Chemistry 0094 R10
Fall 2000
Test #1

45

Wednesday, September 27, 2000 **Time:** 1 hour, 50 minutes

Name: ANSWERS Student Number: _____

*This test consists of **six** pages of questions and a periodic table. Please ensure that you have a complete paper and, if you do not, obtain one from me **immediately**. Good luck!*

***Please note:** All work must be shown in order to receive **any** credit for a question.*

1) **[2 marks]** Rewrite each of the following numbers in scientific notation:

a) 0.00287 2.87×10^{-3} b) 630.0 6.300×10^{2}

c) 400 4×10^{2} d) 28.6 2.86×10^{1}

2) **[2 marks]** Perform each mathematical operation and report the answer (using any method you wish) to the correct number of significant figures.

a) 4.000/2.0

2.0

b) 16.283 + 90

106.283

c) (13.7 + 4.62)*21.6

395.712

d) $(2.00 + \sqrt{4.0})/(3.681 - 4.1282)$

-8.94

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3) **[9 marks total]** Perform the indicated unit conversions. *Your method and units must be clearly shown to receive full marks.* 1 L = 1 dm^3, and 1 mL = 1 cm^3.

a) **[1 mark]** 9.5 mm → μm

$$9.5\,mm \times \frac{1\times10^{-3}\,m}{1\,mm} \times \frac{1\,\mu m}{1\times10^{-6}\,m} = \boxed{9.5\times10^{3}\,\mu m}$$

b) **[1 mark]** 2.18 km^2 → hm^2

$$2.18\,km^2 \times \left(\frac{1000\,m}{1\,km}\right)^2\left(\frac{1\,hm}{100\,m}\right)^2 = \boxed{218\,hm^2}$$

c) **[2 marks]** 10 m/s → km/hr

$$10\,\frac{m}{s} \times \frac{1\,km}{1000\,m} \times \frac{60\,sec}{1\,min} \times \frac{60\,min}{1\,hr} = \boxed{36\,\frac{km}{hr}}$$

d) **[2 marks]** 2.8 μg/L → mg/cm^3

$$2.8\,\frac{\mu g}{dm^3} \times \left(\frac{1\times10^{-6}\,g}{1\,\mu g}\right) \times \left(\frac{1\,mg}{1\times10^{-3}\,g}\right) \times \left(\frac{1\,dm}{0.1\,m}\right)^3\left(\frac{1\times10^{-2}\,m}{1\,cm}\right)^3$$

$$= \boxed{2.8\times10^{-6}\,\frac{mg}{cm^3}}$$

e) **[1 mark]** 75°F → K

$75°F - 32°F = 43°F$

$43°F \times \frac{5°C}{9°F} = 23.\overline{8}\,°C; \quad +273.15 = 297.0\overline{38}\,K$

f) **[2 marks]** 8.12 dg/cm^3 → mg/dm^3

$$8.12\,\frac{dg}{cm^3} \times \left(\frac{0.1\,g}{1\,dg}\right)\left(\frac{1\,mg}{1\times10^{-3}\,g}\right)\left(\frac{1\,cm}{1\times10^{-2}\,m}\right)^3\left(\frac{0.1\,m}{1\,dm}\right)^3$$

$$= \boxed{8.12\times10^{5}\,\frac{mg}{dm^3}}$$

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4) **[10 marks total]** A CD player spins your CDs at about five rotations per second. Each revolution moves about 1.00 feet of the audio track on the CD under the laser that reads it. (1 inch = 2.54 cm exactly, 12 inches = 1 foot exactly, 5280 feet = 1 mile exactly, and approximately 365.25 days = 1 year)

a) **[2 marks]** How long (in metres) is the track on a 74-minute CD?

$$\frac{74\ \text{mins}}{\text{CD}} \times \frac{60\ \text{sec}}{\text{min}} \times \frac{5\ \text{rotations}}{1\ \text{sec}} \times \frac{1\ \text{foot}}{\text{rotation}} \times \frac{12\ \text{inches}}{1\ \text{foot}} \times \frac{2.54\ \text{cm}}{1\ \text{inch}} \times \frac{1\times10^{-2}\ \text{m}}{1\ \text{cm}}$$

$$= \boxed{6766.56\ \frac{\text{m}}{\text{CD}}}$$

b) **[4 marks]** Let's suppose that my CD player at home, now eleven years old, plays an average of one 74-minute CD per day. If the circumference of the earth is 24,800 miles, how old (in years) will my CD player be when the length of the audio tracks read by the laser is exactly the circumference of the earth?

$$24{,}800\ \text{mi} \times \frac{5280\ \text{feet}}{\text{mi}} \times \frac{12\ \text{inches}}{\text{Foot}} \times \frac{2.54\ \text{cm}}{1\ \text{inch}} \times \frac{1\times10^{-2}\ \text{m}}{1\ \text{cm}}$$

$$= 39911731.2\ \text{m around the earth.}$$

$$39911731.2\ \text{m} \times \frac{1\ \text{CD}}{6766.56\ \text{m}} = 5898.37\ldots\ \text{CD's}$$

$$5898.37\ \text{CD's} \times \frac{1\ \text{day}}{1\ \text{CD}} \times \frac{1\ \text{year}}{365.25\ \text{days}} = \boxed{16.1\ \text{years old}}$$

c) **[4 marks]** Each of those CDs that gets played needs to be stored in a box that is 5.625 inches wide, 4.9375 inches tall, and 0.375 inches thick. If I played a different CD every day until the length of the audio track that had passed under the laser was the circumference of the earth, what volume (in cubic meters) would be occupied by the boxes needed to store all those CDs?

$$5.625\ \text{in} \times 4.9375\ \text{in} \times 0.375\ \text{in} \times \left(\frac{2.54\ \text{cm}}{1\ \text{in}}\right)^3 \times \left(\frac{1\times10^{-2}\ \text{m}}{1\ \text{cm}}\right)^3$$

$$= 1.707\times10^{-4}\ \frac{\text{m}^3}{\text{CD box}}$$

$$5898.37\ \text{CD boxes} \times 1.707\times10^{-4}\ \frac{\text{m}^3}{\text{CD box}} = \boxed{1.01\ \text{m}^3}$$

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5) **[4 marks]** Iron (Fe) has a density of 7.83 g/cm^3. You have in front of you a beaker which, when empty, has a mass of 253.55 grams. You fill it to the very top (stopping *just* before it overflows) with 582.5 mL of water (density 0.9974 g/mL). To this you start adding iron pellets, which causes water to spill out. If the amount of water that spills out is exactly equal to the volume of iron added, what mass of iron will you have to add so that the beaker, left-over water, and iron have a combined mass of 1000 grams?

Let volume of iron be V:

mass of iron added = $V\text{mL} \times 7.83\frac{\text{g}}{\text{mL}} = 7.83V$

mass of water lost = $V\text{mL} \times 0.9974\frac{\text{g}}{\text{mL}} = 0.9974V$

mass of container w/ iron = mass container + mass water + mass Fe

253.55 580.9855g 7.83V

−0.9974V

want: $1000 = 253.55 + 580.9855 - 0.9974V + 7.83V$

$\Rightarrow V = \boxed{24.22\text{mL Fe}} = \boxed{189.6\text{g Fe}}$

6) **[2 marks]** A 28.3-gram block of gold (density 19.3 g/cm^3) is cut exactly in half. What are the densities of the two new pieces?

$\boxed{19.3\text{g/cm}^3}$

7) **[2 marks]** Classify the following as physical or chemical changes to the indicated substance or mixture:

a) Milk is warming. P

b) Paint is drying. C

c) A penny is dissolving in Coke. C

d) Bread is baking in the oven. C

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8) **[2 marks]** Classify the following as either homogeneous or heterogeneous mixtures:

a) Chalk Homo

b) A sandwich Hetero

c) Paint Homo

d) The inside of a tomato Hetero

9) **[5 marks total]** Given the following table:

n	Z	A	e	nuclide symbol
1	1	2	1	$^{2}_{1}H^{\bullet}$
7	8	15	7	$^{15}_{8}O^{+1}$
4	3	7	6	$^{7}_{3}Li^{3-}$
7	6	13	10	$^{13}_{6}C^{4-}$

a) **[4 marks]** Fill in the missing information in the table above.

b) **[1 mark]** How many protons will there be in a 3- ion of the heaviest isotope of phosphorus?

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10) **[4 marks]** In one experiment, exactly ½ gram of N_2 was converted to NO_2, and in another, exactly 2 grams of N_2 were converted to N_2O_5. What is the value of the ratio:

$$\frac{\text{mass O in } NO_2}{\text{mass O in } N_2O_5}$$

for these two experiments?

$N_2 \rightarrow 2NO_2$ 4 oxygens to 2N

$N_2 \rightarrow N_2O_5$ 5 oxygen to 2N

for 1g each $\frac{4}{5}$

For ½g + 2g: $\frac{\frac{1}{2} \times 4}{2 \times 5} = \frac{2}{10} = \boxed{\frac{1}{5}}$

11) **[3 marks]** A single molecule of ammonia contains one nitrogen atom and three hydrogen atoms. If $\frac{\text{mass of H in ammonia}}{\text{mass ammonia}}$ is 0.177553, what is the value of the ratio

$$\frac{\text{mass of one N atom}}{\text{mass of one H atom}}$$

Note: You may not use the periodic table in your solution.

If 1g of sample, then 0.177553 g H + 0.822447g N

Mass of 1 H in sample would be $\frac{0.177553}{3} = 0.0591843$

$\frac{\text{Mass N}}{\text{Mass H}} = \frac{0.822447\text{g}}{0.0591843} = \frac{13.8963}{1}$