

Transposing Formulæ

1. Transpose the following formulæ.

- a) $F = ma$ $a =$
- b) $pV = NRT$ $T =$
- c) $qU = h \cdot \frac{c}{\lambda_{\min}}$ $\lambda_{\min} =$
- d) $E_{\text{pot}} = mg\Delta h$ $\Delta h =$
- e) $F_e = k_e \cdot \frac{q_1 \cdot q_2}{r^2}$ $q_2 =$
- f) $P_{\text{total}} = c_X \cdot U^2 IZ$ $I =$
- g) $\frac{1}{2}mv^2 = \frac{3}{2}kT$ $T =$
- h) $\frac{\Delta V}{\Delta t} = -\frac{\pi \cdot r^4}{8 \cdot \eta} \cdot \frac{\Delta p}{\Delta l}$ $\Delta p =$
- $\eta =$
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2. Transpose the following formulæ.

- a) $M = \sigma \cdot T^4$ $T =$
- b) $E_{\text{kin}} = \frac{1}{2}mv^2$ $v =$
- c) $\Delta E = \sigma \cdot (T_1^4 - T_2^4) \cdot A \cdot t$ $T_1 =$
- $T_2 =$
- d) $P_{\text{total}} = c_X \cdot U^2 IZ$ $U =$
- e) $\frac{1}{2}mv^2 = \frac{3}{2}kT$ $v =$
- f) $mg\Delta h = \frac{1}{2}mv^2$ $v =$
- g) $F_e = k_e \cdot \frac{q_1 \cdot q_2}{r^2}$ $r =$
- h) $\frac{\Delta V}{\Delta t} = -\frac{\pi \cdot r^4}{8 \cdot \eta} \cdot \frac{\Delta p}{\Delta l}$ $r =$
- i) $f_0 = \frac{1}{2\pi} \cdot \sqrt{\frac{k}{m}}$ $k =$
- $m =$
- j) $f_0 = \frac{1}{2\pi} \cdot \sqrt{\frac{g}{l}}$ $l =$

$$\text{k) } f_0 = \frac{1}{2\pi} \cdot \sqrt{\frac{1}{LC}} \quad L =$$

$$C =$$

3. Transpose the following formulæ.

$$\text{a) } \delta = \frac{\lambda_v}{n \cdot \sin(\omega)} \quad \sin(\omega) =$$

$$\omega =$$

$$\text{b) } \frac{\sin(\alpha_1)}{\sin(\alpha_2)} = \frac{c_1}{c_2} \quad \sin(\alpha_2) =$$

$$\alpha_2 =$$

$$\text{c) } y = y_{\max} \cdot \sin(2\pi f \cdot t + \varphi_0) \quad f =$$

4. Transpose the following formulæ.

$$\text{a) } J = J_0 \cdot e^{-\mu x} \quad x =$$

$$\mu =$$

$$\text{b) } J = J_0 \cdot e^{-\frac{\ln(2)}{D} x} \quad x =$$

$$D =$$

$$\text{c) } U = U_0 \cdot e^{-t/(RC)} \quad t =$$

$$C =$$

$$\text{d) } n_i = n_0 \cdot e^{-\frac{Mg\Delta h}{RT}} \quad \Delta h =$$

$$T =$$

$$\text{e) } \Lambda = \Lambda_0 \cdot 2^{-\frac{t}{T}} \quad t =$$

$$T =$$

$$\text{f) } U = U_{\max} \cdot (1 - e^{-t/(RC)}) \quad t =$$

$$R =$$

5. Transpose the following formulæ.

$$\text{a) } \text{pH} = -\log \left[\frac{[\text{H}^+]}{1\text{M}} \right] \quad [\text{H}^+] =$$

$$\text{b) } E = \log \left(\frac{J_0}{J} \right) \quad J =$$

$$\text{c) } S = k_B \cdot \ln(\Omega) \quad \Omega =$$

$$\text{d) } n_{\text{dB}} = 10 \cdot \log \left(\frac{J}{J_0} \right) \quad J =$$

e) $\text{pH} = \text{p}K + \log\left(\frac{[\text{Base}]}{[\text{Acid}]}\right)$ $[\text{Base}] =$

$[\text{Acid}] =$

f) $\text{pH} = \text{p}K + \log\left(\frac{[\text{Base}]}{c - [\text{Base}]}\right)$ $[\text{Base}] =$

g) $E = E^0 + \frac{RT}{z_e F} \cdot \ln\left(\frac{c_{\text{ox}}}{c_{\text{red}}}\right)$ $c_{\text{ox}} =$

$c_{\text{red}} =$

h) $E = E^0 + \frac{0.059 \text{ V}}{z_e} \cdot \log\left(\frac{c_{\text{ox}}}{c_{\text{red}}}\right)$ $c_{\text{ox}} =$

$c_{\text{red}} =$

Solutions

1.

a) $F = ma$

$$a = \frac{F}{m}$$

b) $pV = NRT$

$$T = \frac{pV}{NR}$$

c) $qU = h \cdot \frac{c}{\lambda_{\min}}$

$$\lambda_{\min} = \frac{hc}{qU}$$

d) $E_{\text{pot}} = mg\Delta h$

$$\Delta h = \frac{E_{\text{pot}}}{mg}$$

e) $F_e = k_e \cdot \frac{q_1 \cdot q_2}{r^2}$

$$q_2 = \frac{F_e \cdot r^2}{k_e \cdot q_1}$$

f) $P_{\text{total}} = c_X \cdot U^2 IZ$

$$I = \frac{P_{\text{total}}}{c_X \cdot U^2 \cdot Z}$$

g) $\frac{1}{2}mv^2 = \frac{3}{2}kT$

$$T = \frac{mv^2}{3k}$$

h) $\frac{\Delta V}{\Delta t} = -\frac{\pi \cdot r^4}{8 \cdot \eta} \cdot \frac{\Delta p}{\Delta l}$

$$\Delta p = -\frac{\Delta V \cdot 8 \cdot \eta \cdot \Delta l}{\Delta t \cdot \pi \cdot r^4}$$

$$\eta = -\frac{\pi \cdot r^4 \cdot \Delta p \cdot \Delta t}{8 \cdot \Delta l \cdot \Delta V}$$

2.

a) $M = \sigma \cdot T^4$

$$T = \sqrt[4]{\frac{M}{\sigma}}$$

b) $E_{\text{kin}} = \frac{1}{2}mv^2$

$$v = \sqrt{\frac{2 \cdot E_{\text{kin}}}{m}}$$

c) $\Delta E = \sigma \cdot (T_1^4 - T_2^4) \cdot A \cdot t$

$$T_1 = \sqrt[4]{\frac{\Delta E}{\sigma \cdot A \cdot t} + T_2^4}$$

$$T_2 = \sqrt[4]{T_1^4 - \frac{\Delta E}{\sigma \cdot A \cdot t}}$$

d) $P_{\text{total}} = c_X \cdot U^2 IZ$

$$U = \sqrt{\frac{P_{\text{total}}}{c_X \cdot I \cdot Z}}$$

e) $\frac{1}{2}mv^2 = \frac{3}{2}kT$

$$v = \sqrt{\frac{3kT}{m}}$$

f) $mg\Delta h = \frac{1}{2}mv^2$

$$v = \sqrt{2g\Delta h}$$

g) $F_e = k_e \cdot \frac{q_1 \cdot q_2}{r^2}$

$$r = \sqrt{\frac{k_e \cdot q_1 \cdot q_2}{F_e}}$$

$$\text{h) } \frac{\Delta V}{\Delta t} = -\frac{\pi \cdot r^4}{8 \cdot \eta} \cdot \frac{\Delta p}{\Delta l}$$

$$r = \sqrt[4]{-\frac{\Delta V \cdot 8 \cdot \eta \cdot \Delta l}{\Delta t \cdot \pi \cdot \Delta p}}$$

$$\text{i) } f_0 = \frac{1}{2\pi} \cdot \sqrt{\frac{k}{m}}$$

$$k = (f_0 \cdot 2\pi)^2 \cdot m$$

$$m = \frac{k}{(f_0 \cdot 2\pi)^2}$$

$$\text{j) } f_0 = \frac{1}{2\pi} \cdot \sqrt{\frac{g}{l}}$$

$$l = \frac{g}{(f_0 \cdot 2\pi)^2}$$

$$\text{k) } f_0 = \frac{1}{2\pi} \cdot \sqrt{\frac{1}{LC}}$$

$$L = \frac{1}{C \cdot (f_0 \cdot 2\pi)^2}$$

$$C = \frac{1}{L \cdot (f_0 \cdot 2\pi)^2}$$

3.

$$\text{a) } \delta = \frac{\lambda_v}{n \cdot \sin(\omega)}$$

$$\sin(\omega) = \frac{\lambda_v}{n \cdot \delta}$$

$$\omega = \arcsin\left(\frac{\lambda_v}{n \cdot \delta}\right) \quad (\arcsin(\) \text{ can also be written as } \mathbf{\sin^{-1}(\)})$$

$$\text{b) } \frac{\sin(\alpha_1)}{\sin(\alpha_2)} = \frac{c_1}{c_2}$$

$$\sin(\alpha_2) = \frac{\sin(\alpha_1) \cdot c_2}{c_1}$$

$$\alpha_2 = \arcsin\left(\frac{\sin(\alpha_1) \cdot c_2}{c_1}\right)$$

$$\text{c) } y = y_{\max} \cdot \sin(2\pi f \cdot t + \varphi_0) \quad f = \frac{\arcsin\left(\frac{y}{y_{\max}}\right) - \varphi_0}{2\pi \cdot t}$$

4.

$$\text{a) } J = J_0 \cdot e^{-\mu x}$$

$$x = -\frac{\ln\left(\frac{J}{J_0}\right)}{\mu} = \frac{\ln\left(\frac{J_0}{J}\right)}{\mu} = \frac{\log\left(\frac{J_0}{J}\right)}{\mu \cdot \log(e)}$$

$$\mu = \frac{\ln\left(\frac{J_0}{J}\right)}{x}$$

$$\text{b) } J = J_0 \cdot e^{-\frac{\ln(2)}{D} x}$$

$$x = \frac{D \cdot \ln\left(\frac{J_0}{J}\right)}{\ln(2)} = D \cdot \log_2\left(\frac{J_0}{J}\right)$$

$$D = \frac{x \cdot \ln(2)}{\ln\left(\frac{J_0}{J}\right)} = \frac{x}{\log_2\left(\frac{J_0}{J}\right)}$$

$$\text{c) } U = U_0 \cdot e^{-t/(RC)}$$

$$t = RC \cdot \ln\left(\frac{U_0}{U}\right)$$

$$C = \frac{t}{R \cdot \ln\left(\frac{U_0}{U}\right)}$$

$$d) n_i = n_0 \cdot e^{-\frac{Mg\Delta h}{RT}}$$

$$\Delta h = \frac{RT}{Mg} \cdot \ln\left(\frac{n_0}{n_i}\right)$$

$$T = \frac{Mg\Delta h}{R \cdot \ln\left(\frac{n_0}{n_i}\right)}$$

$$e) \Lambda = \Lambda_0 \cdot 2^{-\frac{t}{T}}$$

$$t = T \cdot \log_2\left(\frac{\Lambda_0}{\Lambda}\right) = \frac{T \cdot \ln\left(\frac{\Lambda_0}{\Lambda}\right)}{\ln(2)}$$

$$T = \frac{t}{\log_2\left(\frac{\Lambda_0}{\Lambda}\right)} = \frac{t \cdot \ln(2)}{\ln\left(\frac{\Lambda_0}{\Lambda}\right)}$$

$$f) U = U_{\max} \cdot (1 - e^{-t/(RC)})$$

$$t = -RC \cdot \ln\left(1 - \frac{U}{U_{\max}}\right)$$

$$R = -\frac{t}{C \cdot \ln\left(1 - \frac{U}{U_{\max}}\right)}$$

5.

$$a) \text{pH} = -\log\left[\frac{[\text{H}^+]}{1\text{M}}\right]$$

$$[\text{H}^+] = (10^{-\text{pH}})\text{M}$$

$$b) E = \log\left(\frac{J_0}{J}\right)$$

$$J = J_0 \cdot 10^{-E}$$

$$c) S = k_B \cdot \ln(\Omega)$$

$$\Omega = e^{\frac{S}{k_B}}$$

$$d) n_{\text{dB}} = 10 \cdot \log\left(\frac{J}{J_0}\right)$$

$$J = J_0 \cdot 10^{\frac{n_{\text{dB}}}{10}}$$

$$e) \text{pH} = \text{pK} + \log\left(\frac{[\text{Base}]}{[\text{Acid}]}\right)$$

$$[\text{Base}] = [\text{Acid}] \cdot 10^{(\text{pH}-\text{pK})}$$

$$[\text{Acid}] = \frac{[\text{Base}]}{10^{(\text{pH}-\text{pK})}}$$

$$f) \text{pH} = \text{pK} + \log\left(\frac{[\text{Base}]}{c - [\text{Base}]}\right)$$

$$[\text{Base}] = \frac{c \cdot 10^{(\text{pH}-\text{pK})}}{1 + 10^{(\text{pH}-\text{pK})}}$$

$$g) E = E^0 + \frac{RT}{z_e F} \cdot \ln\left(\frac{c_{\text{ox}}}{c_{\text{red}}}\right)$$

$$c_{\text{ox}} = c_{\text{red}} \cdot e^{\frac{(E-E^0) \cdot z_e F}{RT}}$$

$$c_{\text{red}} = \frac{c_{\text{ox}}}{e^{\frac{(E-E^0) \cdot z_e F}{RT}}}$$

$$h) E = E^0 + \frac{0.059 \text{ V}}{z_e} \cdot \log\left(\frac{c_{\text{ox}}}{c_{\text{red}}}\right)$$

$$c_{\text{ox}} = c_{\text{red}} \cdot 10^{\frac{(E-E^0) \cdot z_e}{0.059 \text{ V}}}$$

$$c_{\text{red}} = \frac{c_{\text{ox}}}{10^{\frac{(E-E^0) \cdot z_e}{0.059 \text{ V}}}}$$