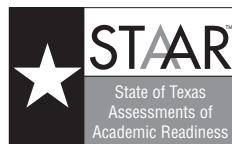


STAAR PHYSICS REFERENCE MATERIALS



FORCE AND MOTION

$$\text{Average velocity} = \frac{\text{displacement}}{\text{change in time}}$$

$$v_{\text{avg}} = \frac{\Delta d}{\Delta t}$$

$$\text{Acceleration} = \frac{\text{final velocity} - \text{initial velocity}}{\text{change in time}}$$

$$a = \frac{v_f - v_i}{\Delta t}$$

$$\text{Acceleration} = \frac{(\text{final velocity})^2 - (\text{initial velocity})^2}{2(\text{displacement})}$$

$$a = \frac{v_f^2 - v_i^2}{2\Delta d}$$

$$\text{Displacement} = \left(\begin{array}{l} \text{initial} \\ \text{velocity} \end{array} \right) \left(\begin{array}{l} \text{change} \\ \text{in time} \end{array} \right) + \frac{1}{2} (\text{acceleration}) \left(\begin{array}{l} \text{change} \\ \text{in time} \end{array} \right)^2$$

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

$$\text{Centripetal acceleration} = \frac{(\text{tangential velocity})^2}{\text{radius}}$$

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

$$\text{Net force} = (\text{mass})(\text{acceleration})$$

$$F_{\text{net}} = ma$$

$$\text{Work} = (\text{force})(\text{distance})$$

$$W = Fd$$

$$\text{Torque} = (\text{force})(\text{lever arm})$$

$$\tau = Fr$$

$$\text{Power} = \frac{\text{work}}{\text{time}}$$

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

$$\text{Pythagorean theorem}$$

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

GRAVITATIONAL, ELECTRICAL, AND MAGNETIC FORCES

$$\text{Force of gravitational attraction between 2 objects} = \left(\begin{array}{l} \text{universal gravitation constant} \end{array} \right) \left(\frac{\left(\begin{array}{l} \text{mass of 1st object} \\ \text{mass of 2nd object} \end{array} \right)}{\left(\begin{array}{l} \text{distance between centers of objects} \end{array} \right)^2} \right)$$

$$F_g = G \left(\frac{m_1 m_2}{d^2} \right)$$

$$\text{Force between 2 charged particles} = \left(\begin{array}{l} \text{Coulomb's constant} \end{array} \right) \left(\frac{\left(\begin{array}{l} \text{charge of 1st particle} \\ \text{charge of 2nd particle} \end{array} \right)}{\left(\begin{array}{l} \text{distance between particles} \end{array} \right)^2} \right)$$

$$F_{\text{electric}} = k_c \left(\frac{q_1 q_2}{d^2} \right)$$

$$\text{Electrical power} = (\text{voltage})(\text{current})$$

$$P = VI$$

$$\text{Current} = \frac{\text{voltage}}{\text{resistance}}$$

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

$$\text{Equivalent resistance for resistors in series}$$

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

$$\text{Equivalent resistance for resistors in parallel}$$

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

STAAR PHYSICS REFERENCE MATERIALS



ENERGY AND MOMENTUM

$$\text{Kinetic energy} = \frac{1}{2}(\text{mass})(\text{velocity})^2$$

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

$$\text{Gravitational potential energy} = (\text{mass}) \left(\begin{array}{l} \text{acceleration} \\ \text{due to gravity} \end{array} \right) (\text{height})$$

$$PE_g = mgh$$

$$\text{Elastic potential energy} = \frac{1}{2} \left(\begin{array}{l} \text{spring} \\ \text{constant} \end{array} \right) \left(\begin{array}{l} \text{distance stretched} \\ \text{or compressed} \end{array} \right)^2$$

$$PE_{\text{elastic}} = \frac{1}{2}kx^2$$

$$\text{Energy} = (\text{power})(\text{time})$$

$$E = Pt$$

$$\text{Work} = \text{change in kinetic energy}$$

$$W = \Delta KE$$

$$\text{Mechanical energy} = \text{kinetic energy} + \text{potential energy}$$

$$ME = KE + PE$$

$$\text{Law of conservation of energy}$$

$$KE_i + PE_i = KE_f + PE_f$$

$$\text{Momentum} = (\text{mass})(\text{velocity})$$

$$p = mv$$

$$\text{Impulse} = (\text{force})(\text{change in time}) = (\text{mass})(\text{change in velocity})$$

$$J = F\Delta t = m\Delta v$$

$$\text{Law of conservation of momentum}$$

$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$$

$$\text{Heat gained or lost} = (\text{mass}) \left(\begin{array}{l} \text{specific} \\ \text{heat} \end{array} \right) \left(\begin{array}{l} \text{change in} \\ \text{temperature} \end{array} \right)$$

$$Q = mc_p \Delta T$$

WAVES AND LIGHT

$$\text{Velocity} = (\text{frequency})(\text{wavelength})$$

$$v = f\lambda$$

$$\frac{1}{\text{Focal length}} = \frac{1}{\text{distance to image}} + \frac{1}{\text{distance to object}}$$

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

$$\text{Energy} = (\text{mass})(\text{speed of light})^2$$

$$E = mc^2$$

STAAR PHYSICS REFERENCE MATERIALS



CONSTANTS AND CONVERSIONS

$$c = \text{speed of light} = 3.00 \times 10^8 \frac{\text{m}}{\text{s}}$$

$$g = \text{acceleration due to gravity} = 9.8 \frac{\text{m}}{\text{s}^2}$$

$$G = \text{universal gravitation constant} = 6.67 \times 10^{-11} \frac{\text{N} \cdot \text{m}^2}{\text{kg}^2}$$

$$k_c = \text{Coulomb's constant} = 8.99 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2}$$

$$m_E = \text{mass of Earth} = 5.97 \times 10^{24} \text{ kg}$$

$$r_E = \text{radius of Earth} = 6.37 \times 10^6 \text{ m}$$

$$\text{newton (N)} = \frac{\text{kg} \cdot \text{m}}{\text{s}^2}$$

$$\text{joule (J)} = \text{N} \cdot \text{m}$$

$$\text{watt (W)} = \frac{\text{J}}{\text{s}} = \frac{\text{N} \cdot \text{m}}{\text{s}}$$

$$\text{hertz (Hz)} = \frac{\text{cycle}}{\text{s}}$$

STAAR PHYSICS REFERENCE MATERIALS



| | | | |
|---------|-----------|---------|---------------|
| 1 | H | 1 | 1A |
| 1 | Hydrogen | 1.008 | 2A |
| 2 | Li | 3 | 4 |
| 6.941 | Lithium | 9.012 | Be |
| 11 | Na | 11 | 12 |
| 22.990 | Sodium | 24.305 | Mg |
| 19 | K | 20 | Ca |
| 39.098 | Potassium | 40.078 | Scandium |
| 4 | Rb | 38 | Titanium |
| 85.468 | Rubidium | 87.62 | Scandium |
| 5 | Sr | 39 | Yttrium |
| 56 | Strontium | 88.906 | Zirconium |
| 6 | Ba | 56 | Yttrium |
| 132.905 | Barium | 174.967 | Zirconium |
| 7 | Cs | 88 | Lutetium |
| 137.328 | Cesium | (262) | Hafnium |
| 87 | Fr | 103 | Dubnium |
| 223 | Radium | (267) | Rutherfordium |
| 1 | H | 1 | 2A |

| | |
|-----------------|-----------|
| Atomic number — | 14 |
| Symbol — | Si |
| Atomic mass — | 28.086 |

| | | | |
|---------|--------------|---------|---------------|
| 1 | H | 1 | 1A |
| 1 | Hydrogen | 1.008 | 2A |
| 2 | Li | 3 | 4 |
| 6.941 | Lithium | 9.012 | Beryllium |
| 11 | Na | 11 | 12 |
| 22.990 | Sodium | 24.305 | Magnesium |
| 19 | K | 20 | Ca |
| 39.098 | Potassium | 40.078 | Scandium |
| 4 | Rb | 38 | Titanium |
| 85.468 | Rubidium | 87.62 | Scandium |
| 5 | Sr | 39 | Yttrium |
| 56 | Strontium | 88.906 | Zirconium |
| 6 | Ba | 56 | Yttrium |
| 132.905 | Barium | 174.967 | Zirconium |
| 7 | Cs | 88 | Lutetium |
| 137.328 | Cesium | (262) | Hafnium |
| 87 | Fr | 103 | Dubnium |
| 223 | Radium | (267) | Rutherfordium |
| 1 | H | 1 | 2A |
| 10.812 | Baron | 12.011 | Carbon |
| 13 | B | 13 | C |
| 14.0908 | Praseodymium | 14.4242 | Neodymium |
| 91 | P | 92 | U |
| 231.036 | Protactinium | 238.029 | Uranium |
| 90 | T | 91 | Pa |
| 232.038 | Thorium | (227) | Rutherfordium |
| 140.116 | Cerium | 140.908 | Praseodymium |
| 138.905 | Lanthanum | 140.908 | Praseodymium |
| 89 | A | 90 | Ce |
| (227) | Actinium | 90 | Ce |
| 231.036 | Protactinium | 140.908 | Praseodymium |
| 232.038 | Thorium | 140.908 | Praseodymium |
| 13 | Al | 14 | Si |
| 12.011 | Carbon | 14.007 | Nitrogen |
| 13 | Si | 14 | Al |
| 14.007 | Nitrogen | 15.999 | Oxygen |
| 15 | P | 15 | Si |
| 30.974 | Phosphorus | 32.066 | Sulfur |
| 28.086 | Silicon | 30.974 | Phosphorus |
| 26.982 | Aluminum | 26.982 | Aluminum |
| 31 | Ga | 30 | Zn |
| 69.723 | Gallium | 69.723 | Gallium |
| 72.64 | Germanium | 72.64 | Germanium |
| 32 | Ge | 29 | Ni |
| 114.818 | Silver | 58.693 | Nickel |
| 112.412 | Cadmium | 56.845 | Cobalt |
| 49 | Ag | 45 | Cr |
| 107.868 | Palladium | 44 | Mn |
| 106.42 | Rhodium | 42 | Fe |
| 46 | Pd | 43 | Mn |
| 102.906 | Ruthenium | 41 | Mo |
| 101.07 | Ruthenium | 40 | Nb |
| 100.207 | Ruthenium | 39 | Y |
| 98 | Tc | 98 | Zr |
| 95.96 | Molybdenum | 92.906 | Zr |
| 96.36 | Techneium | 91.224 | Y |
| 97 | Ru | 90 | Os |
| 101.07 | Ruthenium | 89 | Re |
| 102.906 | Ruthenium | 73 | W |
| 106.42 | Ruthenium | 72 | Ta |
| 107.868 | Ruthenium | 71 | Hf |
| 108.207 | Ruthenium | 70 | Lu |
| 109.23 | Ruthenium | 69 | Ta |
| 109.086 | Ruthenium | 68 | Bh |
| 108 | Hs | 67 | Db |
| 107 | Meitnerium | 66 | Sm |
| 106 | Seaborgium | 65 | Pm |
| 105 | Seaborgium | 64 | Eu |
| 104 | Dubnium | 63 | Am |
| 103 | Dubnium | 62 | Pr |
| 102 | Bohrium | 61 | Nd |
| 101 | Bohrium | 60 | Sm |
| 100 | Hassium | 59 | Pr |
| 100 | Hassium | 58 | La |
| 101 | Meitnerium | 57 | Ce |
| 102 | Seaborgium | 56 | La |
| 103 | Bohrium | 55 | Ce |
| 104 | Hassium | 54 | Pr |
| 105 | Hassium | 53 | Pr |
| 106 | Bohrium | 52 | Sm |
| 107 | Bohrium | 51 | Eu |
| 108 | Hassium | 50 | Am |
| 109 | Hassium | 49 | Pm |
| 110 | Meitnerium | 48 | Pr |
| 111 | Meitnerium | 47 | Sm |
| 112 | Bohrium | 46 | Eu |
| 113 | Hassium | 45 | Am |
| 114 | Hassium | 44 | Pm |
| 115 | Bohrium | 43 | Pr |
| 116 | Bohrium | 42 | Sm |
| 117 | Hassium | 41 | Eu |
| 118 | Hassium | 40 | Am |
| 119 | Bohrium | 39 | Pm |
| 120 | Hassium | 38 | Pr |
| 121 | Bohrium | 37 | Sm |
| 122 | Hassium | 36 | Eu |
| 123 | Bohrium | 35 | Am |
| 124 | Hassium | 34 | Pm |
| 125 | Bohrium | 33 | Pr |
| 126 | Hassium | 32 | Sm |
| 127 | Bohrium | 31 | Eu |
| 128 | Hassium | 30 | Am |
| 129 | Bohrium | 29 | Pm |
| 130 | Hassium | 28 | Pr |
| 131 | Bohrium | 27 | Sm |
| 132 | Hassium | 26 | Eu |
| 133 | Bohrium | 25 | Am |
| 134 | Hassium | 24 | Pm |
| 135 | Bohrium | 23 | Pr |
| 136 | Hassium | 22 | Sm |
| 137 | Bohrium | 21 | Eu |
| 138 | Hassium | 20 | Am |
| 139 | Bohrium | 19 | Pm |
| 140 | Hassium | 18 | Pr |
| 141 | Bohrium | 17 | Sm |
| 142 | Hassium | 16 | Eu |
| 143 | Bohrium | 15 | Am |
| 144 | Hassium | 14 | Pm |
| 145 | Bohrium | 13 | Pr |
| 146 | Hassium | 12 | Sm |
| 147 | Bohrium | 11 | Eu |
| 148 | Hassium | 10 | Am |
| 149 | Bohrium | 9 | Pm |
| 150 | Hassium | 8 | Pr |
| 151 | Bohrium | 7 | Sm |
| 152 | Hassium | 6 | Eu |
| 153 | Bohrium | 5 | Am |
| 154 | Hassium | 4 | Pm |
| 155 | Bohrium | 3 | Pr |
| 156 | Hassium | 2 | Sm |
| 157 | Bohrium | 1 | Eu |
| 158 | Hassium | 0 | Am |
| 159 | Bohrium | -1 | Pm |
| 160 | Hassium | -2 | Pr |
| 161 | Bohrium | -3 | Sm |
| 162 | Hassium | -4 | Eu |
| 163 | Bohrium | -5 | Am |
| 164 | Hassium | -6 | Pm |
| 165 | Bohrium | -7 | Pr |
| 166 | Hassium | -8 | Sm |
| 167 | Bohrium | -9 | Eu |
| 168 | Hassium | -10 | Am |
| 169 | Bohrium | -11 | Pm |
| 170 | Hassium | -12 | Pr |
| 171 | Bohrium | -13 | Sm |
| 172 | Hassium | -14 | Eu |
| 173 | Bohrium | -15 | Am |
| 174 | Hassium | -16 | Pm |
| 175 | Bohrium | -17 | Pr |
| 176 | Hassium | -18 | Sm |
| 177 | Bohrium | -19 | Eu |
| 178 | Hassium | -20 | Am |
| 179 | Bohrium | -21 | Pm |
| 180 | Hassium | -22 | Pr |
| 181 | Bohrium | -23 | Sm |
| 182 | Hassium | -24 | Eu |
| 183 | Bohrium | -25 | Am |
| 184 | Hassium | -26 | Pm |
| 185 | Bohrium | -27 | Pr |
| 186 | Hassium | -28 | Sm |
| 187 | Bohrium | -29 | Eu |
| 188 | Hassium | -30 | Am |
| 189 | Bohrium | -31 | Pm |
| 190 | Hassium | -32 | Pr |
| 191 | Bohrium | -33 | Sm |
| 192 | Hassium | -34 | Eu |
| 193 | Bohrium | -35 | Am |
| 194 | Hassium | -36 | Pm |
| 195 | Bohrium | -37 | Pr |
| 196 | Hassium | -38 | Sm |
| 197 | Bohrium | -39 | Eu |
| 198 | Hassium | -40 | Am |
| 199 | Bohrium | -41 | Pm |
| 200 | Hassium | -42 | Pr |
| 201 | Bohrium | -43 | Sm |
| 202 | Hassium | -44 | Eu |
| 203 | Bohrium | -45 | Am |
| 204 | Hassium | -46 | Pm |
| 205 | Bohrium | -47 | Pr |
| 206 | Hassium | -48 | Sm |
| 207 | Bohrium | -49 | Eu |
| 208 | Hassium | -50 | Am |
| 209 | Bohrium | -51 | Pm |
| 210 | Hassium | -52 | Pr |
| 211 | Bohrium | -53 | Sm |
| 212 | Hassium | -54 | Eu |
| 213 | Bohrium | -55 | Am |
| 214 | Hassium | -56 | Pm |
| 215 | Bohrium | -57 | Pr |
| 216 | Hassium | -58 | Sm |
| 217 | Bohrium | -59 | Eu |
| 218 | Hassium | -60 | Am |
| 219 | Bohrium | -61 | Pm |
| 220 | Hassium | -62 | Pr |
| 221 | Bohrium | -63 | Sm |
| 222 | Hassium | -64 | Eu |
| 223 | Bohrium | -65 | Am |
| 224 | Hassium | -66 | Pm |
| 225 | Bohrium | -67 | Pr |
| 226 | Hassium | -68 | Sm |
| 227 | Bohrium | -69 | Eu |
| 228 | Hassium | -70 | Am |
| 229 | Bohrium | -71 | Pm |
| 230 | Hassium | -72 | Pr |
| 231 | Bohrium | -73 | Sm |
| 232 | Hassium | -74 | Eu |
| 233 | Bohrium | -75 | Am |
| 234 | Hassium | -76 | Pm |
| 235 | Bohrium | -77 | Pr |
| 236 | Hassium | -78 | Sm |
| 237 | Bohrium | -79 | Eu |
| 238 | Hassium | -80 | Am |
| 239 | Bohrium | -81 | Pm |
| 240 | Hassium | -82 | Pr |
| 241 | Bohrium | -83 | Sm |
| 242 | Hassium | -84 | Eu |
| 243 | Bohrium | -85 | Am |
| 244 | Hassium | -86 | Pm |
| 245 | Bohrium | -87 | Pr |
| 246 | Hassium | -88 | Sm |
| 247 | Bohrium | -89 | Eu |
| 248 | Hassium | -90 | Am |
| 249 | Bohrium | -91 | Pm |
| 250 | Hassium | -92 | Pr |
| 251 | Bohrium | -93 | Sm |
| 252 | Hassium | -94 | Eu |
| 253 | Bohrium | -95 | Am |
| 254 | Hassium | -96 | Pm |
| 255 | Bohrium | -97 | Pr |
| 256 | Hassium | -98 | Sm |
| 257 | Bohrium | -99 | Eu |
| 258 | Hassium | -100 | Am |
| 259 | Bohrium | -101 | Pm |
| 260 | Hassium | -102 | Pr |
| 261 | Bohrium | -103 | Sm |
| 262 | Hassium | -104 | Eu |
| 263 | Bohrium | -105 | Am |
| 264 | Hassium | -106 | Pm |
| 265 | Bohrium | -107 | Pr |
| 266 | Hassium | -108 | Sm |
| 267 | Bohrium | -109 | Eu |
| 268 | Hassium | -110 | Am |
| 269 | Bohrium | -111 | Pm |
| 270 | Hassium | -112 | Pr |
| 271 | Bohrium | -113 | Sm |
| 272 | Hassium | -114 | Eu |
| 273 | Bohrium | -115 | Am |
| 274 | Hassium | -116 | Pm |
| 275 | Bohrium | -117 | Pr |
| 276 | Hassium | -118 | Sm |
| 277 | Bohrium | -119 | Eu |
| 278 | Hassium | -120 | Am |
| 279 | Bohrium | -121 | Pm |
| 280 | Hassium | -122 | Pr |
| 281 | Bohrium | -123 | Sm |
| 282 | Hassium | -124 | Eu |
| 283 | Bohrium | -125 | Am |
| 284 | Hassium | -126 | Pm |
| 285 | Bohrium | -127 | Pr |
| 286 | Hassium | -128 | Sm |
| 287 | Bohrium | -129 | Eu |
| 288 | Hassium | -130 | Am |
| 289 | Bohrium | -131 | Pm |
| 290 | Hassium | -132 | Pr |
| 291 | Bohrium | -133 | Sm |
| 292 | Hassium | -134 | Eu |
| 293 | Bohrium | -135 | Am |
| 294 | Hassium | -136 | Pm |
| 295 | Bohrium | -137 | Pr |
| 296 | Hassium | -138 | Sm |
| 297 | Bohrium | -139 | Eu |
| 298 | Hassium | -140 | Am |
| 299 | Bohrium | -141 | Pm |
| 300 | Hassium | -142 | Pr |
| 301 | Bohrium | -143 | Sm |
| 302 | Hassium | -144 | Eu |
| 303 | Bohrium | -145 | Am |
| 304 | Hassium | -146 | Pm |
| 305 | Bohrium | -147 | Pr |
| 306 | Hassium | -148 | Sm |
| 307 | Bohrium | -149 | Eu |
| 308 | Hassium | -150 | Am |
| 309 | Bohrium | -151 | Pm |
| 310 | Hassium | -152 | Pr |
| 311 | Bohrium | -153 | Sm |
| 312 | Hassium | -154 | Eu |
| 313 | Bohrium | -155 | Am |
| 314 | Hassium | -156 | Pm |
| 315 | Bohrium | -157 | Pr |
| 316 | Hassium | -158 | Sm |
| 317 | Bohrium | -159 | Eu |
| 318 | Hassium | -160 | Am |
| 319 | Bo | | |