
Answer the following questions:

1-a-i: Prove that the pressure of ideal gas molecules on the wall of gas container is equal to third of gas density ρ multiplied by the mean square velocity of gas molecules $\overline{C^2}$

ii-: Deduce of the gas molecules pressure at infinite altitude measured from the ground center.

b-i: Derive an expression for the molecular velocity distribution function according to molecules velocity components at any altitude. Indicate the shape and properties of this function.

ii: Deduce an expression for the total number of gas molecules per unit volume according to their velocity components along the three directions x, y and z. Prove that the molecular velocity distribution function depends on the molecules velocity components along these three directions, Indicate the shape of this function at different gas absolute temperatures, give an explanation for this shape.

C-i-: 10 gm of oxygen gas at 3 atmospheric pressure and 10 °C. After heating at constant pressure, the gas is expanded and occupied volume equals 10 liter, calculate the following :

- The gas volume before heating.
- The gas temperature after heating.
- The gas density before and after heating.

(Using) $\mu_{O_2} = 16 \text{ kg/mol}$ and $R=8.314 \text{ J/mol.k}$)

2-a-i: Prove that the slope of the relation curve between pressure P and volume V of the ideal gas in an adiabatic process is greater than the slope of this relation in an isothermal process. Put the schematic diagram of these two relations and write an expression for the first law of thermodynamics during these two processes.

ii-: Prove that $C_p > C_v$ and $C_p / C_v = \gamma$ for the ideal gas.

b-i-: Derive an expression for the work done at constant gas temperature and during the variation of this temperature from T_1 to T_2

ii: Find the relations govern the ideal gas variation at constant heat quantity.

C-i-: Assume 2.7 mole of a diatomic gas occupies an initial volume $V_i = 8 \text{ liter}$ at 307K^0 . The gas is adiabatically expanded to a final volume $V_f = 20 \text{ liters}$. Prove that the work done during this adiabatic process is approximately equal to the change of gas internal energy $du = n C_v (T_f - T_i)$ where n is the number of gas moles and T_i , T_f are respectively the initial and final gas temperatures. Is the gas temperature increased or decreased in this case, give the reason.

(Using $\gamma=1.4$, $R=8.314 \text{ J/mol. K}^0$, $C_v=5/2 R$ and $k=1.38 \times 10^{-23} \text{ J/mol. k}^0$)

Look to back page 1

3- a-i- Prove that the gas molecules mean free path λ . multiplied by the gas pressure P is proportional to gas temperature T .

ii- Deduce the relation between the gas viscosity coefficient η and the mean free path λ . of gas molecules.

b-i- Derive the equation which describe: 1st - the behavior of real gas of mass M and molecular weight μ . 2nd - the behavior of this gas at its gaseous and liquid states and between these two states.

ii- Write an expression for: - V_c , P_c and T_c of the real gas and deduce an expression for the temperature at which the real gas changes to an ideal gas.

C-i- A gas molecule of diameter 3×10^{-8} cm at one atmospheric pressure and absolute Zero temperature, calculate the molecule mean free path and average number of collisions per second occurred for these molecules where its most probable velocity $C_m = 480 \text{ ms}^{-1}$ Assuming that the mass of gas molecule is 46.23×10^{-27} kg, calculate the gas viscosity coefficient in this case . Using $k = 1.38 \times 10^{-23} \text{ J/mol.k}^0$. Calculate $\bar{C}$ for these molecules.

4-a-i- Put an expression for the first law of thermodynamics in terms of entropy change during the isothermal and adiabatic processes.

ii- Explain on a diagram how the heat engine completes Caront Cycle. Deduce an expression for the total work done during this cycle and the efficiency of this heat engine.

b-i- Write an expression for Maxwell's equations in thermodynamics and for the entropy change in terms of C_p and C_v of real gas.

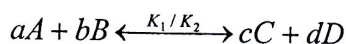
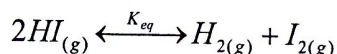
ii- Find an expression for $C_p - C_v$ in terms of the isothermal elastic coefficient λ_T and thermal expansion coefficient α_p . Using this expression to prove that $C_p - C_v = R$

C-i- Find the equation of entropy change when a gas of mass M and molecular weight μ is isothermally expanded from volume V_1 to volume V_2 .

ii: 8 gm oxygen gas is isothermally expanded from $V_1 = 10$ liter to volume $V_2 = 40$ liter. Calculate the total entropy change of this oxygen gas mass.

Where $\mu_{O_2} = 16 \text{ kg/mole}$, and $R = 8.314 \text{ J/mol. K}^0$

With my best wishes
Prof. Dr. Abdel-Haleem Turkey

Section II (Physical Chemistry)**(Marks: 25)****Answer the following questions****I) Choose the correct answer:****(Marks: 10)****1) Under Isothermal expansion of an ideal gas:** $\Delta S^\#$ increase as the volume a) decrease b) increases c) constant**2) For irreversible Isothermal processing of an ideal gas:** $\Delta G^\# = \dots$ a) > 0.00 b) < 0.00 c) ΔR **3) $\Delta E = \dots - \dots$** a) $Q - H$, b) $Q - W$, c) nRT , d) $nRdT$ **4) $\Delta H = \Delta E + \dots$** a) ΔF , b) ΔR , c) ΔW , d) ΔC_p **5) In carnot cycle, the maximum work done $W_m = \dots$** **6) ΔS under isothermal expansion of ideal gas is equal:**a) $nRT \ln \frac{V_2}{V_1}$, b) $nR \ln \frac{V_2}{V_1}$, c) $C_p \ln T$, d) $C_v \ln P$ **7) $\frac{-d(\ln K_{eq})}{dT} = \dots$ 8) $\frac{-d(\ln K_{eq})}{d(\frac{1}{T})} = \dots$ 9) $\frac{P_1}{P_2} = \dots$ 10) $\Delta G^\# = \Delta G^{\#0} + \dots$** **II) Show, how can you calculate the $\Delta S^\#$ of n moles of an****III) ideal gas when it is expanded isothermally at:****Variable V, P, and T****(Marks: 3)****IV) Consider a hypothetical reaction between gases:****Describe, how you can determine the relation between:****(Marks: 4)** $\Delta G^\#, \Delta G^{\#0}$ and K_{eq} **V) When gaseous ozone (O_3) is formed from molecular oxygen by the****reaction: $3O_2 \rightleftharpoons 2O_3$ What is K_{eq}** **(Marks: 3)****if: $\Delta G^{\#0} = 39.1 \text{ Kcal.mol}^{-1}$, $R = 1.98 \text{ cal/mol.deg}$ at: 250, 300, and 400 K****VI)) The equilibrium constants (K_p) for the reaction:****(Marks: 5)****are: $K_{p1} = 2.18 \times 10^{-2}$ at $T_1 = 764K$ and $K_{p2} = 1.64 \times 10^{-2}$ at $T_2 = 667K$** **Find: 1) $\Delta H^{\#0}$, $\Delta G_1^{\#0}$ and $\Delta G_2^{\#0}$ for the reaction****Good Luck****Examiners: Prof. Dr. Amna S A Zidan, Prof. Dr. Seddique M Ahmed**

Physical and Inorganic Chemistry
(250CH)

Section (I)

Answer the following:

- 1- a- Explain the reason for **(Five only)** from the following: (5 Marks)
- I) Concentrated solution of HF acid is not kept in glass bottle.
 - II) SO_2 used as oxidizing and reducing agents.
 - III) CO_2 is an acidic oxide.
 - IV) Cesium ions conduct electricity more than lithium ions.
 - V) KCl is soluble in water but CaCO_3 is not.
 - VI) CO is a poisonous gas.
- b- How you can prepare **(Three only)** from the following: (4.5 Marks)
- H_2 , NH_3 , HI , urea
- c- What products are formed when each of group (I) metals burnt in oxygen?
How do these products react with water? (3 Marks)
- 2- a- Choose the correct answer and comment **(Three only)** (6 Marks)
- I) Which solution of the following reagents gives a precipitate when CO_2 is bubbled into it [KOH , NaOH , $\text{Ba}(\text{OH})_2$]
 - II) Which one of the following species contains an odd number of electrons (CO , NH_4^+ , NO)
 - III) The element which has the maximum number of oxidation state (C, N, Cl)
 - IV) The compound which contains hydrogen bond (CH_4 , H_2S , H_2O)
- b- In each pairs of acids, state which is stronger and why? HF and HI, H_2SO_4 and H_2SO_3 , HClO and HIO . (3 Marks)
- c- Give three examples of Freon's and how do they damage the environment .(3.5Marks)



Answer four (4) only of the following questions:

Question (1):

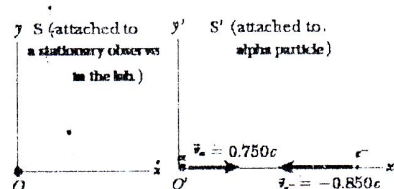
(12.5 Mark)

a- Put (✓) or (✗):

(2.5 Mark)

- 1- The proper time is always the shortest time interval. ()
- 2- Compton shift $\Delta\lambda$ depends on the type of scattering material. ()
- 3- The probability of pair production increases only by decreasing the photon energy. ()
- 4- In blackbody radiation, as the temperature increases, the maximum of the curve shifts toward higher frequencies. ()
- 5- In photoelectric effect, the maximum kinetic energy of photoelectrons depends on the intensity of incident electromagnetic waves. ()

- b- Suppose you have an electron and an alpha particle moving through a piece of beam pipe inside a particle accelerator. The particles are traveling in opposite direction. The speed of the electron is $0.850c$ and the speed of the alpha particle is $0.750c$, both measured by a stationary observer in the lab. What is the speed of the electron as observed from the alpha particle, in units of the speed of light?



(5 Mark)

c-Write Bohr's hypotheses for his atomic model. Using these assumptions, prove that the distance between any two successive energy levels increases by increasing the quantum number n . (5 Mark)

Question (2):

(12.5 Mark)

a- Why the pair production process, cannot occur in the vacuum?

(2.5 Mark)

b- What is the emitted photon energy for second line of the Balmer series? (5 Mark)

c- In Compton Effect, at each angle the *X-ray* scattered with two different wavelengths one wavelength does not change as the angle is varied. The other wavelength varies strongly with angle. Explain that. (5 Mark)

Question (3):

(12.5 Mark)

a- Choose the correct statement:

(2.5 Mark)

- 1- You are driving on a freeway at a relativistic speed. Straight ahead of you, a technician standing on the ground turns on a searchlight and a beam of light moves exactly directly at you as seen by the technician. As you observe the beam of light, do you measure the magnitude of the horizontal component of its velocity as:
a- equal to c b- equal to zero c- greater than c d- less than c
- 2- According to the Heisenberg uncertainty principle, if the position of a moving particle is known, what other quantity cannot be known?
a- mass. b- charge. c- spin. d- velocity.
- 3- When an electron moves from a lower to a higher energy level, the electron
a- always doubles its energy. b- emits a quantum of energy.
c- absorbs a quantum of energy. d- moves closer to the nucleus.
- 4- Frank Hertz experiment has proved that:
a- The nucleus is the center of the atom's mass and charge and its size is very small.
b- The existence of energy levels experimentally.
c- The charge is quantized.
d- The electron has spin.
- 5- Rutherford experiment has proved that:
a- The nucleus is the center of the atom's mass and charge and its size is very small.
b- The existence of energy levels experimentally.
c- The charge is quantized.
d- The electron has spin.
- b- The work function for tungsten metal is 4.52 eV . (a) What is the cutoff wavelength λ_0 for tungsten? (b) What is the maximum kinetic energy of the electrons when radiation of wavelength 198 nm is used? (c) What is the stopping potential in this case? **(5 Mark)**

- c- Use the Lorentz transformation equations in difference form to show that simultaneity is not an absolute concept. (5 Mark)

Question (4):

(12.5 Mark)

- a- Put (✓) or (✗):

(2.5 Mark)

- 1- The Rutherford model failed to explain the hydrogen atom's spectrum. ()
- 2- Maxwell's equations are invariant under Galilean transformation. ()
- 3- Rutherford's model destroyed by the electromagnetic theory. ()
- 4- The minimum wavelength λ_{min} of *X-rays* depend on the kind of the metal target. ()
- 5- Heisenberg's uncertainty principle says "It impossible to measure simultaneously the position and the momentum of a particle". ()

b- A ball of mass 50 g moves with a speed of 30 m/s. If its speed is measured to an accuracy of 0.1%, what is the minimum uncertainty in its position? (5 Mark)

c- Bohr's model failed to explain the fine structure of the hydrogen atom's spectrum, explain that, and discuss the Sommerfeld's modification to overcome this deficiency. Explaining the energy level schemas before and after modification, and clarifying the selection rule. (5 Mark)

Question (5):

(12.5 Mark)

a- Put (✓) or (✗):

(2.5 Mark)

- 1- Bohr's corresponding principle says "the smaller quantum number, the closer quantum physics approaches classical physics". ()
 - 2- According to Max Plank, oscillator can emit radiation by dropped to any lowest energy state where the amount of energy emitted is $\Delta\epsilon = nhf$. ()
 - 3- In Compton scattering, scattered photon has smaller wavelength than the incident one. ()
 - 4- No time lag between the illumination of the metal and the emission of the photoelectrons. ()
 - 5- Energy can be converted to mass but mass can't be converted to energy. ()
- b- Compute the de Broglie wavelength of the following: (a) A 1000 kg automobile traveling at 100 m/s. (b) An electron with a kinetic energy of 1 eV. (5 Mark)

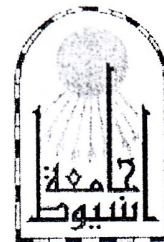
- c- Prove the Duane-Hunt law, which gives the minimum wavelength λ_{min} of *X-rays* that can be emitted by Bremsstrahlung in an *X-ray* tube by accelerating electrons through an excitation voltage V into a metal target.

(5 Mark)

Electron charge e	$1.6 \times 10^{-19} \text{ C}$	Planck constant h	$6.626 \times 10^{-34} \text{ Joule.sec}$
Electron mass m_e	$9.1 \times 10^{-31} \text{ kg}$	Light speed c	$3 \times 10^8 \text{ m.sec}^{-1}$
Proton mass m_p	$1.672 \times 10^{-27} \text{ kg}$	Coulomb constant k	$9 \times 10^9 \text{ N.m.C}^{-2}$
Rydberg constant R	$1.097 \times 10^7 \text{ m}^{-1}$	Ionization energy of the hydrogen atom E_0	13.6 eV



Physics Department
Faculty of Science
Assiut University



Physics 271P – Physical optics & optical fibers

THIS TEST HAS ELEVEN PAGES

DURATION OF TEST: THREE HOUR

Date: 29th DECEMBER 2017.

Examiner: Dr. Ahmed Mostafa Amry

Answer ONLY 30 question from Part I.

Answer All questions from Part II.

Part I: Multiple Choice (30 Points)

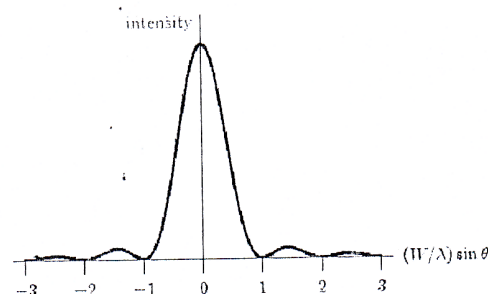
Circle the one best answer to each question

1. Optical active crystals rotates the
 - a. vibrating plane
 - b. polarization plane
 - c. diffraction plane
 - d. interference plane
2. Which is not optically active?
 - a. Sugar
 - b. tartaric acid
 - c. water
 - d. sodium chlorate
3. In double slit experiment we observe
 - a. interference fringes only
 - b. diffraction fringes only
 - c. both interference and diffraction fringes
 - d. polarized fringes
4. When light incident normally on thin film the path difference depends upon
 - a. thickness of the film only
 - b. nature of the film only
 - c. angle of incidences only.
 - d. all thickness nature and angle of incidence

5. Which one of the following properties of light does not change with the nature of the medium?
- Velocity
 - wavelength
 - amplitude
 - frequency
6. A diffraction grating has 500 lines per mm. Its slit spacing or grating element will be equal to
- 500 mm
 - 5×10^{-3} mm
 - 2×10^{-5} mm
 - 2×10^{-3} mm
7. Units of "optical path length" are:
- m^{-1}
 - m
 - m^2
 - m/Hz
8. Interference of light is evidence that:
- the speed of light is very large.
 - light is a transverse wave.
 - light is a wave phenomenon.
 - none of the above.
9. In a Young's double-slit experiment the center of a bright fringe occurs wherever waves from the slits differ in the distance they travel by a multiple of:
- a fourth of a wavelength.
 - a half a wavelength.
 - a wavelength.
 - none of the above.
10. In the equation $\sin \theta = \lambda/a$ for single-slit diffraction, θ is:
- the angle to the first minimum.
 - the angle to the second maximum.
 - the phase angle between the extreme rays D.
 - $N\pi$ where N is an integer.
11. No fringes are seen in a single-slit diffraction pattern if:
- the screen is far away.
 - the wavelength is less than the slit width.
 - the wavelength is greater than the slit width.
 - the wavelength is less than the distance to the screen.

12. In a plane polarized light:
- vibration in all direction.
 - vibration in two mutually perpendicular directions.
 - vibration take place in a direction $\perp$ the direction of propagation of light.
 - no vibration at all.

13. Light of wavelength is normally incident on some plane optical device. The intensity pattern shown is observed on a distant screen (θ is the angle measured from the normal of the device). The device could be:



- single slit of width W
 - a single slit of width $2W$
 - two narrow slits with separation W
 - two narrow slits with separation $2W$
14. In the equation $d \sin \theta = m \lambda$ for the lines of a diffraction grating m is:
- the number of slits.
 - the slit width.
 - the slit separation.
 - the order of the line.
15. 600-nm light is incident on a diffraction grating with a ruling separation of 1.7×10^{-6} m. The second order line occurs at a diffraction angle of:
- 0
 - 10°
 - 21°
 - 45°
16. Monochromatic light is normally incident on a diffraction grating that is 1 cm wide and has 10,000 slits. The first order line is deviated at a 30° angle. What is the wavelength, in nm, of the incident light?
- 300nm
 - 400 nm
 - 500 nm
 - 600 nm
17. Basic principle of an optical fiber is:
- Reflection
 - Polarization
 - Scattering
 - Total internal reflection

18. A light beam incident on a diffraction grating consists of waves with two different wavelengths. The separation of the two first order lines is great if:
- the dispersion is great
 - the resolution is great
 - the dispersion is small
 - the resolution is small
19. A diffraction grating just resolves the wavelengths 400.0 nm and 400.1 nm in first order. The number of slits in the grating is:
- 400
 - 40
 - 4000
 - 40000
20. X rays are:
- electromagnetic waves
 - negatively charged ions
 - rapidly moving electrons
 - rapidly moving protons
21. Bragg's law for X-ray diffraction is $2d \sin \theta = m\lambda$, where θ is the angle between the incident beam and:
- a reflecting plane of atoms
 - the refracted beam
 - the scattered beam
 - the normal to the scattered beam
22. The longest X-ray wavelength that can be diffracted by crystal planes with a separation of 0.316 nm is:
- 0.158 nm
 - 0.316 nm
 - 0.474 nm
 - 0.632 nm
23. A beam of X rays of wavelength 0.20 nm is diffracted by a set of planes in a crystal whose separation is $3.1 \times 10^{-8} \text{ cm}$. The smallest angle between the beam and the crystal planes for which a reflection occurs is:
- 0.70 rad
 - 0.33 rad
 - 0.033 rad
 - 0.066 rad
24. A beam of x rays of wavelength 0.10 nm is found to diffract in second order from the face of a LiF crystal at a Bragg angle of 30° . The distance between adjacent crystal planes, in nm, is about:
- 0.15
 - 0.20
 - 0.25
 - 0.30

25. A surface on which all the points have the same state of vibration is known as
- Wave-length
 - Wave-let
 - Wave-packet
 - Wave-front
26. In Young's experiment, two coherent sources are placed 0.90 mm apart and the fringes are observed one meter away. If it produces the dark fringe at a distance of 1 mm from the central fringe the wavelength of monochromatic light used would be:
- $60 \times 10^{-4} \text{ cm}$
 - $10 \times 10^{-4} \text{ cm}$
 - $10 \times 10^{-5} \text{ cm}$
 - $6 \times 10^{-5} \text{ cm}$
27. A Young's double-slit experiment uses a monochromatic source. The shape of the interference fringes formed on a screen is:
- circle
 - hyperbola
 - parabola
 - straight line
28. Electromagnetic waves
- always travel at the same speed.
 - need a medium to travel through.
 - can travel through a vacuum.
 - cannot travel through the vacuum of outer space.
29. Destructive interference in waves occurs when a crest and a trough overlap.
- $2 \times \text{wavelength}$
 - $1/2 \text{ wavelength}$
 - $4 \times \text{wavelength}$
 - $1/4 \text{ wavelength}$
30. Polarization refers to the
- prevention of electricity flowing in electrolyte solution
 - rapid dissolving of magnesium in dilute acid
 - slow dissolving of magnesium in conc. Acid
 - electricity flowing in electrolyte solution.
31. Light of wavelength 5200 angstroms is incident normally on a transmission diffraction grating with 2000 lines per centimeter. The first-order diffractive maximum is at an angle, with respect to the incident beam, that is most nearly
- 3°
 - 6°
 - 9°
 - 12°

32. In a double-slit interference experiment, d is the distance between the centers of the slits and w is the width of each slit, as shown in the figure above. For incident plane waves, an interference maximum on a distant screen will be "missing" when



a. $d = \sqrt{2} w$

b. $d = \sqrt{3} w$

c. $2d = w$

d. $2d = 3w$

33 Central spot of Newton's rings

a. Bright

b. dark for large wavelength

c. dark

d. bright for large wavelength

34. Thin film constructive interference occurs when the wavelength of a wave is in multiples of

a. $2 \times \text{wavelength}$

b. $1/2 \times \text{wavelength}$

c. $4 \times \text{wavelength}$

d. $1/4 \times \text{wavelength}$

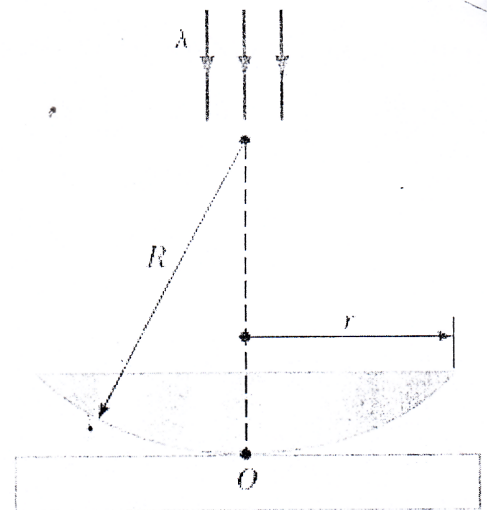
Part II: Work Problems (20 Points)

Show all your work and explain each major step to receive full credit.

1. A double-slit source with slit separation 0.2 mm is located 1.2 m from a screen. The distance between successive bright fringes on the screen is measured to be 3.30 mm . What is the wavelength of the light?

Solution:

3. In a Newton's-rings experiment, a plano-convex glass ($n=1.52$) lens having diameter 12.0 cm is placed on a flat plate as shown in Figure. When 650-nm light is incident normally, 55 bright rings are observed with the last one right on the edge of the lens. (a) What is the radius R of curvature of the convex surface of the lens? (b) What is the focal length of the lens?



Solution:

4. Unpolarized light of intensity I_0 is incident on a series of three polarizing filters. The axis of the second filter is oriented at 45° to that of the first filter, while the axis of the third filter is oriented at 90° to that of the first filter. What is the intensity of the light transmitted through the third filter?

Solution:

5. What is Brewster's angle for reflection from air off a glass($n=1.52$) surface?

Solution:

END OF EXAM



Assiut University
Faculty of Science

Department of Physics

First semester 2017-2018 Final Exam (50%)

Course : Modern Physics
Code : P215
Section : Phys. and Phys./Chem.
Time : 3 Hours
Date : 4 Jan. /2018

Part I:

(10 Mark)

Write number of each statement and put [$\sqrt$] or [$\times$], then discuss your answer (if $\sqrt$ or $\times$):

- 1- The emissivity for the blackbody depends on the material that make the blackbody.
- 2- In photoelectric, number of photoelectrons reach to collector per second depends only on the type of collector metal.
- 3- By applying negative voltage to emitter the photocurrent decreases gradually.
- 4- Photoelectron emission from a given metal does not take place unless the frequency of incident light is equal or greater than a certain minimum frequency f_0 .
- 5- No time lag between the illumination of the metal and the emission of the photoelectrons.
- 6- Compton shift $\Delta\lambda$ depends on the type of scattering material.
- 7- In Compton scattering, scattered photon has smaller wavelength than the incident one.
- 8- The matter wave is a probability wave.
- 9- The matter wave should has localization property.
- 10- According to Plank, oscillator can emit radiation by dropping to next lower energy state.

Part II: Answer four (4) only of the following questions:

Question (1):

(10 Marks)

- a) Derive the frequency f and wavelength λ of emitted spectral line of Hydrogen atom according to Bohr Model. ($E_n = -\frac{me^4}{8h^2\epsilon_0^2} \times \frac{1}{n^2}$). (5 Marks)
- b) Write names and equations of first three spectral series in Hydrogen atom and its conditions. (3 Marks)
- c) Photon emitted from transition of electron from $n_i = 5$, the wavelength of emitted photon is 12.9×10^{-7} m. Calculate n_f and frequency of emitted photon. What is the series of this photon? ($R = 1.097373 \times 10^7 \text{ m}^{-1}$) (2 Marks)

Question (2):

(10 Marks)

- a) Discuss how de Broglie explained Bohr's quantization condition. (5 Marks)
- b) Calculate the wavelength of the wave associated to the electron in the second orbit of Hydrogen atom ($r_n = a_0 n^2$, $a_0 = 5.32 \times 10^{-11} \text{ m}$). (3 Marks)
- c) Calculate the possible states for the principle quantum number $n = 4$ according to Sommerfeld model. (2 Marks)

Question (3):

(10 Marks)

- a) Derive Lorentz velocity transformation equations. (7 Marks)
- b) At small velocities $v \ll c$, show that the Lorentz velocity transformations will reduce to Galilean velocity transformations. (3 Marks)

Question (4):

(10 Marks)

- a) Derive expression for time dilation under Lorentz transformation. (7 Marks)
- b) If the total energy of a particle is n times its rest energy, what is its momentum? (3 Marks)

Question (5):

(10 Marks)

- a) Derive expression for relativistic kinetic energy T . (6 Marks)
- b) Show that T can be reduced to classical form at small velocities and draw a figure to represent relativistic and classical T ? (4 Marks)



Part I: In the following multiple choice questions, please choose the correct answer. You must write down the steps to get the correct answer (20 Grade/2 points each)

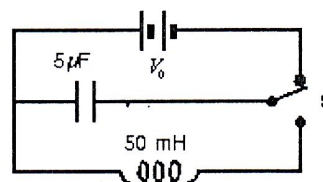
1. A charged capacitor and an inductor are connected in series. At time $t = 0$ the current is zero, but the capacitor is charged. If T is the period of the resulting oscillations, the next time, after $t = 0$ that the current is a maximum is:

a. T b. $T/4$ c. $T/2$ d. $2T$

2. A capacitor in an LC oscillator has a maximum potential difference of 15 V and a maximum energy of $360\text{ }\mu\text{J}$. At a certain instant the energy in the capacitor is $40\text{ }\mu\text{J}$. At that instant what is the potential difference across the capacitor?

a. zero b. 5 V c. 10 V d. 15 V

3. In the circuit shown, switch S is first pushed up to charge the capacitor. When S is then pushed down, the current in the circuit will oscillate at a frequency of:



a. 318 Hz b. 0.01 Hz c. 12.5 Hz d. depends on V_0

4. An RLC series circuit has $L=100\text{ mH}$ and $C=1\text{ }\mu\text{F}$. They are connected to 10^3 Hz source and the source emf is found to lead the current by 75° . Then, the value of R is:

a. $10\text{ }\Omega$ b. $75\text{ }\Omega$ c. $95\text{ }\Omega$ d. $126\text{ }\Omega$

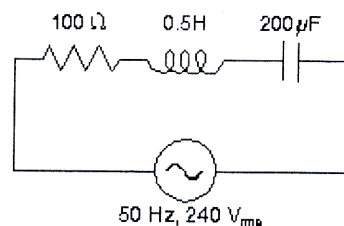
5. An RLC circuit has a capacitance of $12\text{ }\mu\text{F}$, an inductance of 25 mH , and a resistance of $60\text{ }\Omega$. The current oscillates with an angular frequency of:

a. $2.9 \times 10^2\text{ rad/s}$ b. $1.4 \times 10^3\text{ rad/s}$ c. $1.8 \times 10^3\text{ rad/s}$ d. $2.2 \times 10^3\text{ rad/s}$

6. A $35 \mu\text{F}$ capacitor is connected to an AC source of emf with a frequency of **400 Hz** and a maximum emf of **20 V**. The maximum current is:

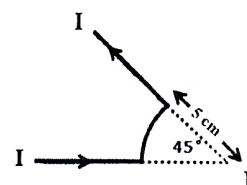
a. 0.28 A b. 1.8 A c. 230 A d. 1400 A

7. The total impedance of the circuit shown is:



a. 21Ω b. 50Ω c. 60Ω d. 65Ω

8. The segment of wire is formed into the shape shown in the figure below and carries a current $I=3 \text{ A}$. The resulting magnetic field at the point P is:

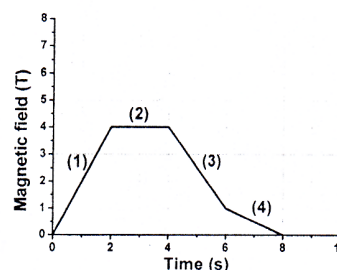


a. $1.5 \mu\text{T}$ b. $4.7 \mu\text{T}$ c. $9.43 \mu\text{T}$ d. $12 \mu\text{T}$

9. Solenoid #2 has twice the radius and six times the number of turns per unit length as solenoid #1. The ratio of the magnetic field in the interior of #2 to that in the interior of #1 is:

a. 2 b. 4 c. 6 d. 8

10. The graph shows the magnitude B of a uniform magnetic field that is perpendicular to the plane of a conducting loop. The rank of the five regions indicated on the graph according to the magnitude of the emf induced in the loop, from least to greatest, is:

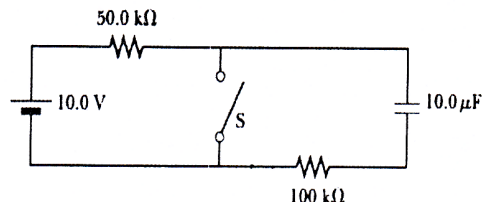


a. 1, 2, 3, 4 b. 4, 3, 1, 2 c. 4, 3, 2, 1 d. 2, 4, 3, 2

Part II: Answer only FOUR questions from the following five questions (30 Grade/ 7.5 points each)

Question 1:

- i. An uncharged capacitor (**C**) and a resistor (**R**) are connected in series to a battery (ϵ), where $\epsilon = 12\text{ V}$, $C = 5\text{ }\mu\text{F}$, and $R = 8 \times 10^5\text{ }\Omega$. Find the time constant of the circuit, the maximum charge on the capacitor, the maximum current in the circuit, and the charge and current as functions of time.
- ii. In the circuit below, the switch **S** has been open for a long time. It is then suddenly closed. Determine the time constant **(a)** before the switch is closed and **(b)** after the switch is closed. **(c)** Let the switch be closed at $t=0$. Determine the current in the switch as a function of time.



Question 2:

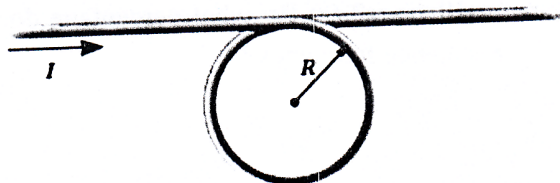
- i. Consider an **LC** circuit in which $L = 500\text{ mH}$ and $C = 0.1\text{ }\mu\text{F}$. **(a)** What is the resonance frequency ω_0 ? **(b)** If a resistance of $1\text{ k}\Omega$ is introduced into this circuit, what is the frequency of the damped oscillations? **(c)** By what percentage does the frequency of the damped oscillations differ from the resonance frequency?

- ii. A rectangular loop of area $A=0.16 \text{ m}^2$ is placed in a region where the magnetic field is perpendicular to the plane of the loop. The magnitude of the field is allowed to vary in time according to $B=0.35e^{-t/2}$, where B is in tesla and t is in seconds. What is the numerical value for ϵ at $t=4 \text{ s}$, and what is the maximum value of ϵ ?

Question 3:

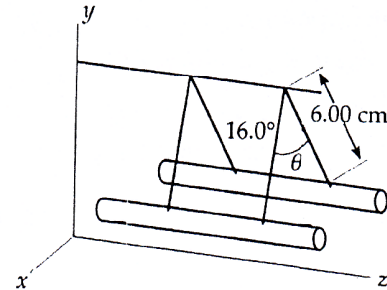
- i. Two coils are close to each other. The first coil carries a current given by $i(t)=5e^{-0.025t}$, where i is in amperes and t is in seconds. At $t=0.8 \text{ s}$, the *emf* measured across the second coil is -3.2 V . What is the mutual inductance of the coils?

- ii. A conductor consists of a circular loop of radius $R=15 \text{ cm}$ and two long, straight sections as shown in Figure below. The wire lies in the plane of the paper and carries a current $I=1 \text{ A}$. Find the magnetic field (**magnitude and direction**) at the center of the loop.



Question 4:

- i. Two long, parallel wires, each having a mass per unit length of 40 g m^{-1} , are supported in a horizontal plane by strings 6 cm long. When both wires carry the same current, I , the wires repel each other so that the angle, θ , between the supporting strings is 16° .
- (a) Are the currents in the same direction or in opposite directions?
- (b) Find the magnitude of the current



- ii. An AC generator supplies a peak (not **rms**) voltage of 150 V at 60 Hz . It is connected in series with a 35 mH inductor, $45 \text{ }\mu\text{F}$ capacitor and $85 \text{ }\Omega$ resistor. Determine the following:
- (a) The **rms** voltage of the generator
- (b) The impedance of the circuit
- (c) The power factor for this circuit
- (d) The resonant frequency of this circuit

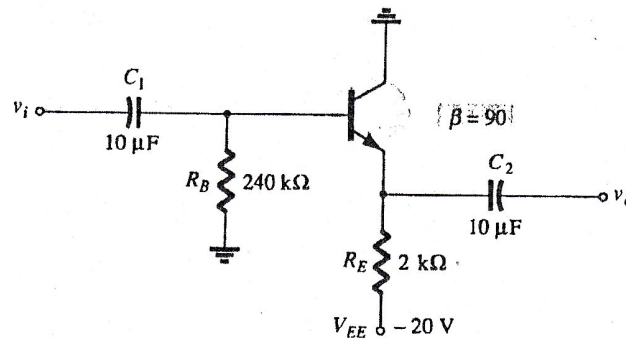


ANSWER THE FOLLOWING QUESTIONS

الإمتحان في صفحتين

Question1

- (a) Describe in your own words the conditions established by forward- and reverse-bias conditions on a p-n junction diode and how the resulting current is affected.
(b) Determine V_{CE} and I_E for the following network



Question2

Calculate the voltage gain ($A_v = V_L/V_i$) for the following network, if :

- (1) $V_i = 500$ mV and $R = 1$ kΩ.
(2) The source has an internal resistance of 100Ω in series with V_i .

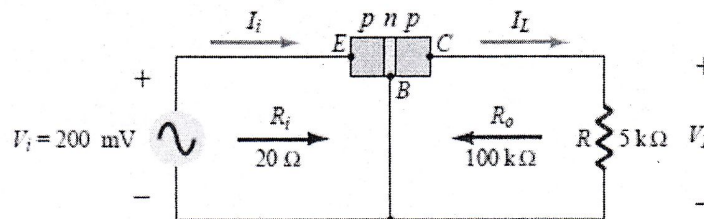
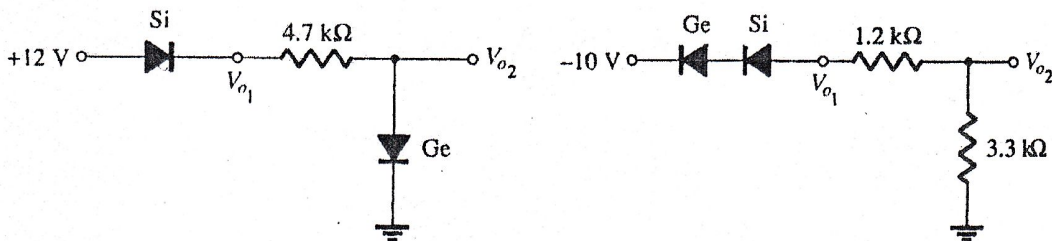


Figure 2

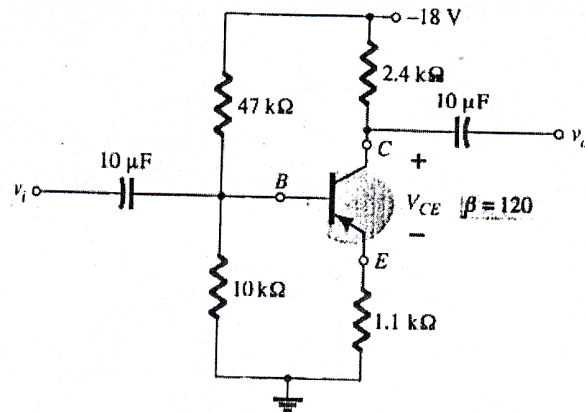
Question3

Determine V_{o1} and V_{o2} for the following networks.



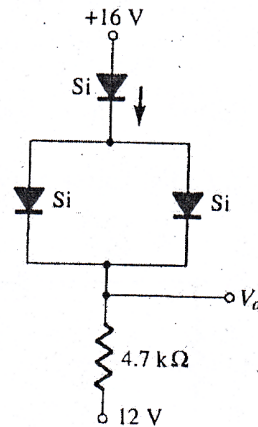
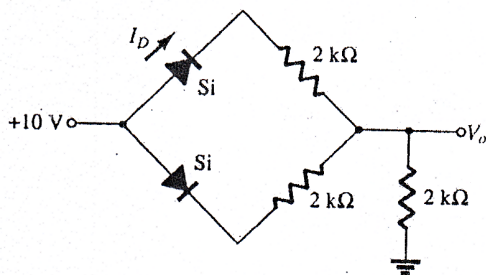
Question4

Determine V_{CE} for the voltage-divider bias configuration of the following network



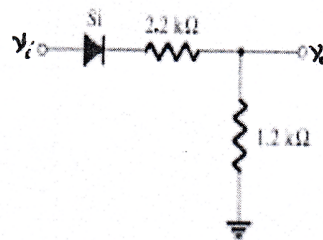
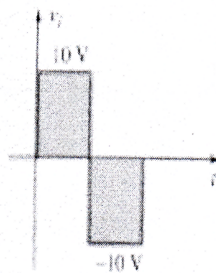
Question5

Determine V_o and I for the following networks.

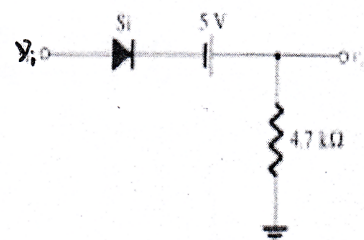


Question6

Determine v_o for each network of the following for the input shown.



(a)



(b)

GOOD LUCK