### Question 1

Put the following numbers in order from smallest to largest:

0.9, 0.404, 0.005, 0.09, 0.0404

### Question 2

Convert the following common decimals to fractions:

**(a)** 0.2

**(b)** 0.5

**(c)** 0.75

**(d)** 0.05

**(e)** 0.125

**(f)** 0.002

### Question 3

Express the following numbers in Scientific Notation:

**(a)** 19,256

**(b)** 0.0935

**(c)** 100,001

**(d)** 0.0000202

**(e)**$^\star$ 149,597,870,700

**(f)** 1.5

$^\star$*This is the distance (in metres) between the Earth and the Sun. Astronomers define it to be 1 Astronomical Unit (AU) and use it to measure distances in space. For example, Jupiter is 5.2 AU from the sun.*

### Question 4

**(a)** Solve for $v$ in the equation $s = vt$

**(b)** Solve for $u$ in the equation $v = u + at$

**(c)** Solve for $a$ in the equation $v = u + at$

**(d)** Solve for $F$ in the equation $P = \dfrac{F}{A}$

**(e)** Solve for $m_1$ in the equation $F_g = \dfrac{Gm_1m_2}{r^2}$

*(a) - (c) are equations of motion in Physics where $u$ = initial velocity, $v$ = final velocity, $s$ = distance travelled, $a$ = acceleration and $t$ = time.*

*(d) is the Pressure Equation where $F$ = force and $A$ = area.*

*(e) is the Gravitation Equation where $F_g$ = gravitational force, $m_1$ and $m_2$ are the masses of two objects, $r$ is the distance between them and $G$ is the Universal Gravitation Constant $6.673 \times 10^{-11}$.*

### Question 5

Evaluate each of the following (base 10) logarithms (if possible).

**(a)** $\log 10,000$

**(b)** $\log 1$ (Hint: $a^0 = 1$ for any base $a$)

**(c)** $\log 0.1$ (Hint: $\dfrac{1}{a^n} = a^{-n}$ for any base $a$)

**(d)** $\log 0.01$

**(e)** $\log(-10)$

### Question 6

For each of the following (base 10) logarithms, find the two integers either side of it.

**(a)** $\log_2 9$

**(b)** $\log 500$

**(c)** $\log 350$

**(d)** $\log 4$

**(e)** $\log 0.2$

**(f)** $\log 0.02$

### Question 7

Find the value of $N$ in each of the following equations. Express your answer with the appropriate number of significant figures.

**(a)** $\log N = 1.515$

**(b)** $\log N = -0.0013$

**(c)** $\log N = 0.999$

**(d)** $4.00 + \log N = 3.91$

**(e)** $2 \log N = -1$

### Question 8

Convert

**(a)** 12,700 m to km

**(b)** 5.76 GL to L

**(c)** 989 mm to m

**(d)** 0.0006 L to $\mu$L

**(e)** 20 ng to g

### Question 9

Convert

**(a)** 100 $\mu$g to mg **(b)** 0.04 GL to kL **(c)** 2,345,678 $\mu$L to mL

### Question 10

Show that

**(a)** the atomic mass of anhydrous $Na_2HPO_4$ is 141.96
(atomic mass of Na is 22.99, H is 1.008, P is 30.974 and O is 15.999).

**(b)** the atomic mass of sodium thiosulphate $Na_2S_2O_3$ is 158.1
(atomic mass of S is 32.06).

### Question 11

You have 100mL of a 60 mM solution of $Na_2HPO_4.2H_2O$ (atomic mass 156.01 g/mol).

**(a)** How many mmol of $Na_2HPO_4.2H_2O$ does it contain?

**(b)** How many mg of $Na_2HPO_4.2H_2O$ does it contain?

### Question 12

[From CHEM1004 revision sheet] You have a 0.05 M solution of $Na_2HPO_4$ and you take 500 $\mu$L and add 9.5 mL of water. What is the final concentration of $Na_2HPO_4$ in the dilute solution (in mM)?

### Question 13

[From CHEM1004 revision sheet] You make up a solution of $Na_2HPO_4.2H_2O$ (atomic mass 156.01 g/mol) at a concentration of 7.8 mg/mL, then dilute this solution by adding 1 mL of this to 99 mL of $H_2O$. What is the final concentration (in $\mu$M) and what amount of solute is present in 100mL of the dilute solution? Which of the answers below is the most correct answer?

(a) 50 $\mu$M, 5 $\mu$mol
(b) 5 $\mu$M, 0.5 $\mu$mol
(c) 500 $\mu$M, 50 $\mu$mol
(d) 500 $\mu$M, 500 $\mu$mol

### Question 14

[From CHEM1004 revision sheet] You make up a 0.5 M solution of anhydrous $Na_2HPO_4$ (atomic mass 141.96 g/mol). What volume ($\mu$L) of this solution do you need to add to what volume of water (mL) to give 10mL of a 5 mM solution? What approximate weight of $Na_2HPO_4$ (mg) is present in this dilute solution?

(a) 100 $\mu$L of 0.5M $Na_2HPO_4$ + 9.9 mL of $H_2O$, solution contains 7.1 mg of $Na_2HPO_4$
(b) 10 $\mu$L of 0.5M $Na_2HPO_4$ + 9.9 mL of $H_2O$, solution contains 0.71 mg of $Na_2HPO_4$
(c) 100 $\mu$L of 0.5M $Na_2HPO_4$ + 9.9 mL of $H_2O$, solution contains 14.2 mg of $Na_2HPO_4$
(d) 1000 $\mu$L of 0.5M $Na_2HPO_4$ + 9.0 mL of $H_2O$, solution contains 7.1 mg of $Na_2HPO_4$

## Solutions

### Question 1

$$0.005, \quad 0.0404, \quad 0.09, \quad 0.404, \quad 0.9$$

### Question 2

**(a)**
$$\begin{aligned} 0.2 &= \frac{2}{10} \\ &= \frac{{}^{1}\cancel{2}}{{}_{5}\cancel{10}} \\ &= \frac{1}{5} \end{aligned}$$

**(b)**
$$\begin{aligned} 0.5 &= \frac{5}{10} \\ &= \frac{{}^{1}\cancel{5}}{{}_{2}\cancel{10}} \\ &= \frac{1}{2} \end{aligned}$$

**(c)**
$$\begin{aligned} 0.75 &= \frac{7}{10} + \frac{5}{100} \\ &= \frac{70}{100} + \frac{5}{100} \\ &= \frac{75}{100} \\ &= \frac{{}^{3}\cancel{75}}{{}_{4}\cancel{100}} \\ &= \frac{3}{4} \end{aligned}$$

**(d)**
$$\begin{aligned} 0.05 &= \frac{5}{100} \\ &= \frac{{}^{1}\cancel{5}}{{}_{20}\cancel{100}} \\ &= \frac{1}{20} \end{aligned}$$

**(e)**
$$\begin{aligned} 0.125 &= \frac{125}{1000} \\ &= \frac{{}^{1}\cancel{125}}{{}_{8}\cancel{1000}} \\ &= \frac{1}{8} \end{aligned}$$

**(f)**
$$\begin{aligned} 0.002 &= \frac{2}{1000} \\ &= \frac{{}^{1}\cancel{2}}{{}_{500}\cancel{1000}} \\ &= \frac{1}{500} \end{aligned}$$

### Question 3

**(a)** $1.9256 \times 10^4$

**(b)** $9.35 \times 10^{-2}$

**(c)** $1.00001 \times 10^5$

**(d)** $2.02 \times 10^{-5}$

**(e)** $1.495978707 \times 10^{11}$

**(f)** $1.5$ or $1.5 \times 10^0$

## Question 4

**(a)**
$$\begin{aligned} s &= vt \\ \frac{s}{t} &= \frac{v\cancel{t}^{1}}{\cancel{t}_{1}} \\ \frac{s}{t} &= v \end{aligned}$$

**(b)**
$$\begin{aligned} v &= u + at \\ v - at &= u + at - at \\ v - at &= u \end{aligned}$$

**(c)**
$$\begin{aligned} v &= u + at \\ v - u &= u + at - u \\ v - u &= at \\ \frac{v-u}{t} &= \frac{a\cancel{t}^{1}}{\cancel{t}_{1}} \\ \frac{v-u}{t} &= a \end{aligned}$$

**(d)**
$$\begin{aligned} P &= \frac{F}{A} \\ P \times A &= \frac{F}{A} \times \frac{A}{1} \\ PA &= \frac{F}{{}_{1}\cancel{A}} \times \frac{\cancel{A}^{1}}{1} \\ PA &= F \end{aligned}$$

**(e)**
$$\begin{aligned} F_g &= \frac{Gm_1m_2}{r^2} \\ \frac{F_g}{1} \times \frac{r^2}{Gm_2} &= \frac{Gm_1m_2}{r^2} \times \frac{r^2}{Gm_2} \\ \frac{F_g r^2}{Gm_2} &= \frac{{}^{1}\cancel{G}m_1\cancel{m_2}^{1}}{\cancel{r^2}_{1}} \times \frac{\cancel{r^2}_{1}}{{}_{1}\cancel{G}\cancel{m_2}^{1}} \\ \frac{F_g r^2}{Gm_2} &= m_1 \end{aligned}$$

## Question 5

**(a)** $\log 10,000 = 4$ because $10,000 = 10^4$

**(b)** $\log 1 = 0$ because $1 = 10^0$

**(c)** $\log 0.1 = -1$ because $0.1 = \dfrac{1}{10} = 10^{-1}$

**(d)** $\log 0.01 = -2$ because $0.01 = \dfrac{1}{10^2} = 10^{-2}$

**(e)** $\log(-10)$ does not exist because you can't raise a positive number (10) to *any* power and get a negative answer (in this case $-10$).

### Question 6

**(a)** $\log 29$ is between 1 ($\log 10$) and 2 ($\log 100$). The exact answer is $1.462\ldots$

**(b)** $\log 550$ is between 2 ($\log 100$) and 3 ($\log 1000$). The exact answer is $2.7403\ldots$
*Note that the decimal places of this answer are the same as those in* $\log 55 = 1.7403\ldots$

**(c)** $\log 350$ is between 2 ($\log 100$) and 3 ($\log 1000$). The exact answer is $2.5440\ldots$

**(d)** $\log 4$ is between 0 ($\log 1$) and 1 ($\log 10$). The exact answer is $0.6020\ldots$

**(e)** $\log 0.2$ is between $-1$ ($\log 0$) and 0 ($\log 1$). The exact answer is $-0.6989\ldots$

**(f)** $\log 0.02$ is between $-2$ ($\log 0.01$) and $-1$ ($\log 0.1$). The exact answer is $-1.6989\ldots$
*Again, note that the decimal places of this answer are the same as those in (e)*

### Question 7

**(a)** $\log N = 1.515$ so $N = 10^{1.515} = 32.734\ldots = 32.73$ to 4 sig. figs.

**(b)** $\log N = -0.00130$ so $N = 10^{-0.00130} = 0.9970\ldots = 0.997$ to 3 sig. figs.
*Note that the answer is close to 1 since the logarithm is close to 0.*

**(c)** $\log N = 0.999$ so $N = 10^{0.999} = 9.977\ldots = 9.98$ to 3 sig. figs.

**(d)** $4.5 + \log N = 3.9$
Re-arranging: $\log N = -0.6$ so $N = 10^{-0.6} = 0.2511\ldots = 0.25$ to 2 sig. figs.

**(e)** $0.004 \log N = -0.001$
Re-arranging: $\log N = -0.25$ so $N = 10^{-0.25} = 0.5623\ldots = 0.6$ to 1 sig. fig.
*Note that we retain all sig figs during the re-arranging and only round-off at the end.*

### Question 8

**(a)** 12.7 km

**(b)** 5,760,000,000 L

**(c)** 0.989 m

**(d)** 600 $\mu$L

**(e)** 0.00000002 ng

### Question 9

**(a)** 0.1 mg

**(b)** 40,000 kL

**(c)** 2,345.678 mL

### Question 10

**(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 11

**(a)** 6 mmol **(b)** 93.606 mg

### Question 12

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

$C_1 = 0.05$ M or 50 mM

$V_1 = 500$ $\mu$L or 0.5 mL

$V_2 = 500$ $\mu$L + 9.5 mL or 0.5 mL +9.5 mL = 10 mL

Hence $C_2 = 2.5$ mM

### Question 13

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

There are 1000 mL in a litre so

$C_1 = 7.8$ mg/mL = 7800 mg/L.

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

7800 mg/L =? $\times$ 156.01 mg/L.

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

7800 mg/L = 50 $\times$ 156.01 mg/L = 50 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 $C_2 = 0.5$ mM or 500 $\mu$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 $\mu$mol of solute in the dilte solution. *[This makes (c) the correct answer.]*

### Question 14

Astute readers might spot that option (b) must be incorrect because 10 $\mu$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:

$$\begin{aligned} 5\text{ mM} &= 5\text{ mmol per litre} \\ &= 5 \times 141.96\text{ mg per litre} \\ &= 709.8\text{ mg per litre} \end{aligned}$$

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.

### Using STUDY*Smarter* Resources

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