Physics

Name _____
Date _____ Per _____

USING DIMENSIONAL ANALYSIS

Solve the following problems using dimensional analysis. Express your answers in scientific notation with a maximum of three significant figures in boxes.

Convert these quantities into MKS units. We'll start with easy ones.

1. 0.87 minutes

2. 37 grams

3. 17.5 minutes

4. 7,070 lightyears

These next few conversions require more fractions.

5. 9.6 micrograms

6. 765 hours

7. 3.09 days

8. 7.56×10^{-6} years

Use the handout on approximate values to solve these problems.

9. How many times longer is a human life than the life of an unstable nucleus?

10. How many heartbeats are there in a typical human life span?

11. How many lightyears is it to the Andromeda Galaxy from Earth?

12. If the Sun's mass is about average for stars (which it isn't), how many stars are in the Milky Way Galaxy?

13. If we assume that the Sun is pure hydrogen (which it isn't), how many hydrogen atoms are in the Sun?

14. If a beam of light was produced at the edge of the known universe, how many years would it take to reach Earth?

15. If a hydrogen atom contains only one proton and one electron, what is the mass of a proton? How much more massive than an electron is a proton?

16. How many FM radio waves could pass through your brain during a single nerve impulse? Does this indicate why the human brain incapable of detecting radio waves?

TABLE 1.3

APPROXIMATE VALUES OF LENGTH, MASS, AND TIME

Lengths in meters

10^{-17}	Present experimental limit to smallest observable detail
10^{-15}	Diameter of proton
10^{-14}	Diameter of uranium nucleus
10^{-10}	Diameter of hydrogen atom
10^{-8}	Thickness of membranes in cells of living organisms
10^{-6}	Wavelength of visible light
10^{-3}	Size of grain of sand
1	Height of a 4-year-old child
10^{2}	Length of a football field
10^{4}	Greatest ocean depth
10^{7}	Diameter of the earth
10^{11}	Distance from the earth to the sun
10^{16}	Distance traveled by light in 1 year (a light year)
10^{21}	Diameter of the Milky Way galaxy
10^{22}	Distance from earth to nearest large galaxy (Andromeda)
10^{26}	Distance from earth to edge of the known universe

Range of lengths = $10^{26}/10^{-17} = \mathbf{10^{43}}$

Masses in kilograms
(more precise values in parentheses)

10^{-30}	Mass of an electron (9.11×10^{-31} kg)
10^{-27}	Mass of a hydrogen atom (1.67×10^{-27} kg)
10^{-15}	Mass of a bacterium
10^{-5}	Mass of a mosquito
10^{-2}	Mass of a hummingbird
1	Mass of a liter of water (about a quart)
10^{2}	Mass of a person
10^{3}	Mass of a car
10^{8}	Mass of a large ship
10^{12}	Mass of a large iceberg
10^{15}	Mass of the nucleus of a comet
10^{23}	Mass of the moon (7.36×10^{22} kg)
10^{25}	Mass of the earth (5.98×10^{24} kg)
10^{30}	Mass of the sun (1.99×10^{30} kg)
10^{42}	Mass of the Milky Way galaxy (current upper limit)
10^{53}	Mass of the known universe (current upper limit)

Range of masses = $10^{53}/10^{-30} = \mathbf{10^{83}}$

Times in seconds
(more precise values in parentheses)

10^{-23}	Time for light to cross a proton
10^{-22}	Mean life of an extremely unstable nucleus
10^{-15}	Time for one oscillation of visible light
10^{-13}	Time for one vibration of an atom in a solid
10^{-8}	Time for one oscillation of an FM radio wave
10^{-3}	Duration of a nerve impulse
1	Time for one heartbeat
10^{5}	One day (8.64×10^{4} s)
10^{7}	One year (3.16×10^{7} s)
10^{9}	About half the life expectancy of a human
10^{11}	Recorded history
10^{17}	Age of the earth
10^{18}	Age of the universe

Range of times = $10^{18}/10^{-23} = \mathbf{10^{41}}$