

Printed Name: _____ ID Number: _____

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1. In a centrifuge molecules spinning in a liquid have an effective energy of

$U = -\frac{1}{2}m\omega^2 r$ where m is the mass of the molecule, ω the angular velocity and r is the

radial distance from the axis of rotation. Write an equation for $\frac{\rho(r)}{\rho(0)}$ where $\rho(r)$ is the density at r and $\rho(0)$ is on the axis of rotation at temperature T .

2. In a free electron gas with $N/V = 5.90 \times 10^{28} \text{ m}^{-3}$ at $T = 0$ the Fermi Energy E_F is?

3. For an electron gas at $T = 0$ with $E_F = 5$ eV the average E per molecule is?

4. An insulating solid can be approximated as a gas of phonons all at a particular angular frequency ω . If there are N atoms in 3-D space the total energy is?

5. For the same lattice as in the above Problem, what is the equation for the specific heat at constant volume C_V ?

6. What is the value of k the electron wavevector at the Brillouin Zone for a square lattice metal with lattice parameter $a = 0.20$ nm?

7. For a Fermi electron gas at $T = 5800 \text{ K}$ with $E_F = 4.0 \text{ eV}$ the probability that a single state at $E = 3.0 \text{ eV}$ will be occupied is?

8. If the Fermi Energy for a true electron gas at an electron density of 2.54×10^{28} is 3.15 eV , what is the Fermi Energy for an electron gas in a metal with the same density but with $m^* = 1.2 m_e$?

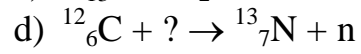
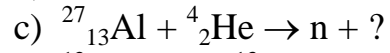
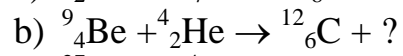
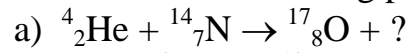
9. Silicon has a band gap of 1.14 eV. What is the longest wavelength of light emitted if intrinsic Si is used as a light emitting diode?

10. Intrinsic Cadmium Sulfide when used as a photoconductor becomes conductive when exposed to light for wavelengths less than 0.52 μm . What is its band gap?

11. Phosphorus has one more electron than Silicon and when it is an impurity in Si it is observed that conductivity of the doped material occurs even at $T = 0$ when it is irradiated with light with wavelength as long as $\lambda = 28 \mu\text{m}$. What is the ionization energy of the donor ground state?

12. What would then be the dielectric constant for Si?

13. List A and Z of the missing particle in the following reactions.



14. Find the Q of the reaction ${}^{234}\text{U} + \text{n} \rightarrow {}^{93}\text{Rb} + {}^{141}\text{Cs} + 2\text{n}$. The mass of ${}^{234}\text{U}$ is 235.043922 u, ${}^{93}\text{Rb}$ is 92.93195 u, ${}^{141}\text{Cs}$ is 140.92005 u and n is 1.008665 u.

15. The weak interaction (responsible for beta decay) is produced by the exchange of a particle of mass 80 GeV. What is the range of this force?

16. A certain sample of radioactive material has a decay rate of 548 Bq at a time we will call $t = 0$. If the rate has fallen to 213 Bq after 48 minutes the half life is?

17. A piece of wood recently cut from a tree shows 12.4 ^{14}C decays per minute. An old piece of the same size shows 3.5 decays per minute. What is the age of the old sample? The half life of ^{14}C is 5730 y.

18. What is the recoil Kinetic Energy of a ^{57}Fe nucleus that emits a 14.4 keV photon? The mass of the Fe is 56.935 u.