 mL of water we only get 9.91 mL of diluted solution instead of the required 10.

From the question $C_1 = 0.5$ M, $V_2 = 10$ mL and $C_2 = 5$ mM and need to find $V_1$.

$C_1$ needs to be at the same sub-unit level as the others so change $C_1$ to 500 mM.

Putting these into the formula gives

$$500V_1 = 5 \times 10 = 50$$

which means that $V_1 = 0.1$ mL (or $\frac{5}{500} = 0.1$ if you need to re-arrange it).

Finally, 0.1 mL is 100 $\mu$L in the required units. [This rules out option (d).]

To find the weight (in mg) in the dilute solution, start with the concentration:

$$5 \, \text{mM} = 5 \, \text{mmol per litre} = 5 \times 141.96 \, \text{mg per litre} = 709.8 \, \text{mg per litre}$$

We have 10 mL of dilute solution, or one hundredth of this amount, so there must be 7.098 mg present. This is close to 7.1, which makes (a) the correct answer.

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