**Physics 8—Thermodynamics Practice Questions (Dr. Petersen)**

1. A man, whose hand had grown since he put on his wedding ring, tries to get it off (we won’t ask why) by pouring hot water over it. Assume his finger will not expand, and the knuckle he must get it over is circular in cross-section with diameter 1.1990 cm with skin compressed, while his ring is 1.1980 cm in diameter. Will he be able to get it off by raising its temperature from 27 oC to 80 oC? Assume the linear coefficient of expansion is 1.00 x 10-5 oC-1. What will be the ring’s new diameter?

2. Steam is passed over 50.0 g ice until it just melts and the puddle left is at 0 oC. How many grams of steam is required to condense to completely melt the ice, so the mixture of condensed steam and water comes to 0 oC? Assume Latent Heats of Fusion and Vaporization are 80 and 540 cal/g oC respectively.

**A computer chip of mass 0.03500 k**g undergoes a crystal phase change from hexagonal close-packed to face-centered cubic at 124 oC in air at 1.013x105 Pa of pressure. This phase transition requires 147,000 J/kg (Latent Heat) and is a constant pressure process. The change in internal energy is computed using the kinetic molecular model: ΔU = 5144.90 J.

3. What is the heat absorbed by the sample (in Joules)?

4. What is the work done on the sample (in Joules)?

5. What is the volume change of the sample during the transition at constant pressure (in cm3)? (Note that we don’t need to know the original volume!)

**Second Set**

6. (a) What will be the change in entropy, ΔS, for the sample while undergoing the phase transition?

(It remains at the transition temperature.) (b) What will be the total entropy change for the sample during the cycle if we bring it back to the original crystal structure by removing the heat necessary?

7. Say we have a substance made of extremely long molecules laid parallel to one another, with the atoms constrained to move in one dimension only. (a) What will be its molar heat capacity, Cv, at room temperature as a multiple of R? (b) Will the heat capacity be lower, higher, or the same at extremely low temperatures?

8. An Otto cycle engine has a compression ratio of r = 6 and an ideal efficiency of 58%, what is the ratio, γ, of specific heats of the gas used?

9. In the above question, if the molar specific heat Cp = 29.7 J/mol K, what is the molar specific heat at constant volume?

10. 6 molecules of a gas are released in a chamber of volume 2V. a) What will be probability that all of them will be found at any given moment in the left half of the chamber? b) what will be the entropy change in going from three on each side to 6 on one side? Get the sign right. c) Is this a violation of the second Law of Thermodynamics?

**Physics 8—Light and Optics Practice Questions (Dr. P)**

1. The speed of light changes when it goes from ethyl alcohol (n1 = 1.361) to carbon tetrachloride (n2 = 1.461). The ratio of speeds v2/v1 is

 A. 1.99, B. 1.07, C. 0.93, D. 0.51, E. 0.76.

2. Light is reflected through a diamond. If the angle of incidence is 30 degrees, and the angle of refraction is 12 degrees, what is the index of refraction?

 A. 1.3, B. 2.4, C. 2.6, D. 1.8, E. 0.4.

3. A dentist uses a concave mirror (focal length 2 cm) to examine some teeth. If the distance from the object to the mirror is 1 cm, what is the magnification of the tooth?

 A. 6, B. 1, C. 4, D. 2, E. 1.5.

4. When an eclipse of the sun is viewed from the earth, its diameter subtends an angle of about 0.5 degrees. A photograph is obtained with a camera lens having a focal length of 183 mm. Find the diameter of the sun's image on the film.

 A. 0.5 mm, B. 0.8 mm, C. 1 mm, D. 1.6 mm, E. 2.4 mm.

5. Light is incident on a double slit. The fourth bright band has an angular distance of 7 degrees f rom the central maximum. What is the distance between the slits (in micrometers). (Assume the frequency of light is 5.4 x 1014 Hz).

 A. 27, B. 21, C. 24, D. 18, E. 14.

6. Monochromatic light is incident on a soap bubble (n = 1.4). How thick is the bubble (in nm) if destructive interference in the reflected light occurs? (λ = 500 nm)

 A. 102, B. 178, C. 54, D. 1, E. 89.

7. Ideally, how close together could 2 objects on the moon's surface be if they can be just resolved by the human eye? D (earth‑moon) = 385,000 km. Wavelength = 5 x 10-7 m. Assume eye fluid has an average n = 1.33. D(pupil) = 0.007 m.

 A. 170 km, B. 33.5 km, C. 25.2 km, D. 85 km.

8. A beam of x‑rays of different frequencies is reflected at 10 degrees off a crystal of interatomic spacing 0.2 nm. Which x‑ray wavelength is preferentially reflected?

 A. 0.0943 nm, B. 0.14 nm, C. 0.0697 nm, D. 1.02 x 10-10 m, E. 3.47 x 10‑11 m.

**Physics 8—Relativity and Quantum Theory Practice Questions (Dr. P)**

1. Fizeau found the speed of light in moving water in the lab frame to be v = c/n + kV, where V is the speed of the water in the lab frame. Both light and water are moving in the same direction. What is k from relativistic considerations?

 A. 0.225, B. 0.437, C. 1.00, D. 1.67.

2. What percent of it’s original length will an object be, moving at 0.99c?

 A. 3.2 %, B. 14 %, C. 38 %, D. 92 %.

3. Calculate the wavelength of a photon whose energy is equivalent to the rest mass energy of an electron of mass 9.11 x 10-31 kg. A. 3.3 x 10-11 m, B. 1.15 x 10-12 m, C. 2.4 x 10-12 m.

4. Calculate the DeBroglie wavelength of a proton moving at 0.900c. The proton mass is 1.67 x 10-27 kg. A. 8.82 x 10-12 m, B. 6.68 x 10-16 m, C. 9.25 x 10-18 m (choose closest).

5. A black dwarf star (cooled white dwarf) is essentially a monatomic crystal of carbon. A carbon atom has mass 2.00 x 10-26 kg. We observe a vibrational spectral line at 512 μm which we suspect to be a transition between adjacent levels in the vibrational spectrum of the crystal. What is the spring constant k for the crystal? A. 0.115 N/m, B. .272 N/m, C. 1.88 N/m.