Physics 151

Scientific Notation, Metric System, & Unit Conversion Review Worksheet

Scientific Notation

1. Rewrite the following numbers in **scientific notation**, in simplest form. Include units. Use appropriate significant figures!

a. Altitude of summit of Mt. Ka‘ala (highest point on O‘ahu): 4020 ft =

b. Altitude of summit of Mauna Kea: 13,796 ft =

c. Thickness of a human hair: 0.015 cm =

d. Wavelength of reddish light: 0.0000007 m =

e. Height of your instructor: 1.80 m =

f. Number of galaxies in the universe: 1 trillion galaxies =

g. Age of the universe in seconds: 430,000,000,000,000,000 s =

h. Volume of a hydrogen atom: 0.000 000 000 000 000 000 000 000 621 cm^3 =

2. **Calculate** the following, and write your answer to each in **scientific notation**. Try to do (a)–(i) first *without* the aid of your calculator, then check your answers by redoing them *with* your calculator. Assume that parts (a)–(h) contain *exact* numbers with infinite precision; for parts (i)–(n), express only the appropriate number of *significant figures* in your final answer. [Note that (b), (c), (g), (l), and (m) contain *division* signs, not plus signs.]

a. $10^{10} \times 10^{4}$ =

b. $10^{10} \div 10^{4}$ =

c. $10^{10} \div 10^{-4}$ =

d. $10^{10} + 10^{4}$ =

e. $10^{10} - 10^{4}$ =

f. $(2 \times 10^{5}) \times (3 \times 10^{12})$ =

g. $(3.5 \times 10^{17}) \div (7 \times 10^{8})$ =

h. $10^{7} - (3 \times 10^{6})$ =

i. $(42.3 \times 10^{-5}) + (5.77 \times 10^{-4})$ =

j. $(34.9 \times 10^{6}) \times (212 \times 10^{-15})$ =

k. $(0.88 \times 10^{-3}) \times (6.3 \times 10^{-10})$ =

l. $(9.876 \times 10^{35}) \div (5.4321 \times 10^{-13})$ =

m. mass of Earth ÷ mass of Moon = $(5.974 \times 10^{27}$ g$) \div (7.348 \times 10^{25}$ g$)$ =

n. mass of Earth − mass of Moon = $(5.974 \times 10^{27}$ g$) - (7.348 \times 10^{25}$ g$)$ =

Powers of Ten

3. Insert the correct **metric prefix** abbreviations (be careful to distinguish upper case from lower case!):

10^{-2} m = 1 _____m	10^{9} y = 1 _____y	10^{3} W = 1 _____W
10^{-3} m = 1 _____m	10^{6} W = 1 _____W	10^{-6} s = 1 _____s
10^{-9} m = 1 _____m	10^{3} g = 1 _____g	10^{9} bytes = 1 _____B
10^{6} Hz = 1 _____Hz	10^{-12} s = 1 _____s	10^{12} bytes = 1 _____B

(*units:* m = meter; g = gram; s = second; Hz = hertz, a unit of frequency; y = year; W = watt, a unit of power; B = byte, a unit of computer information)

4. Match each of the following **length units** to the distance that it is best or most frequently used to describe:

A. Size of an ant	_____ 0.1 nm = 1 Å
B. Size of a person	_____ 100 nm = 1000 Å
C. Distances between neighboring stars	_____ 100 μm
D. Diameter of human hair	_____ 1 mm
E. Size of an atom	_____ 100 cm = 1 m
F. Size of viruses and small bacteria	_____ 1 km
G. Distances within our Solar System	_____ 10^{8} km
H. Distances around Oahu	_____ 10^{13} km

Significant Figures

5. How many **significant figures** are represented in each of the following numbers?

a. 579.420

b. 3.14159265

c. 2×10^{11}

d. 50.

e. 3800

f. 5.60×10^{48}

g. 243.

h. 9.0000×10^{-9}

i. 0.00000030

j. 8

Unit Conversions

6. a. Starting with your age in years, calculate **your age in days**. (You do not need to be exact: forget about leap days, etc.)
b. Approximately how many **days** long is your **total life expectancy**?

7. Use your weight in pounds (while standing on the surface of the Earth) to calculate **your mass in kilograms** and **in grams**. (1 kg weighs approx. 2.205 lb on the surface of the Earth) This is a useful thing to know, since almost every other country in the world uses kilograms!

8. a. Convert the speed 1.0000 m/s [meter/second] to **mi/h [miles/hour]**, expressing your answer to 5 significant figures. (*Useful info:* 1 mile = 5280 feet exactly, and 1 inch = 2.54 cm exactly.)

b. Perform the following **unit conversions**: (*Try NOT looking up the metric prefixes… see how many you can do from memory!)*

1.5 TB = ____________________ GB (*Note:* "B" = byte)

1.5 TB = ____________________ MB

1.5 TB = ____________________ kB

1.5 TB = ____________________ B

45 μg = ____________________ mg

45 μg = ____________________ ng

45 μg = ____________________ kg

550 nm = ____________________ km

6328 Å = ____________________ nm (*Note:* 1 Å = 10^{-10} m)

15 ps = ____________________ ns

15 ps = ____________________ μs

15 ps = ____________________ ms

14 Gy = ____________________ s (*Note:* 1 y = 3.156×10^7 s)

1 km^2 = ____________________ m^2

1 m^2 = ____________________ cm^2

1 km^2 = ____________________ mm^2

1 m^3 = ____________________ cm^3

1 m^3 = ____________________ mm^3

200 cm^3 = ____________________ mL (*Note:* 1 m^3 = 1000 L)

1 km^3 = ____________________ L

1.000 atm = ____________________ mbar (*Note:* 1 atm = 1.013 bar)

100. km/h = ____________________ m/s

1 kg·m/s = ____________________ g·cm/s

9.80 $kg{\cdot}m^2/s^2$ = ____________________ $g{\cdot}cm^2/s^2$

330 $g{\cdot}cm^2$ = ____________________ $kg{\cdot}m^2$

Scientific Hypotheses

9. Is each of the following statements a **testable scientific hypothesis**, or **not**?

a. Light travels slower in glass than in air.

b. Love is more important than knowledge.

c. All objects fall 4.9 meters during the first second after release in a vacuum.

d. The universe is filled with tiny particles called hypotons, which have no mass, no charge, and no known form of interaction with ordinary matter.

e. Vanilla tastes better than chocolate.

f. The majority of Americans prefer vanilla to chocolate.

g. All human actions and choices are predestined.

10. Imagine that you are living long ago, and you are having a discussion about the shape of the world with your colleagues. Devise a **simple test or experiment** that you could perform to test (either support or disprove) one of the following hypotheses:
a_1. The surface of the Earth is an infinite flat plane, or
a_2. The surface of the Earth is (nearly) spherical.

For a bigger challenge: similarly devise a test for each of the following two scientific hypotheses. (*Thought question:* How do we even know *today*, with modern technology, that they are true?)
b. The Earth spins.
c. The Earth orbits the Sun, and not the other way around.

Scientific Notation, Metric System, & Unit Conversion Review Worksheet
SOLUTIONS

1. a. 4.02×10^3 ft (or 4.020; it is unclear whether the final zero is significant)
b. 1.3796×10^4 ft
c. 1.5×10^{-2} cm
d. 7×10^{-7} m
e. 1.80 m (this is the same as writing 1.80×10^0 m)
f. 1×10^{12} galaxies (or simply: 10^{12} galaxies)
g. 4.3×10^{17} s (or 4.30, or 4.300, etc., although there are probably only 2 sig. figs)
h. 6.21×10^{-25} cm^3

2. Assume the values in parts (a)–(h) are exact numbers with infinite precision:
a. $10^{10} \times 10^4 = 10^{(10+4)} = 10^{14}$
b. $10^{10} \div 10^4 = 10^{(10-4)} = 10^6$
c. $10^{10} \div 10^{-4} = 10^{(10--4)} = 10^{14}$
d. $10^{10} + 10^4 = 1.000001 \times 10^{10}$
e. $10^{10} - 10^4 = 9.99999 \times 10^9$
f. $(2 \times 10^5) \times (3 \times 10^{12}) = (2 \times 3) \times (10^5 \times 10^{12}) = 6 \times 10^{(5+12)} = 6 \times 10^{17}$
g. $(3.5 \times 10^{17}) \div (7 \times 10^8) = (3.5 \div 7) \times (10^{17} \div 10^8) = 0.5 \times 10^{(17-8)} = 0.5 \times 10^9 = 5 \times 10^8$
h. $10^7 - (3 \times 10^6) = (10 \times 10^6) - (3 \times 10^6) = (10 - 3) \times 10^6 = 7 \times 10^6$
For parts (i)–(n), observe *significant figures*:
i. $(42.3 \times 10^{-5}) + (5.77 \times 10^{-4}) = 1.000 \times 10^{-3}$
j. $(34.9 \times 10^6) \times (212 \times 10^{-15}) = 7.40 \times 10^{-6}$
k. $(0.88 \times 10^{-3}) \times (6.3 \times 10^{-10}) = 5.5 \times 10^{-13}$
l. $(9.876 \times 10^{35}) \div (5.4321 \times 10^{-13}) = 1.818 \times 10^{48}$
m. $(5.974 \times 10^{27}$ g$) \div (7.348 \times 10^{25}$ g$)$ = ratio of mass of Earth to mass of Moon = 81.30 (or: 8.130×10^1)
n. $(5.974 \times 10^{27}$ g$) - (7.348 \times 10^{25}$ g$)$ = difference of mass of Earth and mass of Moon = 5.901×10^{27} g

3.

10^{-2} m = 1 cm (centimeter)	10^9 y = 1 Gy (gigayear)	10^3 W = 1 kW (kilowatt)
10^{-3} m = 1 mm (millimeter)	10^6 W = 1 MW (megawatt)	10^{-6} s = 1 μs (microsecond)
10^{-9} m = 1 nm (nanometer)	10^3 g = 1 kg (kilogram)	10^9 bytes = 1 GB (gigabyte)
10^6 Hz = 1 MHz (megahertz)	10^{-12} s = 1 ps (picosecond)	10^{12} bytes = 1 TB (terabyte)

4.

A. Size of an ant	E	0.1 nm = 1 Å
B. Size of a person	F	100 nm = 1000 Å
C. Distances between neighboring stars	D	100 μm
D. Diameter of human hair	A	1 mm
E. Size of an atom	B	100 cm = 1 m
F. Size of viruses and small bacteria	H	1 km
G. Distances within our Solar System	G	10^8 km
H. Distances around Oahu	C	10^{13} km

5. a. 6 **b.** 9 **c.** 1 **d.** 2 **e.** 2 (or 3 or 4… it's ambiguous!) **f.** 3 **g.** 3 **h.** 5 **i.** 2 **j.** 1

6. a. Assuming an age of 20. years: (20. y) × (365 d / 1 y) = 7300 d
b. Assuming an 80.-year life expectancy: (80. y) × (365 d / 1 y) = 29,000 d (rounded to 2 significant figures)

7. Assuming a weight of 150. pounds: (150. lb) × (1 kg / 2.205 lb) = 68.0 kg

8. a. 1.0000 m/s = 2.2369 mi/h, or 1.0000 mi/h = 0.44704 m/s

b. 1.5 Tb = 1500 Gb or 1.5×10^3 Gb
1.5 Tb = 1,500,000 Mb or 1.5×10^6 Mb
1.5 Tb = 1.5×10^9 kb
1.5 Tb = 1.5×10^{12} b
45 μg = 0.045 mg or 4.5×10^{-2} mg
45 μg = 45,000 ng or 4.5×10^4 ng
45 μg = 4.5×10^{-8} kg
550 nm = 5.5×10^{-10} km
6328 Å = 632.8 nm
15 ps = 0.015 ns or 1.5×10^{-2} ns
15 ps = 1.5×10^{-5} μs
15 ps = 1.5×10^{-8} ms
14 Gy = 4.4×10^{17} s
1 km^2 = 1,000,000 m^2 or 10^6 m^2
1 m^2 = 10,000 cm^2 or 10^4 cm^2
1 km^2 = 10^{12} mm^2
1 m^3 = 1,000,000 cm^3 or 10^6 cm^3
1 m^3 = 1,000,000,000 mm^3 or 10^9 mm^3
200 cm^3 = 200 mL
1 km^3 = 1,000,000,000,000 L or 10^{12} L
1.000 atm = 1013 mbar
100. km/h = 27.8 m/s
1 kg·m/s = 100,000 g·cm/s or 10^5 g·cm/s
9.80 kg·m^2/s^2 = 98,000,000 g·cm^2/s^2 or 9.80×10^7 g·cm^2/s^2
330 g·cm^2 = 3.3×10^{-5} kg·m^2

9. **a.** Yes. One could devise an experiment to test the relative speed of light in various media.
b. No. This is a subjective statement.
c. Yes. This is a statement that can be tested and, if contradicted by measurements, falsified.
d. No, unless there is *some* way that the hypotons' existence can be detected.
e. No. This is a subjective statement.
f. Yes. A survey can be performed to support or disprove the statement (to within a desired level of certainty).
g. No. There is no possible test that could be performed that might disprove the statement.

10. a. If the Earth is spherical, then ships should disappear over the horizon bottom-first and mast-last. Aristotle also deduced that the Earth must be spherical since lunar eclipses always show the shadow of the Earth as a circle, no matter the direction in which the eclipse happens.
b. If the Earth were not spinning, we would need a new explanation for the Coriolis effect and Foucault's pendulum.
c. If the Earth were not orbiting the Sun, we would need a new explanation for the annual cycle of parallax motion of the nearest stars.