Appendix A

Greek Letters (Complete List)

Letter	Lowercase	Uppercase
Alpha	α ⠨⠁	A ⠨⠠⠁
Beta	β ⠨⠃	B ⠨⠠⠃
Gamma	γ ⠨⠛	Γ ⠨⠠⠛
Delta	δ ⠨⠙	Δ ⠨⠠⠙
Epsilon	ε ⠨⠑	E ⠨⠠⠑
Zeta	ζ ⠨⠵	Z ⠨⠠⠵
Eta	η ⠨⠱	H ⠨⠠⠱
Theta	θ or ϑ ⠨⠹	Θ ⠨⠠⠹
Iota	ι ⠨⠊	I ⠨⠠⠊
Kappa	κ ⠨⠅	K ⠨⠠⠅
Lambda	λ ⠨⠇	Λ ⠨⠠⠇
Mu	μ ⠨⠍	M ⠨⠠⠍
Nu	ν ⠨⠝	N ⠨⠠⠝
Xi	ξ ⠨⠭	Ξ ⠨⠠⠭
Omicron	o ⠨⠕	O ⠨⠠⠕
Pi	π or ϖ ⠨⠏	Π ⠨⠠⠏
Rho	ρ ⠨⠗	P ⠨⠠⠗
Sigma	σ or ς ⠨⠎	Σ ⠨⠠⠎
Tau	τ ⠨⠞	T ⠨⠠⠞
Upsilon	υ ⠨⠥	Υ ⠨⠠⠥
Phi	ϕ or φ ⠨⠋	Φ ⠨⠠⠋
Chi	χ ⠨⠯	X ⠨⠠⠯
Psi	ψ ⠨⠽	Ψ ⠨⠠⠽
Omega	ω ⠨⠺	Ω ⠨⠠⠺

Greek Alphabet (Examples)

This appendix includes some common examples taken from the Nemeth Symbol Library. To see more examples, you can access the full Nemeth Symbol Library at https://www.pathstoliteracy.org/nemeth-symbol-library/.

Lowercase Alpha Examples

1. The secant of alpha equals the square root of two is written

   $\sec\alpha = \sqrt{2}$

   ⠎⠑⠉⠀⠨⠁⠀⠨⠅⠀⠜⠆⠻

2. The cosecant of alpha equals open fraction one over the sine of alpha close fraction is written

   $\csc\alpha = \frac{1}{\sin\alpha}$

   ⠉⠎⠉⠀⠨⠁⠀⠨⠅⠀⠹⠂⠌⠎⠊⠝⠀⠨⠁⠼

3. The cosine of open parenthesis negative alpha close parenthesis equals the cosine of alpha is written

   $\cos(-\alpha) = \cos\alpha$

   ⠉⠕⠎⠀⠷⠤⠨⠁⠾⠀⠨⠅⠀⠉⠕⠎⠀⠨⠁

Lowercase Beta Examples

1. Beta equals 45 degrees is written

   $\beta = 45^\circ$

   ⠨⠃⠀⠨⠅⠀⠼⠲⠢⠘⠨⠡

2. The tangent of two beta equals open fraction two tangent beta over one minus tangent squared beta close fraction is written

   $\tan 2\beta = \frac{2\tan\beta}{1-\tan^2\beta}$

   ⠞⠁⠝⠀⠼⠆⠨⠃⠀⠨⠅⠀⠹⠆⠞⠁⠝⠀⠨⠃⠌⠂⠤⠞⠁⠝⠘⠆⠀⠨⠃⠼

3. One plus cotangent squared beta equals cosecant squared beta is written

   $1 + \cot^2\beta = \csc^2\beta$

   ⠼⠂⠬⠉⠕⠞⠘⠆⠀⠨⠃⠀⠨⠅⠀⠉⠎⠉⠘⠆⠀⠨⠃

Lowercase Gamma Examples

1. The cosine of open parenthesis lowercase gamma plus two pi close parenthesis equals the cosine of lowercase gamma is written

   $\cos(\gamma + 2\pi) = \cos\gamma$

   ⠉⠕⠎ ⠷⠨⠛⠬⠆⠨⠏⠾ ⠨⠅ ⠉⠕⠎ ⠨⠛

2. The cosine of two lowercase gamma equals one minus two sine squared lowercase gamma is written

   $\cos 2\gamma = 1 - 2\sin^2\gamma$

   ⠉⠕⠎ ⠼⠆⠨⠛ ⠨⠅ ⠼⠂⠤⠆⠎⠊⠝⠘⠆ ⠨⠛

3. Sine squared lowercase gamma equals one minus cosine squared lowercase gamma is written

   $\sin^2\gamma = 1 - \cos^2\gamma$

   ⠎⠊⠝⠘⠆ ⠨⠛ ⠨⠅ ⠼⠂⠤⠉⠕⠎⠘⠆ ⠨⠛

Lowercase Delta Examples

1. Lowercase delta is greater than zero is written

   $\delta > 0$

   ⠨⠙ ⠨⠂ ⠼⠴

2. Lowercase delta equals open fraction lowercase epsilon over three close fraction is written

   $\delta = \frac{\varepsilon}{3}$

   ⠨⠙ ⠨⠅ ⠹⠨⠑⠌⠒⠼

3. Zero is less than open absolute value x minus a close absolute value is less than delta is written

   $0 < |x - a| < \delta$

   ⠼⠴ ⠐⠅ ⠳⠭⠤⠁⠳ ⠐⠅ ⠨⠙

Uppercase Delta Examples

1. Uppercase delta y which means the change in y is written

   Δy

   ⠨⠠⠙⠽

2. Uppercase delta x equals x sub two minus x sub one is written

$\Delta x = x_2 - x_1$

⠨⠠⠙⠭⠀⠨⠅⠀⠭⠆⠤⠭⠂

3. The formula for slope m equals open fraction uppercase delta y over uppercase delta x close fraction is written

$m = \frac{\Delta y}{\Delta x}$

⠍⠀⠨⠅⠀⠹⠨⠠⠙⠽⠌⠨⠠⠙⠭⠼

Lowercase Epsilon Examples

1. Lowercase epsilon is greater than zero is written

$\varepsilon > 0$

⠨⠑⠀⠨⠂⠀⠼⠴

2. Open parenthesis lowercase epsilon comma lowercase delta close parenthesis is written

(ε, δ)

⠷⠨⠑⠠⠀⠨⠙⠾

3. Open absolute value f of x minus L close absolute value is less than lowercase epsilon is written

$|f(x) - L| < \varepsilon$

⠳⠋⠷⠭⠾⠤⠠⠇⠳⠀⠐⠅⠀⠨⠑

Lowercase Theta Examples

1. The cotangent of theta equals open fraction cosine of theta over the sine of theta close fraction is written

$\cot\theta = \frac{\cos\theta}{\sin\theta}$

⠉⠕⠞⠀⠨⠹⠀⠨⠅⠀⠹⠉⠕⠎⠀⠨⠹⠌⠎⠊⠝⠀⠨⠹⠼

2. The cosine of two theta equals cosine squared theta minus sine squared theta is written

$\cos 2\theta = \cos^2\theta - \sin^2\theta$

⠉⠕⠎⠀⠼⠆⠨⠹⠀⠨⠅⠀⠉⠕⠎⠘⠆⠀⠨⠹⠤⠎⠊⠝⠘⠆⠀⠨⠹

3. Sine squared theta plus cosine squared theta equals one is written

$\sin^2 \theta + \cos^2 \theta = 1$

⠎⠊⠝⠘⠆ ⠨⠹⠬⠉⠕⠎⠘⠆ ⠨⠹ ⠨⠅ ⠼⠂

Lowercase Lambda Examples

1. Lowercase lambda which often represents wavelength is written

λ

⠨⠇

2. Lambda equals open fraction v over f close fraction is written

$\lambda = \frac{v}{f}$

⠨⠇ ⠨⠅ ⠹⠧⠌⠋⠼

3. v equals f multiplication dot lowercase lambda is written

$v = f \cdot \lambda$

⠧ ⠨⠅ ⠋⠡⠨⠇

Lowercase Pi Examples

1. C equals two pi r is written

$C = 2\pi r$

⠠⠉ ⠨⠅ ⠼⠆⠨⠏⠗

2. The cosecant of open fraction five pi over 3 close fraction is written

$\csc \frac{5\pi}{3}$

⠉⠎⠉ ⠹⠢⠨⠏⠌⠒⠼

3. The cotangent of open parenthesis negative open fraction pi over three close fraction close parenthesis is written

$\cot\left(-\frac{\pi}{3}\right)$

⠉⠕⠞ ⠷⠤⠹⠨⠏⠌⠒⠼⠾

Lowercase Rho Examples

1. Lowercase rho equals 1000 kilograms per meter cubed is written

   $\rho = 1000kg\ /\ m^3$

   ⠨⠗ ⠨⠅ ⠼⠂⠴⠴⠴ ⠅⠛⠸⠌⠰⠍⠘⠒

2. Lowercase rho equals open fraction m over V close fraction is written

   $\rho = \frac{m}{V}$

   ⠨⠗ ⠨⠅ ⠹⠍⠌⠠⠧⠼

3. Lowercase rho equals open fraction ten kilograms over 5 meters cubed is written

   $\rho = \frac{10kg}{5m^3}$

   ⠨⠗ ⠨⠅ ⠹⠂⠴ ⠅⠛⠌⠢ ⠰⠍⠘⠒⠐⠼

Lowercase Sigma Examples

1. Lowercase sigma which is often used to represent the standard deviation in statistics is written

   σ

   ⠨⠎

2. Lowercase sigma equals fourteen point eight two is written

   $\sigma = 14.82$

   ⠨⠎ ⠨⠅ ⠼⠂⠲⠨⠦⠆

3. Lowercase sigma equals the square root of open fraction uppercase sigma open parenthesis x minus x bar close parenthesis squared over n minus 1 is written

   $\sigma = \sqrt{\frac{\Sigma\left(x - \overline{x}\right)^2}{n - 1}}$

   ⠨⠎ ⠨⠅ ⠜⠹⠨⠠⠎⠷⠭⠤⠭⠱⠾⠘⠆⠐⠌⠝⠤⠂⠼⠻

Uppercase Sigma Examples

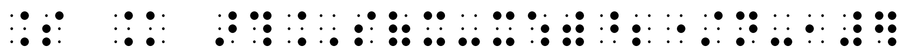
1. The sum i equals one to five of four i minus two is written

   $$\sum_{i=1}^{5} 4i - 2$$

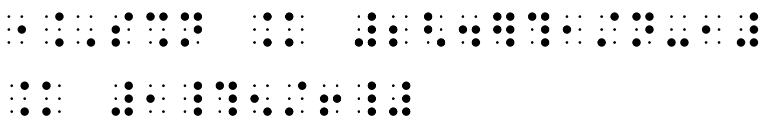
2. Lowercase sigma equals the square root of open fraction uppercase sigma open parenthesis x minus x bar close parenthesis squared over n minus 1 is written

   $$\sigma = \sqrt{\frac{\Sigma\left(x - \overline{x}\right)^{2}}{n-1}}$$

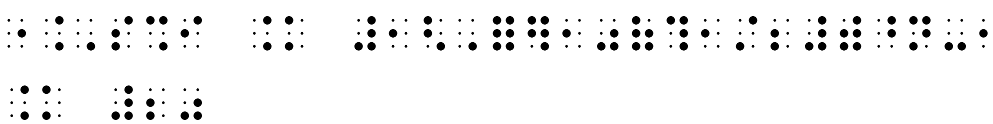
3. The sum from n equals two to four of open fraction one over n minus one close fraction equals one and five-sixths is written

   $$\sum_{n=2}^{4} \frac{1}{n-1} = 1\frac{5}{6}$$

4. The sum from i equals one to infinity of ten open parenthesis one-half close parenthesis to the n minus 1 power equals twenty is written

   $$\sum_{i=1}^{\infty} 10\left(\frac{1}{2}\right)^{n-1} = 20$$

5. The sum from i equals one to n of x sub i is written

   $$\sum\nolimits_{i=1}^{n} x_i$$

Lowercase Phi Examples

1. Open fraction one over the secant of phi close fraction equals the cosine of phi is written

   $$\frac{1}{\sec\varphi} = \cos\varphi$$

   ⠹⠂⠌⠎⠑⠉⠀⠨⠋⠼⠀⠨⠅⠀⠉⠕⠎⠀⠨⠋

2. The cosine of two phi equals two cosine squared phi minus one is written

   $$\cos 2\varphi = 2\cos^2\varphi - 1$$

   ⠉⠕⠎⠀⠼⠆⠨⠋⠀⠨⠅⠀⠼⠆⠉⠕⠎⠘⠆⠀⠨⠋⠤⠂

3. Cosine squared phi equals one minus sine squared phi is written

   $$\cos^2\varphi = 1 - \sin^2\varphi$$

   ⠉⠕⠎⠘⠆⠀⠨⠋⠀⠨⠅⠀⠼⠂⠤⠎⠊⠝⠘⠆⠀⠨⠋

Lowercase Omega Examples

1. The lowercase Greek letter Omega which often represents angular velocity is written

   $$\omega$$

   ⠨⠺

2. Lowercase Greek letter Omega equals fifteen degrees per hour is written

   $$\omega = 15^\circ / \mathit{hour}$$

   ⠨⠺⠀⠨⠅⠀⠼⠂⠢⠘⠨⠡⠐⠸⠌⠓⠕⠥⠗

3. Lowercase Greek letter Omega equals open fraction v over r close fraction is written

   $$\omega = \frac{v}{r}$$

   ⠨⠺⠀⠨⠅⠀⠹⠧⠌⠗⠼

Appendix B
Biology

Hardy-Weinberg Equations

p (frequency of the dominant allele in a population)
q (frequency of the recessive allele in a population)

$$p^2 + 2pq + q^2 = 1$$

⠏⠘⠆⠐⠬⠆⠏⠟⠬⠟⠘⠆⠐⠀⠨⠅⠀⠼⠂

$$p^2 + q = 1$$

⠏⠘⠆⠐⠬⠟⠀⠨⠅⠀⠼⠂

Mean

$\overline{x}$ (mean)
n (size of the sample)
x_i (data value)

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

⠭⠱⠀⠨⠅⠀⠹⠂⠌⠝⠼⠐⠨⠠⠎⠩⠊⠀⠨⠅⠀⠼⠂⠣⠝⠻⠭⠰⠊

Photosynthesis

$$6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$$

⠼⠖⠠⠉⠠⠕⠆⠬⠖⠠⠓⠆⠠⠕⠀⠫⠕⠀⠠⠉⠖⠠⠓⠂⠆⠠⠕⠖⠬⠖⠠⠕⠆

Respiration

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

⠠⠉⠖⠠⠓⠂⠆⠠⠕⠖⠬⠖⠠⠕⠆⠀⠫⠕⠀⠼⠖⠠⠉⠠⠕⠆⠬⠖⠠⠓⠆⠠⠕

Standard Deviation

s (standard deviation)
$\overline{x}$ (mean)
n (size of the sample)
x_i (data value)

$$s = \sqrt{\frac{\sum\left(x_i - \overline{x}\right)^2}{n-1}}$$

⠎ ⠨⠅ ⠜⠹⠨⠠⠎⠷⠭⠰⠊⠐⠤⠭⠱⠾⠘⠆⠐⠌⠝⠤⠂⠼⠻

Appendix C
Chemistry

Chemistry (Common Equations and Formulas)

Avogadro's Law

V_1 (initial volume)
n_1 (initial moles)
V_2 (final volume)
n_2 (final moles)

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

⠹⠠⠧⠂⠌⠝⠂⠼ ⠨⠅ ⠹⠠⠧⠆⠌⠝⠆⠼

Boiling Point Elevation

ΔT_b (boiling point elevation)
K_b (molal boiling point constant)
m (molality)

$$\Delta T_b = K_b m$$

⠨⠠⠙⠠⠞⠰⠃ ⠨⠅ ⠠⠅⠰⠃⠐⠍

Boyles Law

P_1 (initial pressure)
V_1 (initial volume)
P_2 (final pressure)
V_2 (final volume)

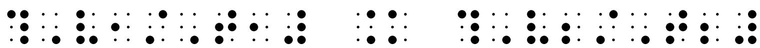
$$P_1 V_1 = P_2 V_2$$

⠠⠏⠂⠠⠧⠂ ⠨⠅ ⠠⠏⠆⠠⠧⠆

Charles Law

V_1 (initial volume)
T_1 (initial temperature)
V_2 (final volume)
T_2 (final temperature)

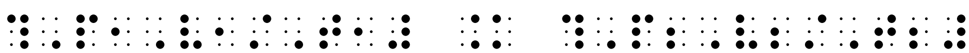
$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$



Combined Gas Law

P_1 (initial pressure)
V_1 (initial volume)
T_1 (initial temperature)
P_2 (final pressure)
V_2 (final volume)
T_2 (final temperature)

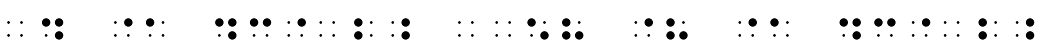
$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$



Density

D (density)
ρ (density which is commonly represented by the lowercase Greek letter rho)
m (mass)
V (volume)

$$D = \frac{m}{V} \text{ or } \rho = \frac{m}{V}$$



Enthalpy of Reaction

ΔH (enthalpy of reaction)
ΔH_f°(products) (enthalpy of products)
ΔH_f°(reactants) (enthalpy of reactants)

$$\Delta H = \Delta H_f^\circ(\text{products}) - \Delta H_f^\circ(\text{reactants})$$

Equilibrium Constant

K_{eq} (equilibrium constant)
[A] (concentration in moles per liter of gas A)
[B] (concentration in moles per liter of gas B)
[C] (concentration in moles per liter of gas C)
[D] (concentration in moles per liter of gas D)
a (coefficient of gas A)
b (coefficient of gas B)
c (coefficient of gas C)
d (coefficient of gas D)

Given the general chemical equation $aA + bB \rightleftharpoons cC + dD$,

$$K_{eq} = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

Final Mass

m_f (final mass)
m_i (initial mass)
n (number of half-lives)

$$m_f = m_i\left(\frac{1}{2}\right)^n$$

Freezing Point Depression

ΔT_f (freezing point depression)
K_f (molal freezing point constant)
m (molality)

$$\Delta T_f = K_f m$$

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Gay-Lussac's Law (aka Amontons Law)

P_1 (initial pressure)
T_1 (initial temperature)
P_2 (final pressure)
T_2 (final temperature)

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

⠹⠠⠏⠂⠌⠠⠞⠂⠼ ⠨⠅ ⠹⠠⠏⠆⠌⠠⠞⠆⠼

Heat Gained or Lost

Q (heat gained or lost)
m (mass)
c_p (specific heat)
ΔT (change in temperature)

$$Q = mc_p\Delta T$$

⠠⠟ ⠨⠅ ⠍⠉⠰⠏⠐⠨⠠⠙⠠⠞

Ideal Gas Law

P (pressure)
V (volume)
n (number of particles in moles)
R (ideal gas constant)
T (temperature in Kelvin)

$$PV = nRT$$

⠠⠏⠠⠧ ⠨⠅ ⠝⠠⠗⠠⠞

Ideal Gas Law (Second Form)

P_1 (initial pressure)
V_1 (initial volume)
n_1 (initial moles)
T_1 (initial temperature)
P_2 (final pressure)
V_2 (final volume)
T_2 (final temperature)
n_2 (final moles)

$$\frac{P_1 V_1}{n_1 T_1} = R = \frac{P_2 V_2}{n_2 T_2}$$

⠹⠠⠏⠂⠠⠧⠂⠌⠝⠂⠠⠞⠂⠼ ⠨⠅ ⠠⠗
⠨⠅ ⠹⠠⠏⠆⠠⠧⠆⠌⠝⠆⠠⠞⠆⠼

Ionization Constant of Water

K_W (ionization constant of water)
$[H^+]$ (hydrogen ion concentration)
$[OH^-]$ (hydroxide ion concentration)

$$K_w = [H^+][OH^-]$$

⠠⠅⠰⠺ ⠨⠅ ⠈⠷⠠⠓⠘⠬⠐⠈⠾⠈⠷⠠⠕⠠⠓⠘⠤⠐⠈⠾

Molality

m (molality)
mol (moles of solute)
kg (kilograms of solvent)

$$m = \frac{mol}{kg}$$

⠍ ⠨⠅ ⠹⠍⠕⠇⠌⠅⠛⠼

Molarity

M (molarity)
mol (moles of solute)
L (liters of solution)

$$M = \frac{mol}{L}$$

⠠⠍ ⠨⠅ ⠹⠍⠕⠇⠌⠠⠇⠼

Percent Error

V_a (accepted value)
V_e (experimental value)

$$\% \, error = \frac{|V_a - V_e|}{V_a} \times 100$$

⠈⠴⠑⠗⠗⠕⠗
⠨⠅ ⠹⠳⠠⠧⠰⠁⠐⠤⠠⠧⠰⠑⠐⠳⠌⠠⠧⠰⠁⠐⠼⠈⠡⠂⠴⠴

Percent Yield

Y_a (actual yield)
Y_t (theoretical yield)

$$\% \, yield = \frac{Y_a}{Y_t} \times 100$$

⠈⠴⠽⠊⠑⠇⠙ ⠨⠅ ⠹⠠⠽⠰⠁⠐⠌⠠⠽⠰⠞⠐⠼⠈⠡⠂⠴⠴

pH

$[H^+]$ (hydrogen ion concentration)

$$pH = -\log[H^+]$$

⠏⠠⠓ ⠨⠅ ⠤⠇⠕⠛ ⠈⠷⠠⠓⠘⠬⠐⠈⠾

Planck's constant

$6.63 \times 10^{-34} J \cdot s$

⠼⠖⠨⠖⠒⠈⠡⠂⠴⠘⠤⠒⠲ ⠰⠠⠚⠡⠰⠎

Planck–Einstein Relation

E (energy)
h (Planck's constant which is $6.63 \times 10^{-34} J \cdot s$)
f (frequency)
c (speed of light)
λ (wavelength which is commonly represented by the lowercase Greek letter lambda)

$$E = hf = \frac{hc}{\lambda}$$

⠠⠑ ⠨⠅ ⠓⠋ ⠨⠅ ⠹⠓⠉⠌⠨⠇⠼

Radioactive Half-Life

N_t (mass of radioactive material at time interval t)
N_o (mass of the original amount of radioactive material)
k (decay constant)
t (time interval for a half-life period)

$$ln \frac{N_t}{N_o} = -kt$$

⠇⠝ ⠹⠠⠝⠰⠞⠐⠌⠠⠝⠰⠕⠐⠼ ⠨⠅ ⠤⠅⠞

Speed of Light

c (speed of light)
f (frequency)
λ (wavelength which is commonly represented by the lowercase Greek letter lambda)
P_1 (partial pressure of component gas 1)
P_2 (partial pressure of component gas 2)
P_3 (partial pressure of component gas 3)

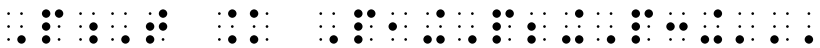
$$P_T = P_1 + P_2 + P_3 + \ldots$$

⠠⠏⠰⠠⠞ ⠨⠅ ⠠⠏⠂⠬⠠⠏⠆⠬⠠⠏⠒⠬⠄⠄⠄

Total Pressure of a Gas

P_T (total pressure of a gas)
P_1 (partial pressure of component gas 1)
P_2 (partial pressure of component gas 2)
P_3 (partial pressure of component gas 3)

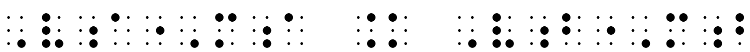
$$P_T = P_1 + P_2 + P_3 + \ldots$$



Volume Molarity Relationship

V_a (volume of solution a)
M_a (molarity of solution a)
V_b (volume of solution b)
M_b (molarity of solution b)

$$V_a M_a = V_b M_b$$



For more information and examples, see the current BANA Guidance
https://www.brailleauthority.org/nemeth-code

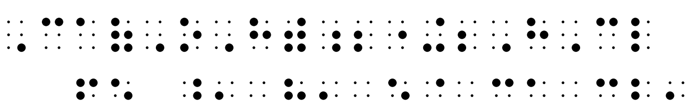
Chemical Nomenclature

Chemical Equations

$$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$$

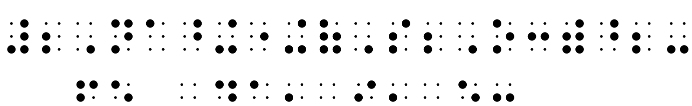
Chemical Equation with Parenthesis

$$Ca(OH)_2 + 2HCl \rightarrow 2H_2O + CaCl_2$$



Equation with Ionic Properties

$$2Na^{+} + (S_2O_3)^{2-} \rightarrow Na_2S_2O_3$$



Equilibrium Equation with States of Matter

$$2H_2(g) + O_2(g) \rightleftarrows 2H_2O(l)$$

⠼⠆⠠⠓⠆⠷⠛⠾⠬⠠⠕⠆⠷⠛⠾
  ⠫⠒⠒⠕⠫⠪⠒⠒ ⠼⠆⠠⠓⠆⠠⠕⠷⠇⠾

Down Pointing Arrow (Precipitation)

(down arrow indicates a precipitate forms in the reaction)

$$Ca_3(PO_4)_2 + 3H_2SO_4 \rightarrow 2H_3PO_4 + 3CaSO_4 \downarrow$$

⠠⠉⠁⠒⠷⠠⠏⠠⠕⠲⠾⠰⠆⠐⠬⠒⠠⠓⠆⠠⠎⠠⠕⠲
  ⠫⠕ ⠼⠆⠠⠓⠒⠠⠏⠠⠕⠲⠬⠒⠠⠉⠁⠠⠎⠠⠕⠲⠫⠩

Up Pointing Arrow (Vaporization)

(up arrow indicates a gas is released)

$$2H_3PO_4 \rightarrow H_4P_2O_7 + H_2O \uparrow$$

⠼⠆⠠⠓⠒⠠⠏⠠⠕⠲ ⠫⠕ ⠠⠓⠲⠠⠏⠆⠠⠕⠶⠬⠠⠓⠆⠠⠕⠫⠣

Appendix D
Periodic Table

It is important to get the student a copy of the periodic table when the rest of the class is using the periodic table. Below are some good sources for a periodic table.

- American Printing House for the Blind (APH) Periodic Table of Elements Reference Booklets, Nemeth (discontinued, but may be available from your state's EOT)
    - Includes:
        - Print Reference Booklet for the teacher https://www.aph.org/product/periodic-table-of-the-elements-reference-chart-and-booklet-print/
        - Braille Reference Booklet for the student https://www.aph.org/product/periodic-table-of-the-elements-reference-chart-and-booklet-braille/
        - Tactile graphic of the Periodic Table of the Elements that spans two facing pages with corresponding print representation (was available with each of the reference booklets above)
- American Printing House for the Blind (APH) Azer's Interactive Periodic Table Study Set (NEMETH) https://www.aph.org/product/azers-interactive-periodic-table-study-set-nemeth/
- Tactile Vision Graphics Periodic Table of Chemical Elements https://tactilevisiongraphics.com/product/table-of-elements/
- More information https://www.perkinselearning.org/technology/blog/accessible-periodic-table-options

Appendix E
Physics

Acceleration

a (acceleration)
t_f (final time)
t_i (initial time)
v_f (final velocity)
v_i (initial velocity)
Δt (change in time)
Δd (change in position, distance traveled, or displacement)
Δv (change in velocity-m/s)

$$a = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i} = \frac{{v_f}^2 - {v_i}^2}{2\Delta d} = \frac{\text{distance}}{\text{time}^2}$$

Centripetal Acceleration

a_c (centripetal acceleration)
v_t (tangential velocity)
r (radius)

$$a_c = \frac{{v_t}^2}{r}$$

Coulomb's Constant

N (Newton)
C (Coulombs)
m (meters)

$$8.988 \times 10^9 \left(\frac{Nm^2}{C^2}\right)$$

Density

m (mass)
V (volume)
ρ (density which is commonly represented by the lowercase Greek letter rho)

$$\rho = \frac{m}{V}$$

⠨⠗ ⠨⠅ ⠹⠍⠌⠠⠧⠼

Displacement

v_i (initial velocity)
a (acceleration)
Δd (distance traveled or displacement)
Δt (change in time)

$$\Delta d = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

⠨⠠⠙⠙ ⠨⠅ ⠧⠰⠊⠐⠨⠠⠙⠞⠬⠹⠂⠌⠆⠼⠁⠨⠠⠙⠞⠘⠆

Distance (for Something Falling)

d (distance traveled)
g (acceleration due to gravity which is 9.8 m/s^2 on earth's surface)
t (time)

$$d = \frac{1}{2} g t^2$$

⠙ ⠨⠅ ⠹⠂⠌⠆⠼⠛⠞⠘⠆

Eccentricity

e (eccentricity)
f (distance between foci of an ellipse)
d (major axis length of an ellipse)

$$e = \frac{f}{d}$$

⠑ ⠨⠅ ⠹⠋⠌⠙⠼

Efficiency

Eff (percent efficiency)
W_O (work out)
W_I (work in)

$$Eff = \frac{W_O}{W_I} \times 100$$

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Einstein's Equation (Mass-Energy Equivalence)

E (energy)
m (mass)
c (speed of light which is 3×10^8 m/s)

$$E = mc^2$$

⠠⠑ ⠨⠅ ⠍⠉⠘⠆

Elastic Potential Energy

EPE (elastic potential energy)
k (spring constant)
x (distance stretched or compressed)

$$EPE = \frac{1}{2}kx^2$$

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Electric Current

I (current)
V (voltage)
R (resistance)

$$I = \frac{V}{R}$$

⠠⠊ ⠨⠅ ⠹⠠⠧⠌⠠⠗⠼

Electric Energy

E (energy)
P (power)
t (time)

$$E = Pt$$

⠠⠑ ⠨⠅ ⠠⠏⠞

Electric Field

E (electric field)
F_E (electric force)
q (test charge)

$$E = \frac{F_E}{q}$$

⠠⠑ ⠨⠅ ⠹⠠⠋⠰⠠⠑⠐⠌⠟⠼

Electric Force

F_E (electrical force between 2 charged particles)
k_C (Coulomb's constant which is $8.988 \times 10^9 \left(\frac{Nm^2}{C^2}\right)$)
q_1 (charge of 1st particle)
q_2 (charge of 2nd particle)
d (distance between particles)

$$F_E = \frac{k_C q_1 q_2}{d^2}$$

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Electric Potential

V (electric potential)
EPE (electric potential energy)
q (charge)

$$V = \frac{EPE}{q}$$

⠠⠧ ⠨⠅ ⠹⠠⠠⠑⠏⠑⠌⠟⠼

Electric Power

P (electric power)
V (voltage)
I (current)

$P = VI$

⠠⠏ ⠨⠅ ⠠⠧⠠⠊

Electric Voltage

V (voltage)
I (current)
R (resistance)

$V = IR$

⠠⠧ ⠨⠅ ⠠⠊⠠⠗

Energy (of Waves)

E (energy)
h (Planck's constant which is $6.63 \times 10^{-34} J \cdot s$)
f (frequency)

$E = hf$

⠠⠑ ⠨⠅ ⠓⠋

Equivalent Resistance (Resistors in Series)

R (series resistance)
R_1 (resistance 1)
R_2 (resistance 2)
R_3 (resistance 3)

$R = R_1 + R_2 + R_3 + \ldots$

⠠⠗ ⠨⠅ ⠠⠗⠂⠬⠠⠗⠆⠬⠠⠗⠒⠬ ⠄⠄⠄

Equivalent Resistance (Resistors in Parallel)

R (parallel resistance)
R_1 (resistance 1)
R_2 (resistance 2)
R_3 (resistance 3)

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

Focal Length (Positive for Concave Mirrors, Negative for Convex Mirrors)

f (focal length)
R (radius of curvature of the mirror's surface)

$$f = \frac{R}{2}$$

Frequency (of Waves)

f (frequency)
T (period)

$$f = \frac{1}{T}$$

Gravitational Constant

N (Newton)
kg (kilogram)
m (meters)

$$G = 6.67 \times 10^{-11} \left(\frac{Nm^2}{kg^2} \right)$$

Gravitational Force (Between Two Objects)

F_g (gravitational force between 2 objects)
G (gravitational constant which is $6.67 \times 10^{-11} \left(\frac{Nm^2}{kg^2} \right)$)
m_1 (mass of 1st object)
m_2 (mass of 2nd object)
d (distance between centers of objects)

$$F_g = \frac{Gm_1m_2}{d^2}$$

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Gravitational Potential Energy

GPE (gravitational potential energy)
m (mass)
g (acceleration due to gravity which is 9.8 m/s^2 on earth's surface)
h (height)

$$GPE = mgh$$

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Heat Gained or Lost

Q (heat gained or lost)
m (mass)
c_p (specific heat)
ΔT (change in temperature)

$$Q = mc_p\Delta T$$

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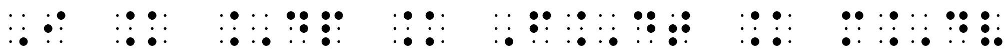
Impulse (Change in Momentum)

I (impulse)
Δp (change in momentum)
F (force)
Δt (change in time, elapsed time)
M (mass)
Δv (change in velocity)

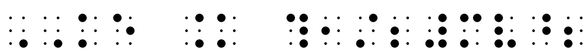
$$I = \Delta p = F\Delta t = m\Delta v$$



Kinetic Energy

KE (kinetic energy)
m (mass)
v (velocity)

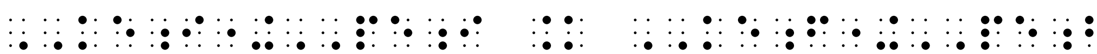
$$KE = \frac{1}{2}mv^2$$



Law of Conservation of Energy

KE_i (initial kenetic energy)
PE_i (initial potential energy)
KE_f (final kinetic energy)
PE_f (final potential energy)

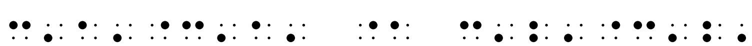
$$KE_i + PE_i = KE_f + PE_f$$



Law of Conservation of Momentum

m_1 (mass of particle A)
u_1 (velocity of particle A before impact)
v_1 (velocity of particle A after impact)
m_2 (mass of particle B)
u_2 (velocity of particle B before impact)
v_2 (velocity of particle B after impact)

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$



Lorentz Factor (Gamma Factor)

ϒ (Lorentz Factor represented by the lowercase Greek letter gamma)
v (velocity)
c (speed of light which is 3×10^{8} m/s)

$$\gamma = \frac{1}{\sqrt{1 - \left(\frac{v}{c}\right)^{2}}}$$

⠨⠛ ⠨⠅ ⠠⠹⠂⠠⠌⠜⠂⠤⠷⠹⠧⠌⠉⠼⠾⠘⠆⠐⠻⠠⠼

Mechanical Energy

ME (mechanical energy)
KE (kinetic energy)
PE (potential energy)

$$ME = KE + PE$$

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Mirror Equation

f (focal length)
d_i (distance to image)
d_o (distance to object)

$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

⠹⠂⠌⠋⠼ ⠨⠅ ⠹⠂⠌⠙⠰⠊⠐⠼⠬⠹⠂⠌⠙⠰⠕⠐⠼

Momentum

p (momentum)
m (mass)
v (velocity)

$$p = mv$$

⠏ ⠨⠅ ⠍⠧

Net Force

F (net force, sum of all forces)
m (mass)
a (acceleration)

$F = ma$

⠠⠋ ⠨⠅ ⠍⠁

Period (of Waves)

T (period)
f (frequency)

$T = \frac{1}{f}$

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Period (of a Pendulum)

T (period)
l (length)
g (acceleration due to gravity which is 9.8 m/s^2 on earth's surface)

$T = 2\pi\sqrt{\frac{l}{g}}$

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Planck's Constant

J (Joule)
s (second)

$6.63 \times 10^{-34} J \cdot s$

⠼⠖⠨⠖⠒⠈⠡⠂⠴⠘⠤⠒⠲ ⠰⠠⠚⠡⠰⠎

Position

x (position)
x_0 (initial position)
v_0 (initial velocity)
t (time)
a (acceleration)

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$

⠭ ⠨⠅ ⠭⠴⠬⠧⠴⠞⠬⠹⠂⠌⠆⠼⠁⠞⠘⠆

Power

P (power)
W (work done)
t (time interval)

$$P = \frac{W}{t}$$

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Pressure

P (pressure)
F (Newtons)
A (area in meters squared)

$$P = \frac{F}{A}$$

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Pythagorean Theorem

a and b (legs)
c (hypotenuse)

$$a^2 + b^2 = c^2$$

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Restoring Force

F (restoring force)
k (spring constant)
x (displacement)

$$F = -kx$$

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Speed

s (speed)
Δd (distance traveled)
Δt (change in time)

$$s = \frac{\Delta d}{\Delta t}$$

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Torque

τ (torque which is commonly represented by the lowercase Greek letter tau)
F (force)
r (lever arm)

$$\tau = Fr$$

⠨⠞ ⠨⠅ ⠠⠋⠗

Velocity (Average)

v_{avg} (average velocity)
t_f (final time)
t_i (initial time)
x_f (final position)
x_i (initial position)
Δx (change in position, distance traveled, or displacement)
Δt (change in time)

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

⠧⠰⠁⠧⠛ ⠨⠅ ⠹⠨⠠⠙⠭⠌⠨⠠⠙⠞⠼
⠨⠅ ⠹⠭⠰⠋⠐⠤⠭⠰⠊⠐⠌⠞⠰⠋⠐⠤⠞⠰⠊⠐⠼

Velocity (for Constant Acceleration)

v_f (final or instantaneous velocity)
v_i (initial velocity)
a (acceleration)
t (time)

$$v_f = v_i + at$$

⠧⠰⠋ ⠨⠅ ⠧⠰⠊⠐⠬⠁⠞

Velocity (for Something Falling)

v (velocity)
v_f (final or instantaneous velocity)
v_i (initial velocity)
g (acceleration due to gravity which is 9.8 m/s^2 on earth's surface)
t (time)

$v = gt$ or $v_f = v_i - gt$

⠧ ⠨⠅ ⠛⠞ ⠠⠄⠕⠗ ⠧⠰⠋ ⠨⠅ ⠧⠰⠊⠐⠤⠛⠞

Velocity (of Waves)

v (velocity)
f (frequency)
λ (wavelength which is commonly represented by the lowercase Greek letter lambda)

$$v = f \cdot \lambda$$

⠧ ⠨⠅ ⠋⠡⠨⠇

Weight (Object with Only Force of Gravity Acting On It)

W (weight)
m (mass)
g (acceleration due to gravity which is 9.8 m/s^2 on earth's surface)

$$W = mg$$

⠠⠺ ⠨⠅ ⠍⠛

Work

W (work)
F (force)
d (distance)
θ (angle between the force direction and movement direction which is commonly represented by the lowercase Greek letter theta)
ΔKE (change in kinetic energy)

$W = Fd$ or $W = Fd\cos\theta$ or $W = \Delta KE$

⠠⠺ ⠨⠅ ⠠⠋⠙ ⠠⠄⠕⠗ ⠠⠺ ⠨⠅ ⠠⠋⠙⠉⠕⠎⠨⠹
⠠⠄⠕⠗ ⠠⠺ ⠨⠅ ⠨⠠⠙⠠⠅⠠⠑

Appendix F
Metric System

10^n	Prefix	Symbol	Decimal
10^{24}	Yotta	Y	1,000,000,000,000,000,000,000,000
10^{21}	Zetta	Z	1,000,000,000,000,000,000,000
10^{18}	Exa	E	1,000,000,000,000,000,000
10^{15}	Peta	P	1,000,000,000,000,000
10^{12}	Tera	T	1,000,000,000,000
10^9	Giga	G	1,000,000,000
10^6	Mega	M	1,000,000
10^3	Kilo	k	1,000
10^2	Hecto	h	100
10^1	Deka	da	10
10^0	(Base)		1
10^{-1}	Deci	d	0.1
10^{-2}	Centi	c	0.01
10^{-3}	Milli	m	0.001
10^{-6}	Micro	µ	0.000001
10^{-9}	Nano	n	0.000000001
10^{-12}	Pico	p	0.000000000001
10^{-15}	Femto	f	0.000000000000001
10^{-18}	Atto	a	0.000000000000000001
10^{-21}	Zepto	z	0.000000000000000000001
10^{-24}	Yocto	y	0.000000000000000000000001

References

Braille Authority of North America. *BANA Guidelines for the Transcription of Early Educational Materials from Print to Braille*. Retrieved from https://www.brailleauthority.org/early-learning-materials

Braille Authority of North America. (2018). *Guidance for Transcription Using the Nemeth Code Within UEB Contexts*. Retrieved from https://www.brailleauthority.org/nemeth-code

Braille Authority of North America. (2007-2015). Addendum, applications, and updates. Retrieved from https://www.brailleauthority.org/nemeth-code

Braille Authority of North America. (2010). *Guidelines and Standards for Tactile Graphics.* Retrieved from http://www.brailleauthority.org/tg/index.html

Common Core State Standards Initiative. (2010). *Common Core State Standards for Mathematics*. Washington, DC: National Governors Association Center for Best Practices and the Council of Chief State School Officers. Retrieved from http://www.corestandards.org/Math/

International Council on English Braille. (2013). *The Rules of Unified English Braille* (2nd ed.). Retrieved from http://iceb.org/Rules%20of%20Unified%20English%20Braille%202013.pdf

Maryland Department of Education. (2015). *Maryland College and Career Ready Standards for Unified English Braille.* Retrieved from https://www.pathstoliteracy.org/wp-content/uploads/2023/08/MD_College_and_Career_Ready_Standards_for_Unified_English_Braille_Math.pdf

National Federation for the Blind. (2015). *Instruction Manual for Braille Transcribing – UEB Edition*. Baltimore, MD: Author. https://nfb.org/programs-services/braille-certification/ueb-resources

Nemeth, A. (1972). *The Nemeth Braille Code for Mathematics and Science Notation*. Louisville, KY: American Printing House for the Blind. https://www.brailleauthority.org/nemeth-code