ESR320 Environmental Systems I
PROBLEM SET 1

Units and Unit Conversions / Significant Digits

Please complete the following problems (engineering paper please). Make sure you report all answers with the correct number of significant digits. To remove any ambiguity in the given numbers a "trailing decimal point" (as in "50.") tells you that the previous zeros are all significant.

1. Volume per time in the U.S. is commonly measured in cubic feet per second (cfs). What is the equivalent, in cubic feet per second, of 10. cubic meters per hour ($m^3\ h^{-1}$)?

2. The concept of precipitation "volume" is commonly expressed in terms of a volume per unit area, which has units of depth. That is generally the case in measuring rainfall over a known area, like a river basin. A wet region may receive 2000. mm of rainfall per year. How many inches of rain fall in the area?

3. If 89.5 cm of rain fall per year over a river basin that is 1250 mi^2 in area, what is the volume of water received over a year in cubic meters?

4. An acre is 4047 m^3 and a hectare (ha) is 10,000. m^2 or 2.47 acres. In the U.S., a commonly used unit of volume for water is the acre-ft or the volume of water required to cover one acre of land with water 1 ft deep.
(a) How many cubic feet are in an acre-ft?
(b) How many cubic meters?
(c) How many acre-ft of water are required to cover 500. ha to a depth of 3.0 inches?

5. Another commonly used unit of volume is the U.S. gallon (= 0.003785 m3). Portland's residential per capita daily consumption of water is 84 gallons. How many cubic meters per second is that?

6. One U.S. mile = 5280. ft.
a) How many acres are there in a square mile?
b) How many square kilometers are there in a square mile?
c) How many hectares are there in a square mile?

7. How many significant figures are there in each of the following expressions?
(a) 6.50 cm (b) 0.00560 m (c) 6.02×10^{23} atoms (d) 25,000 m

8. How many significant figures are there in the values of x obtained from the following expressions?
(a) x = 21.00 cm - 20.19 cm
(b) $x = (12.0\text{cm})^3$
(c) x = (6.9 cm)(2.40 cm)
(d)x= (16.2 g + 1.4 g) / (l1.2 cm3)

9. The Ideal Gas Law states that $PV = nRT$. If P is in atm, V in liters, n in mol and T in K, what are the units of the universal gas constant R?

10. Quck basic calculus check:
Find the area bounded by the coordinate axes and the line x + y = 1 by:

a) integrating the function with respect x and
b) geometrically (i.e., graph the function and use a common relation from geometry).

11. What would be the weight in pounds of a l2-kg mass on a planet where the acceleration due to gravity is 31.7 ft/s^2 ?

12. How far in feet does a canoe, moving at 18. mi/h, travel forward during the time that it takes to complete one oar stroke lasting 3.0 s?

13. An automobile travels on a straight road for 50. km at 30. km/h; it then continues in the same direction for another 40. km at 60. Km/h. What is the average speed of the car during this 80. km trip?

14. The density ofwater is about 1.00 glcm3 . What is the mass ofwater, in kilograms, required to fill a flask with a volume of650 mm3 ?

15. Oil spreads out on water to form a film about 1.0 x 10^2 nm thick. How many square kilometers of ocean will be covered by the slick formed when 300 barrels of oil are spilled? (1 barrel = 31.5 U.S. gallons)

16. A student checks the purity of a water sample by determining its density at 25°C. She finds the value given for pure water in a handbook to be 0.9970 *g/cm3* . She measures out 25 cm^3 of the sample from a cylinder and determines its mass to be 25.624. What is the measured density?

17. Suppose that an analysis of an air sample taken from the Sunset Highway tunnel through the Tualatin Mountains in west Portland shows that it contained 8.4 x 10^{-7} g/L of carbon monoxide (CO). Express the concentration of CO in mol/L.

18. When one gram of gasoline burns in an automobile engine, the amount of energy given off is about 1.03 x 10^4 cal. Express this in joules.

19. Basic physics check: What are the SI units for the following properties. Give both a named unit (where one exists) and then give the underlying fundamental units: (in m, kg, s). For example: Energy: Joule = kg m^{-2} s^{-2}

a) Momentum (P)
b) Pressure (p)
c) Power (no common symbol)
d) Velocity (v)
e) Density (ρ)
f) Dynamic viscosity (μ)
g) Kinematic viscosity (υ)
h) Thermal diffusion coefficient (α)
i) Specific heat (c_p or c_v)
j) Acceleration (a)