

Position: # (your seat #).....

Your Name: Last, First.....

Name of Workshop Instructor: Last, First.....

Total points: 36

$c=3 \times 10^8$ m/s (the speed of light) $E(\text{in Joules})=1.6 \times 10^{-19} \times E(\text{in eV})$

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$$v = \frac{\lambda}{T} = f\lambda \quad (11-6)$$

First law of thermodynamics $\Delta U=Q+W$

$\Delta S=Q/T$ -- entropy change (const temp)

Work done on gas= $-P\Delta V=-P(V_f-V_i)$ (const pressure)

$E=hf$ photon energy $h=6.6 \times 10^{-34}$ Js

Photoelectric equation: $hf=\phi+K$ kinetic energy
 $K=p^2/2m$

Work function $\phi=hf_0$ where f_0 threshold frequency

de Broglie wavelength $\lambda=h/p$ Mass of electron $=9 \times 10^{-31}$ kg

Energy of photon emitted by electron moving from E_i to E_f
 $hf=E_i-E_f$

Energies in H atom $E_n=-13.6/n^2$ eV

Ideal gas $K=3/2kT=1/2mv_{rms}^2$, $k=1.38 \times 10^{-23}$ J/K

$PV=NkT$ ideal gas law N =number of atoms

Q1.(4 pts) What is the rms speed of an oxygen molecule at 25° C

(mass of oxygen molecule = 5.3×10^{-26} kg).

What is the pressure exerted on the sides of a container of volume 1 m³ by 10^{24} such molecules ?

Q2.(2pts) State the Pauli principle governing the behavior of electrons

Q3. (3 pts) Give a definition of heat. What is the entropy change when 500 J of heat is supplied to a gas at a constant temperature of 20 °C

Q4. (2 pts) The minimum energy required to remove an electron from a particular metal is 2.6 eV. What is The longest wavelength photon that can eject an electron from this surface ?

Q5. (3pts) Calculate the wavelength of EM radiation emitted when an electron makes a transition from an energy level of hydrogen with quantum number $n=5$ down to the $n=2$ level. What is name given to this radiation eg infrared, X-ray etc ?

Q6. (5pts) Explain what is meant by wave-particle duality. A cathode ray tube accelerates electrons to an energy of 1000 eV. What is their de Broglie wavelength ? If they are passed through a small slit describe what happens. At what distance from the axis of symmetry will we find a minimum intensity of transmitted electrons ?

Q7. (4pts) Give the name of the three possible ways in which electrons can absorb or emit photons. Explain how one of these is crucial to the operation of a laser.

Q8. (5pts) What is the uncertainty principle ? Write down a mathematical form of this principle. If an electron is confined to a region of size 1×10^{-10} m estimate its momentum and kinetic energy.

Q9. (5 pts) A metal with work function 1.2 eV is irradiated with light of wavelength 220 nm. Calculate The maximum kinetic energy of the ejected electrons

Q10. (3pts) The light source used in question 9 is a 200 W laser. Calculate the number of photons emitted per second. If the intensity of the beam is increased what will happen to the energy of the ejected electrons. Explain.