ISP209 Spring 2001 **Homework 1** Name:________________________

Due: Thurs., Jan. 18, 2:40 pm, in Rm 118PA. SN:________________________

Homework Problems

1. Which force, electromagnetic(**E**), gravitational(**G**), weak nuclear(**WN**) or strong nuclear(**SN**), is primarily responsible for the following actions:

falling from a tree. **G**

orbiting of planets. **G**

exploding of a firecracker. **E**

fusion of Deuterium in the sun . **SN**

ebbing of the tide. **G**

burning of a candle. **E**

heating a TV dinner in a microwave oven. **E**

cycling of ATP & ADP in the body. **E**

airconditioning a room. **E**

firing of a gun. **E**

recording on an audio tape. **E**

pressurizing a balloon. **E**

dissolving sugar in water. **E**

coloring of paints. **E**

melting of an ice cube. **E**

ringing of a bell. **E**

breathing the air. **E**

smelling a flower. **E**

flying a jet plane. **E** and **G**

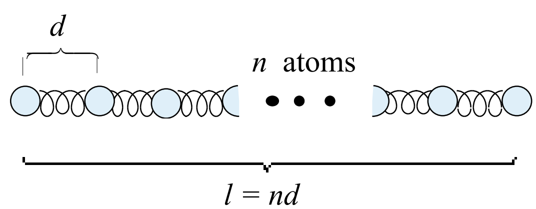
freezing of ice cream. **E**

decay of the isotope Carbon-14. **WN**

fertilizing of a egg. **E**

2. What is the common name for the electromagnetic forces generated in an object when it is stretched from its ends? Tension . Where else do these forces exist in addition to the ends of the object? Throughout the object .

3. What is the name of the electromagnetic forces generated in an object in response to squeezing? Compression. Where else do these forces exist in addition to the ends of the object? Throughout the object .



4. As shown above, the atoms along a sharp edge of a bar, l = 10.00 cm long , are spaced, $d = 7.130 \times 10^{-9}$ cm apart. Use the relationship, $\boxed{l = nd}$, between the length l, and atomic spacing, d, to determine how many atoms, n, are located along the edge of the bar. (use scientific notation with 4 significant digits in calculations, 3 in the expressed answers, and show your work below).

Total number of atoms, $n = l / d = (10.00 \text{ cm}) / (7.130 \times 10^{-9} \text{ cm}) = 1.40 \times 10^{9}$

The number of atoms along the length is 1.40×10^{9}.

Use the relationship again to answer the next few questions. (4 significant digits when available in the calculations, 3 in the expressed answers; and show your work).

What is the new spacing of the atoms, D, along the object when stretched by $S = 1.0\times 10^{-2}$ cm along its length? (answer in 3 significant figures)

$$d = l / n; \quad \text{New spacing } D = L / n = (10.01 \text{ cm}) / 1.40\times 10^{9} = 7.15\times 10^{-9} \text{ cm}$$

The new spacing along the length is $\underline{7.15\times 10^{-9}\text{ cm}}$.

Along one edge of the stretched object, how many atoms lie in the region extending beyond the old length?

$$n = l / d;\ \text{number beyond old length, } n_b = S / D = (0.01 \text{ cm}) / (7.15\times 10^{-9} \text{ cm}) = 1.40\times 10^{6}$$

The number beyond the old length is $\underline{1.40\times 10^{6}}$.

Along one edge of the stretched object, how many atoms are within the old length?

$$n = l / d;\ \text{number within the old length, } n_w = l / D = (10 \text{ cm}) / (7.15\times 10^{-9} \text{ cm}) = 1.40\times 10^{9}$$

The number within the old length is $\underline{1.40\times 10^{9}}$.

Answer the questions above again, considering the number of atoms within the volume, and not just along one edge, if it has a width and height of 1cm each.

$$\text{In an area 1x1 cm}^2\text{, the number of atoms, } n_{1x1} = \left[(1 \text{ cm}) / (7.13\times 10^{-9} \text{ cm})\right]^2 = 1.96\times 10^{16}$$

$$\text{Total number of atoms (by volume)} = n\, n_{1x1} = \left(1.40\times 10^{9}\right)\left(1.96\times 10^{16}\right) = 2.74\times 10^{25}$$

$$\text{Number beyond old length (by volume)} = n_b\, n_{1x1} = \left(1.40\times 10^{6}\right)\left(1.96\times 10^{16}\right) = 2.74\times 10^{22}$$

$$\text{Number within the old length(by volume)} = n_w\, n_{1x1} = \left(1.40\times 10^{9}\right)\left(1.96\times 10^{16}\right) = 2.74\times 10^{25}$$

The number of atoms in the bar is $\underline{2.74\times 10^{25}}$.

The new spacing along bar's length is $\underline{7.15\times 10^{-9}\text{ cm}}$.

The number beyond the old bar length is $\underline{2.74\times 10^{22}}$.

The number within the old bar length is $\underline{2.74\times 10^{25}}$.

5. In an atom with a diameter 1×10^{-10}m, what fraction of the volume is occupied by the nucleus with a diameter 1×10^{-14}m? ($V = \frac{4}{3}\pi r^3$ for a sphere)

$$\frac{V_{nucl}}{V_{atom}} = \frac{\frac{4}{3}\pi r_{nucl}^3}{\frac{4}{3}\pi r_{atom}^3} = \left[\frac{r_{nucl}}{r_{atom}}\right]^3 = \left[\frac{0.5\times 10^{-14}}{0.5\times 10^{-10}}\right]^3 = \left(1\times 10^{-4}\right)^3 = \underline{1\times 10^{-12}} = \frac{1}{1\times 10^{12}}$$

The nucleus occupies (fraction) $\underline{1\times 10^{-12}}$ of the volume.

6. What happens to an object that is elastically (see text for the definition) distorted when the distorting forces are removed? An object will <u>return to normal length</u> when the forces elastically distorting it are removed.

7. Which of the following solids <u>in normal use</u> **do not** behave elastically?

   <u>beach sand</u>, a guitar string, a drum stick, a concrete walkway, the wing of an airplane, an igloo, <u>ice cream</u>, <u>an accordion</u>, <u>a banana</u>, <u>a feather pillow</u>, a tooth pick, an eyelash.

   List 5 other solid objects that **do** behave elastically in normal use.

   <u>forks</u> <u>floors</u> <u>windows</u> <u>chairs</u> <u>paper clips</u>

8. True or <u>false</u>: when balanced forces act on my body I don't feel them.
9. <u>True</u> or false: the forces acting on the atoms in an undistorted object are balanced.
10. How does a neutral object obtain a positive charge? <u>removing electrons</u>
11. Maxwell determined that light combined the effects of which two (previously thought to be very different) forces? <u>electric</u> and <u>magnetic</u> .
12. If I compare the speed of light measured while running toward its source to a measurement while at rest, (Don't answer this question without reading the discussion of the Michelson and Morley experiment in section B of this chapter) does the speed change?

    The speed of light (*does* or <u>*does not*</u>) change

    On the Earth, does the speed of a car depend on the speed of the observer?

    The speed of a vehicle on earth (<u>*does*</u> or *does not*) change.

Who developed the single theory that can explain both phenomena? <u>Albert Einstein</u>

13. What are the two conditions that must be met by a new theory of nature before it is accepted and can replace an existing theory?

    1. Make better predictions than the old theory for specific phenomena.
    2. Explain why predictions of the old theory were adequate for most phenomena.

14. What occurs in a battery to move electrons from one pole of the battery to the other? See section C of this chapter for a discussion of batteries.

    <u>chemical</u> reactions move electrons from the + pole to the – pole.

15. How many oxygen atoms are contained within a molecule of oxygen gas? <u>two</u> .

    What must happen to oxygen molecules when oxygen gas is used to burn hydrogen gas (H_2) to form water molecules (see text)? <u>oxygen atoms in the O_2 molecule must separate</u> .