Assiut University – Faculty of Science
Physics Department
2023-2024 – 2nd semester (May 22, 2023)

كلية العلوم
جامعة أسيوط

Electricity & AC circuits - Code: P226 | **Final Exam** | **Time: 2h**

Instructor: Prof. Dr. Hicham Eldin Mahfoz Kotb

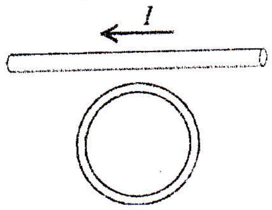
Q1 (14)	Q2 (18)	Q3 (18)	Total (50 marks)

"The most certain way to succeed is always to try ..... just one more time."- Thomas Edison

الاختبار مكون من 6 صفحات

Q1: Circle the correct answer for the following questions: (13 Marks)

1. A circular loop of wire is placed next to a long straight wire which carries an increasing current I. What current does this induce in the circular loop?

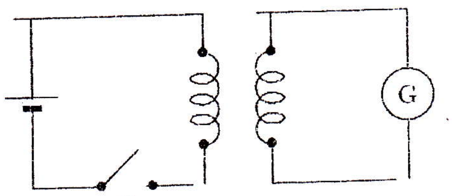


a. a clockwise current
b. a counterclockwise current
c. an alternating current
d. zero current

2. In a purely resistive circuit the current:
a. leads the voltage by one-fourth of a cycle
b. lags the voltage by one-fourth of a cycle
c. is in phase with the voltage
d. none of the above

3. The rms value of an ac current is:
a. its peak value.
b. its average value.
c. that direct current that produces the same rate of heating in a resistor as the actual current.
d. zero.

4. In the circuit shown, there will be a non-zero reading in galvanometer G:



a. only just after the switch S is closed
b. only just after S is opened
c. only just after S is opened or closed
d. never

5. .... can be used as a source of alternating voltage.
a. Power supply
b. Dry battery
c. Generator
d. Fuel cell

6. The receiving circuit of a radio is a series ....
a. LC circuit with natural frequency in the radio frequency range.
b. RL circuit with low time constant.
c. RC circuit with high time constant.
d. RLC circuit with high power factor.

7. The working principle of essentially all electric motors is:

a. Opposite electric charges attract and like charges repel.
b. A current-carrying conductor placed perpendicular to a magnetic field will experience a force.
c. Iron is the only element that is magnetic.
d. A magnetic north pole carries a positive electric charge, and a magnetic south pole carries a negative electric charge.

8. The unit of the power factor is:

a. Ohm
b. radian
c. watt
d. dimensionless

9. If the input to an *RLC* series circuit is $V = V_m \sin\omega t$, then the current in the circuit is

a. $\frac{V_m}{R}\sin\omega t$

b. $\frac{V_m \sin\omega t}{\sqrt{R^2+\omega^2 L^2}}$

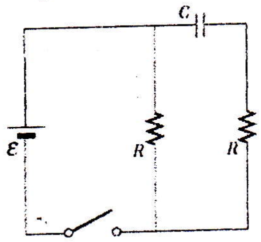
c. $\frac{V_m \sin\omega t}{\sqrt{R^2+(\omega L + 1/\omega C)^2}}$

d. $\frac{V_m \sin(\omega t - \phi)}{\sqrt{R^2+(\omega L - 1/\omega C)^2}}$

10. Which of the following statements might be true for a resistor connected to a sinusoidal AC source?

a. $P_{av} = 0$ and $i_{av} = 0$
b. $P_{av} = 0$ and $i_{av} > 0$
c. $P_{av} > 0$ and $i_{av} = 0$
d. $P_{av} > 0$ and $i_{av} > 0$

11, 12. For the circuit, the capacitor is initially uncharged. Just after the switch is closed, the current in the battery is approximately:



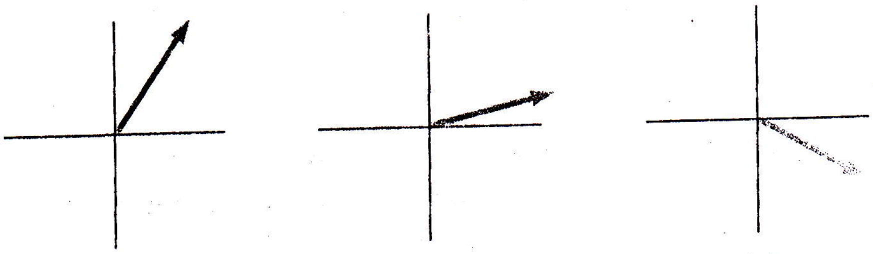
a. zero
b. ε/R
c. ε/2R
d. 2ε/R

13. For the same circuit, after a very long time, the current in the battery is approximately:

a. zero
b. ε/R
c. ε/2R
d. 2ε/R

14. The given figure shows the voltage phasor at three instants of time. Which part of the figure represents the instant of time at which the instantaneous value of the voltage has the largest magnitude?

a. (a)
b. (b)
c. (c)
d. There is no difference at all.



(a) (b) (c)

Q2: Circle the correct choice and show your answer. (18 Marks)

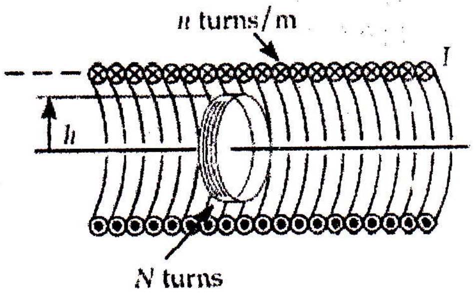
1. (3 marks) **A long solenoid has n = 400 turns per meter and carries a current given by I = (30.0 A)(1-$e^{-1.60t}$). A second coil that has a radius of (h = 6 cm) and consists of N = 250 turns exists inside the solenoid and coaxial with it. Find the induced emf in the coil? [$\mu_0 = 4\pi\times10^{-7}$ T.m/A]**

a) (1-$e^{-1.60t}$)

b) (68.2 mV)$e^{-1.60t}$

c) $e^{-1.60t}$

d) 68.2 mV



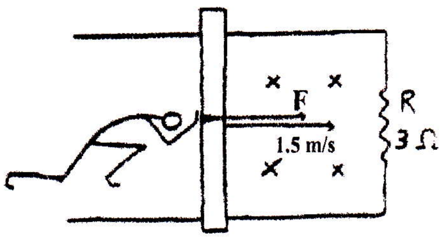
2. (3 marks) **An experimentalist push a conducting bar of length 2 m, to move on two frictionless parallel rails with speed of 1.5 m/s in the presence of uniform magnetic field of 3 T. Calculate the force F that the experimentalist should use to keep the bar moving with constant speed.**

a) 18 N, to the right

b) 3 N, to the right

c) 9 N, to the left

d) 27 N, to the left



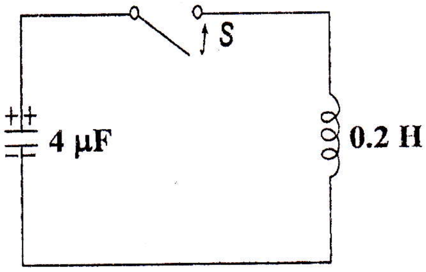
3. (4 marks) **Before the switch is closed in the figure, the potential across the capacitor is 200 V. At some instant after the switch is closed, the instantaneous current is 0.70 A. What is the energy in the capacitor at this instant?**

a) 140 mJ

b) 0.70 J

c) 286 mJ

d) 31 mJ



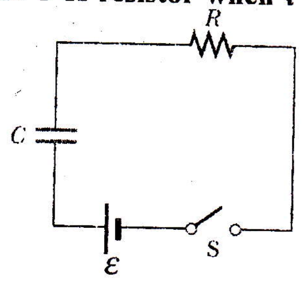
4. (4 marks) **In the circuit shown, the capacitor is initially uncharged. At time t = 0, switch S is closed. If τ denotes the time constant, what is the approximate current through the 3 Ω resistor when t = τ/100?**

a) 0.25 A

b) 0.5 A

c) 0.75 A

d) zero



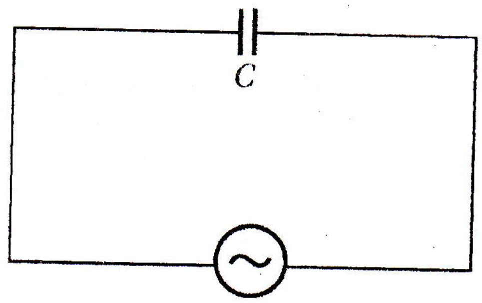
5. (4 marks) **An 8 μF capacitor is connected to the terminals of a 60 Hz AC source whose rms voltage is 150 V. Find the capacitive reactance and the rms current in the circuit?**

a) 0.11 A

b) 0.35 A

c) 0.45 A

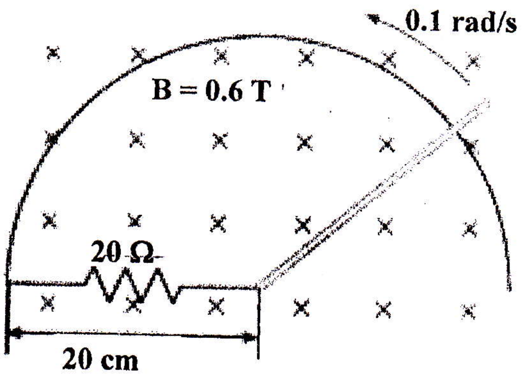
d) zero



Q3. Answer the following problems: (18 Marks)

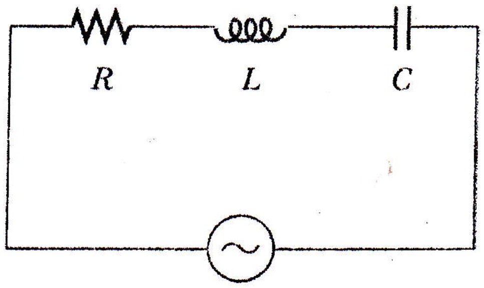
I. (4 marks) **A conducting bar rotates with a constant angular speed ω=0.1 rad/s about a pivot at one end. If the other end of this bar is moving on a circular conducting arc and a uniform magnetic field B is directed perpendicular into the plane of rotation as shown in the given figure.**

Find the value and direction of the current passing in the resistance 20 Ω of the circuit.



II. In the shown series RLC circuit, R= 866 Ω, L= 80 H, and an C=80 μF. The AC power supply provides an rms voltage of 3 kV and operates at an angular frequency of 25 rad/s.

(a) (3 marks) What is the rms current for this circuit?

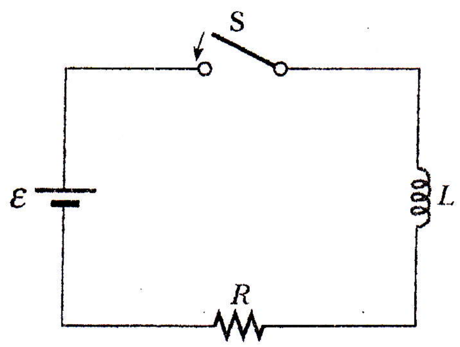


(b) (2 marks) What is the average power delivered by the AC power supply?

(c) (2 marks) What is the maximum possible rms current that could be obtained by adjusting the frequency of the power supply?

III. When the switch in the shown Figure below is closed, the current takes 3 ms to reach 98% of its final value. Given R = 10 Ω and ε = 50 V, find the following:

(a) (3 marks) The inductive time constant.



(b) (2 marks) **The inductance L.**

(c) (2 marks) **The value of the final steady-state current.**

End of the exam.

"Your Success and Happiness Lie on YOU"- Helen Adams Keller.

	Assiut University Faculty of Science Department of Physics Second Semester (2023-2024) Final Exam (50%)	Physics Program Level: (2) Date: May 21st, 2024 Time: 3 hours	كلية العلوم جامعة أسيوط
Course Title: Modern Physics Teaching Staff: Prof. Dr. Salah A. Makhlouf			Code: P 215

Constants & Conversion of units

Electron mass: $m = 9.11 \times 10^{-31}\,kg$ *& Proton mass:* $m = 1.673 \times 10^{-27}\,kg$
Electron charge: $e = 1.6 \times 10^{-19}\,C$
Planck's constant: $h = 6.626 \times 10^{-34}\,J\cdot s$ *and* $\hbar = 1.054 \times 10^{-34}\,J\cdot s$
Avogadro's number: $N_A = 6.02 \times 10^{23}$ *atom/mole*
Speed of light: $c = 3 \times 10^{8}\,m/s$
Boltzmann's constant: $k_B = 1.38 \times 10^{-23}\,J/K$
Compton wavelength: $\lambda_c = 2.426\,pm$
Rydberg Constant $R = 1.097 \times 10^{7}\,m^{-1}$
For hydrogen atom: Bohr radius $a_0 = 5.292 \times 10^{-11}\,m$ *&* $E_{ion} = 13.6\,eV$
$\varepsilon_0 = 8.85 \times 10^{-12}\,C^2/N\,m^2$
$1\,eV = 1.6 \times 10^{-19}\,J$
$1\,Å = 10^{-10}\,m$ *&* $1\,nm = 10^{-9}\,m$

Marks of Q

Part One) Choose the correct option for the following questions (1 Mark each) (26 Marks)

1. The wavelengths of which electromagnetic waves lie between those of ultraviolet light and gamma rays?

a) Radio waves b) X-Rays
c) Microwaves d) Infrared waves

2. Which of the following properties is/are possible in case of X-rays?

a) Polarization b) Diffraction
c) Interference d) All of the above

3. The wave nature of electrons was first proved by the:

a) Photoelectric effect b) Double slit experiment
c) Davison and Germer experiment d) Compton effect

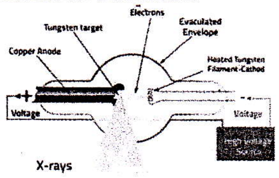
4. Compton scattering establishes:

a) the photonic nature of electromagnetic wave
b) the wave nature of electromagnetic wave
c) both wave and particle nature of electromagnetic wave
d) that the electron is a material particle

5. A non-relativistic proton has a kinetic energy E which is equal to that of a photon. The wavelength of the proton is λ_1 and that of the photon is λ_2. The ratio of $(\frac{\lambda_2}{\lambda_1})$ is proportional to:

a) $\sqrt{E}$ b) E
c) $\frac{1}{\sqrt{E}}$ d) $\frac{1}{E}$

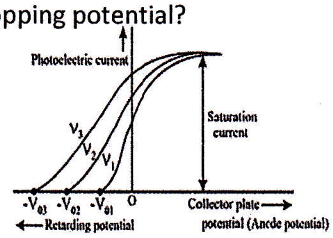
6. If the potential difference (V) applied to an X-ray tube is doubled while keeping the separation between the filaments and the target as same, what will happen to the cutoff wavelength (λ_{min})?



a) Will remains same b) Will be doubled
c) Will be four times of the original wavelength c) Will be halved

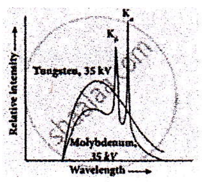
7. In the given graph of photocurrent and anode potential which of the following conditions will be true if the velocity of the photoelectron is v_1, v_2 and v_3 respectively, and V_{01}, V_{02} and V_{03} are stopping potential?

a) $v_1 > v_2 > v_3$
b) $v_1 < v_2 < v_3$
c) $v_1 = v_2 = v_3$
d) None of the above



8. Which characteristic quantity of X-ray spectra does not change when the target material is changed:

a) Intensity
b) wavelengths of characteristic lines
c) shape of the continuous spectra
d) cutoff wavelength (λ_{min})



9. A family of planes with spacing (d) of $NaCl$ crystal reflects a beam of X-ray in first order at a Bragg angle of $\theta = 30°$. The wavelength (λ) given by the same units for (d) of the used X-rays beam is:

a) $1.00\ d$ b) $0.50\ d$
c) $1.50\ d$ d) $2.00\ d$

Marks of Q

10. Laser Rays are:

a) instrument to measure the velocity of airplane
b) instrument to measure the intensity of *X*-rays
c) highly coherent waves
d) none of the above

11. Which of the following is a correct relation according to Heisenberg's Uncertainty principle?

a) $\Delta x \cdot \Delta p \leq h/4\pi$
b) $\Delta x \cdot \Delta p \leq h^2/4\pi$
c) $\Delta x \cdot \Delta p \geq h/4\pi$
d) $\Delta x \cdot \Delta p\ 6h^2/4\pi$

Solu

12. Which of the following statements are correct?

a) The Heisenberg uncertainty principle applies to electrons, but not to protons.
b) It is impossible to determine simultaneously both the position and time of an electron
c) It is impossible to determine simultaneously both the mass and time of an electron
d) It is impossible to determine simultaneously both the time and energy of an electron with accuracy.

13. Among the following particle which one will have the largest wavelength, if all have the same kinetic energy:

a) Electron ($m_e = 9.1 \times 10^{-31}\ kg$)
b) Proton ($m_p = 1.67 \times 10^{-27}\ kg$)
c) Neutron ($m_n = 1.67 \times 10^{-27}\ kg$)
d) Alpha particle ($m_\alpha = 6.64 \times 10^{-27}\ kg$)

14. The probability that a particle exists in a given small region of space is proportional to:

a) the square of the frequency of its wave function
b) the square of its momentum
c) the square of the wavelength of its wave function
d) the square of the magnitude of its wave function

15. A proton of charge (+e) and an α-particle of charge (+2e) are accelerated under the same potential difference V. If $m_\alpha = 4\ m_p$, the ratio of de-Broglie wavelengths of the proton and the α-particle ($\frac{\lambda_p}{\lambda_\alpha}$) is:

a) $\sqrt{8}$
b) $\frac{1}{\sqrt{8}}$
c) $\frac{1}{4}$
d) 4

16. What is the quantum number n of a particle of mass m confined to a one-dimensional box of length L when its momentum is $4h/L$?

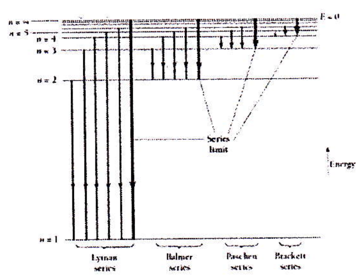
a) 1
b) 4
c) 2
d) 8

17. The radius of the n-th stationary orbit of hydrogen atom is proportional to

a) $\frac{1}{n}$
b) n^2
c) $\frac{1}{n^2}$
d) n

18. Which series of hydrogen spectrum corresponds to ultraviolet region?

a) Balmer series
b) Lyman series
c) Paschen series
d) Pfund series



19. The ratio of <u>minimum</u> wavelengths of Lyman to Balmer series will be:

a) $\frac{5}{4}$
b) $\frac{1}{4}$
c) $\frac{5}{2}$
d) $\frac{1}{2}$

Marks of Q

20. A nuclear reaction gives off a total of $10^{17}\,J$ energy. How much mass is spent in the process?

a) $\frac{1000}{9}kg$
b) $\frac{10}{9}kg$
c) $\frac{1}{9}kg$
d) $\frac{100}{9}kg$

21. The energy of a particle in a one dimensional box is proportional to:

a) $\frac{1}{n}$
b) n^2
c) $\frac{1}{n^2}$
d) n

22. Consider the following statements:

(1) No object can move faster than the speed of light.

(2) Space and time are relative, and all motion must be relative to a frame of reference.

a) Both (1) and (2) statements are correct
b) Only (1) is correct statement
c) Only (2) is correct statement
c) Both (1) and (2) are wrong statements

23. The mass energy relation is the outcome of ....

a) Quantum theory
b) General theory of relativity
c) Field theory of relativity
d) Special theory of relativity

24. The speed of a fast moving (relativistic) electron, having total energy of *2 MeV*, is about:

a) *0.95 c*
b) *0.99 c*
c) *0.98 c*
d) *0.97 c*

25. Relative to a stationary observer, a rod of length $L_0 = 1.0\ m$ is moving at $v = 0.8\ c$. It would appear to the observer that the rod's length L is:

a) $0.8\ m$
b) $0.6\ m$
c) $1.0\ m$
d) $1.25\ m$

26. At what speed should a clock be moved so that it may appear to lose *5 minutes* in each hour? Hint: $t = 60$ *minutes*, $t_0 = 55$ *minutes*

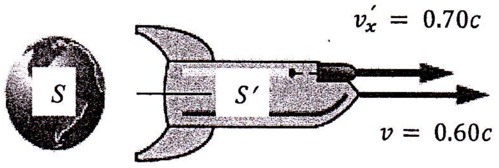
a) $\frac{\sqrt{13}}{12}c$
b) $\frac{\sqrt{23}}{14}c$
c) $\frac{\sqrt{13}}{14}c$
d) $\frac{\sqrt{23}}{12}c$

27. What is the time dilatation factor (γ) of a muon travelling with a velocity of *80%* that of the velocity of light?

a) *0.60*
b) *1.66*
c) *0.20*
d) *5.00*

28. A spaceship (S')moving away from the earth (S) with velocity $v = 0.60c$ fires a rocket in the direction of travel with a speed of $v_x' = 0.70c$ relative to the spaceship, where c is the velocity of light. What will be the approximate velocity of the rocket (v_x) as observed from the earth?

a) *0.92 c*
b) 0.17 c
c) 0.10 c
d) 1.30 c



Marks of Q

Part Two: Answer Four (4) only of the following questions **(24 Marks)**

Q1) **(6 Marks)**

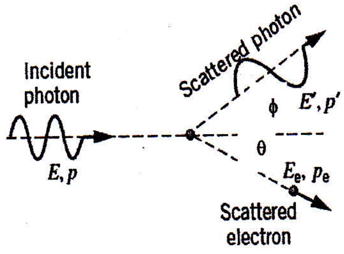
A photon undergoing Compton scattering has an energy after scattering of $(E') = 650\ keV$, and the electron recoils with an energy of $(E_e) = 150\ keV$.

(a) Find the wavelength (λ') of the scattered photons in pm units?

(b) Find the wavelength (λ) of the incident photon in pm units?

(c) Find the angle (ϕ) at which the photon is scattered?

(d) Find the angle (θ) at which the electron recoils?



Marks of Q

Q2) **(6 Marks)**

a) A proton of mass $m = 1.673 \times 10^{-27} kg$ moving at a speed of $v = 0.86\ c$. Find the relativistic momentum (p) expressed in units of $\frac{kg \cdot m}{s}$ and the de-Broglie wavelength in pm units? (3 Marks)

b) We wish to measure simultaneously the wavelength and position of a photon. Assume that the wavelength measurement gives $\lambda = 6000\ \AA$ with an accuracy of one part in a million, that is $\frac{\Delta\lambda}{\lambda} = 10^{-6}$. What is the minimum uncertainty in the position Δx of the photon? (3 Marks)

Marks of Q

(6 Marks)

Q3)

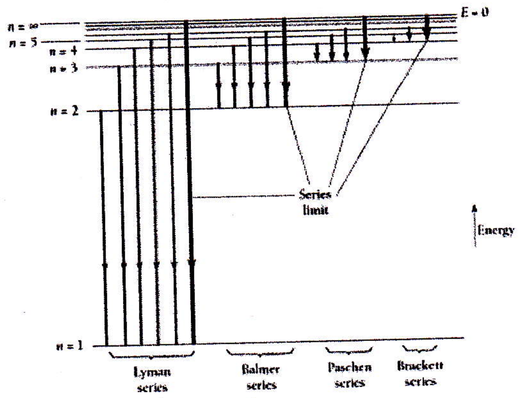
The figure below shows the spectral series of Hydrogen. A hydrogen atom is in the $n = 2$ state absorbs a photon and the electron jumps to the $n = 4$ state.

a) What is the wavelength of absorbed photon (λ) in nm?

b) How many photons might be emitted from this atom following this absorption?

c) Compute the wavelengths ($\lambda_1 : 4 \rightarrow 3$), ($\lambda_2 : 4 \rightarrow 1$) and ($\lambda_3 : 3 \rightarrow 2$) of the emitted photons?

d) Which photon (or photons) lies in the IR, visible or UV region of the spectrum?



Marks of Q

Q4) **(6 Marks)**

Consider the point of view of an observer (S) who is moving toward the Earth with the muon whose velocity $v = 0.998\ c$ crossing the height of the atmosphere whose thickness (L_0) is $10^4\ m$ for an observer at the earth (S').

a) In the reference frame of the observer who is moving with the muon, what is the apparent thickness (L) of the Earth's atmosphere?
b) How much time does the muon take to reach the earth's surface?
c) If the proper lifetime of the muon is $t_0 = 2.2 \times 10^{-6} s$, explain whether the muon reaches the earth's surface or not?
d) For the observer on the earth (S'), what is the apparent lifetime (t) of the muon?
e) For the point of view of the observer on the earth (S'), does the muon cross the $10^4\ m$ thickness of the atmosphere and reach the earth during the lifetime (t) you calculated in part (d)?

Marks of Q

Q5) **(6 Marks)**

A proton of mass $m = 1.673 \times 10^{-27} kg$ and a kinetic energy $(KE) = \frac{1}{2}mc^2$, i.e. half of its rest energy (E_0). Use the relativistic equations to answer the following questions:

a) Find the proton's rest energy (E_0) in MeV units?

b) Show that the speed of the proton is given by $v = \frac{\sqrt{5}}{3}c$?

c) Determine the total energy of the proton (E) in MeV units?

d) What is the proton's momentum (p) in MeV/c units?

e) Determine the potential difference (V) through which the proton would have to be accelerated to attain this speed?

Assiut University **Faculty of Science** **Physics Department**		**Final Exam 2024** **Date:** June 6th, 2024 **Allowed time:** 3 hours

Course Name: ***Physics of Metals, Alloys and Ceramics*** **Course Code:** P256
Coordinator: Dr. Alaa Abd-Elnaiem

Answer all the following questions

Question (I): In the following multiple-choice questions, please circle the correct answer(s). You must write down the steps to get the correct answer if needed **(12 Marks)**

1. "solid + liquid" results in a "liquid" upon heating during ……………..…. reaction.
   A. Eutectic **B.** Peritectic **C.** Monotectic **D.** Syntectic **E.** None of these
2. The following is not the two-dimensional (2D) imperfection:
   A. Dislocation. **B.** Precipitates. **C.** Surface defects. **D.** Grain boundary. **E.** Twin boundary.
3. Ir has an FCC crystal structure, a density of 22.4 g/cm^3, and an atomic weight of 192.2 g/mol, then the radius of an iridium atom equal? (Hint: N_A=6.022 × 10^{23} atoms/mol)
   A. 0.553 nm **B.** 0.439 nm **C.** 0.363 nm **D.** 0.211 nm **E.** 0.136 nm
4. Determine the indices for the direction shown in the cubic unit cell shown in **Figure 1**:
   A. $[0\bar{1}\bar{1}]$ **B.** $[\bar{2}10]$ **C.** $[112]$ **D.** $[11\bar{2}]$ **E.** $[0\bar{1}1]$
5. A specimen of aluminum having a rectangular cross-section of 10 mm×12.7 mm is pulled in tension with 3.55×10^4 N force, producing only elastic deformation. If the elastic modulus for Al is 69×10^9 N/m^2, the resulting strain is:
   A. 6.2×10^{-4} **B.** 4.1×10^{-3} **C.** 7.5×10^{-2} **D.** 1.3×10^{-2} **E.** 0.154
6. Above the following line, the liquid phase exists for all compositions in a phase diagram:
   A. Tie-line. **B.** Solvus. **C.** Solidus. **D.** Liquidus. **E.** None of these.
7. Coordination number in FCC crystal structure:
   A. 2. **B.** 4. **C.** 6. **D.** 8. **E.** 12.
8. Thermodynamically stable defects:
   A. Point defects. **B.** Line defects. **C.** Surface defects. **D.** Volume defects. **E.** Twin boundary.

Question (II): Answer the following problems **(18 Marks)**

1. Determine the expected diffraction angle (2θ) for the first-order reflection from the (113) set of planes for FCC platinum, which has an atomic radius of 0.1387 nm, when monochromatic radiation of wavelength 0.1542 nm is used.
2. Silver (Ag) and palladium (Pd) both have the FCC crystal structure and Pd forms a substitutional solid solution for all concentrations at room temperature. Compute the unit cell edge length for a 75 wt% Ag–25 wt% Pd alloy. The room-temperature density of Pd is 12.02 g/cm^3 and the density of Ag is 10.49 g/cm^3, while the atomic weight for Pd and Ag is 106.4 g/mol, and 107.9 g/mol, respectively.
3. Titanium (Ti) has an HCP unit cell for which the ratio of the lattice parameters c/a is 1.58. If the radius of the Ti atom is 0.1445 nm, (a) determine the unit cell volume, and (b) calculate the density of Ti and compare it with the literature value (4.51 g/cm^3). [Hint: A_{Ti}= 47.87 g/mol; N_A=6.22×10^{23} atoms/mol]
4. Gold (Au) forms a substitutional solid solution with silver (Ag). Compute the number of gold atoms per cubic centimeter for a silver-gold alloy that contains 10 wt% Au and 90 wt% Ag. The densities of pure gold and silver are 19.32 and 10.49 g/cm^3, respectively. [Hint: A_{Au}= 196.97 g/mol; A_{Ag} = 107.9 g/mol]

5. The unit cell for tin has tetragonal symmetry, with a and b lattice parameters of 0.583 and 0.318 nm, respectively. If its density, atomic weight, and atomic radius are 7.30 g/cm^3, 118.69 g/mol, and 0.151 nm, respectively, compute the atomic packing factor.
6. A piece of copper (Cu) originally 305 mm long is towed in tension with a stress of 276 MPa. If the deformation is entirely elastic, what will be the resultant elongation? (Hint: Elastic modulus for Cu is 110 GPa)

Question (III): **(8 Marks)**

1. For a 30 wt% Sn-70 wt% Pb alloy at 200˚C, *in below phase diagram* **(Figure 2)**:
   (a) What phase(s) is (are) present?
   (b) What is (are) the composition(s) of the phase(s)?
   (c) Calculate the relative amount of each phase present in terms of a mass fraction.
   (d) State the name, chemical formula, and temperature of the invariant reaction at 61.9 wt% Sn.
   (e) Investigate in detail the microstructure for slow and fast cooling from 300 °C to 100 °C for this composition.
2. Describe in detail the phase diagram shown in **Figure 2** and state the different equilibrium lines.

Question (IV): **(12 Marks)**

1. What is meant by solid solution and what is the type of solid solution (explain with sketch)? And what is the condition for complete soluble metal A in metal B in the solid state?
2. What are the steps to prepare a sample for testing microscopy?
3. Determine the Miller indices for planes A, B, and C in **Figure 3** and draw [001] direction in the cubic system.
4. What is the basic difference between the Vickers hardness test and the Rockwell hardness test?

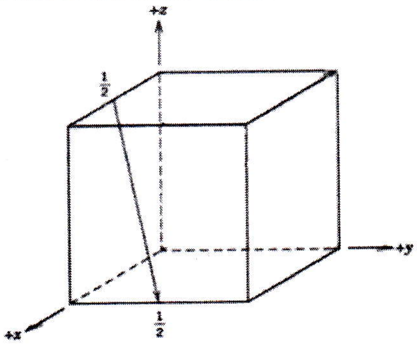


Figure 1

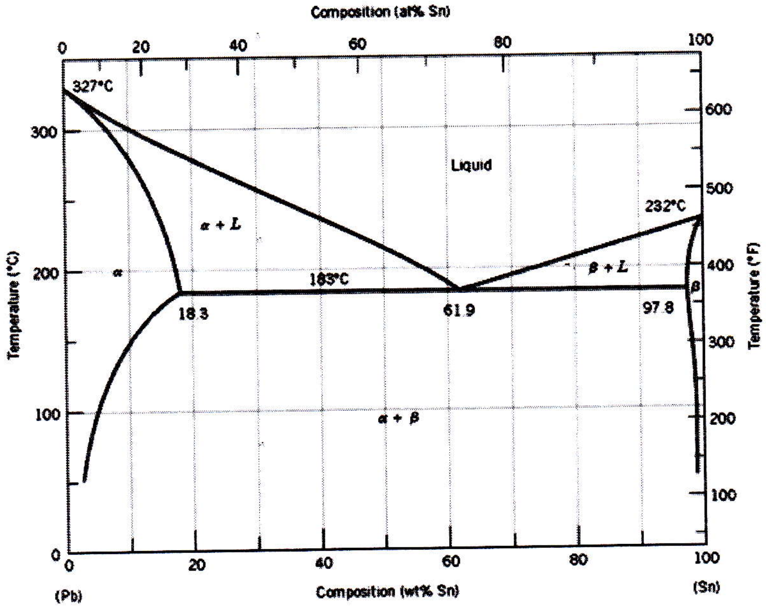


Figure 2

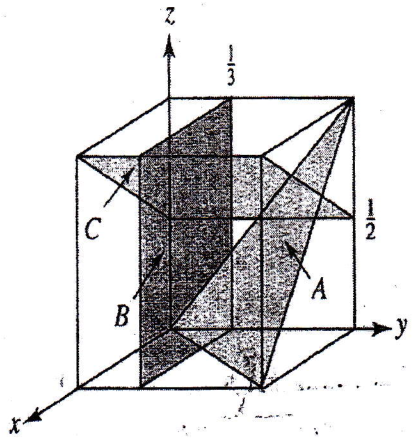


Figure 3

BEST WISHES,,,

Assiut University
Faculty of Science
Department of Physics
Second semester 29/5/2024

Course: Modern Physics
Code: P225
Time: 2 Hour
Final Exam 50%

كلية العلوم
جامعة أسيوط

The exam is written in seven (7) pages

Answer four (4) only of the following questions:

Question (1): **(12.5 Marks)**

i- Put (✓) or (✗): **(2.5 Marks)**

1-	X-ray is the reverse phenomenon of photoelectric emission.	( )
2-	Compton shift $\Delta\lambda$ depends on the type of scattering material.	( )
3-	Bohr's corresponding principle says, "the smaller quantum number, the closer quantum physics approaches classical physics".	( )
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.	( )

ii- If we considered the Sun as a black-body, estimate the surface temperature of the Sun from the following information. The wavelength marking the maximum power emission of the Sun "λ_{max}" is *500 nm*. **(5 Marks)**

iii- Write the postulates of the special theory of relativity. **(5 Marks)**

Question (2): **(12.5 Marks)**

i- **Choose the correct statement:** **(2.5 Marks)**

1-	**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.**	
2-	**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.**	
3-	**A *γ ray* photon has five times the energy of an *X-ray* photon. What can be said about their wavelengths?**		
	(a) We cannot say anything because we have no clue about their relative frequencies.		
	(b) $\lambda_{\gamma\ ray} = 5\lambda_{X\text{-}ray}$.	**(c)** $\lambda_{\gamma\ ray} = \lambda_{X\text{-}ray}/5$.	
	(d) $\lambda_{\gamma\ ray} = \lambda_{X\text{-}ray}$.	**(e)** $\lambda_{\gamma\ ray} = (\lambda_{X\text{-}ray})^2$.	
4-	**Which of the following is the best paraphrasing of the Heisenberg uncertainty principle?**		
	(a) Only if you know the exact position of a particle can you know the exact momentum of the particle.		
	(b) The larger the momentum of a particle, the smaller the position of the particle.		
	(c) The more precisely you know the position of a particle, the less well you can know the momentum of the particle.		
	(d) The position and momentum of a particle can both be measured precisely at the same time.		
5-	**In the Bohr model of the hydrogen atom, by increasing the quantum number, the energy difference between any two successive levels in the atom .....**		
	(a) increasing	**(b) be equal**	
	(c) decreasing	**(d) all of the above**	

ii- **At what speed does a clock move if it runs at a rate which is one-half the rate of a clock at rest?** **(5 Marks)**

iii- Write Bohr's hypotheses for his atomic model. Using these assumptions, prove that the fine-structure constant α is very nearly equal to 1/137. The quantity α, which is equal to the ratio v_1/c where v_1 is the velocity of the electron in the first circular Bohr orbit of Hydrogen atom and c is the speed of light in vacuum. **(5 Marks)**

Question (3): **(12.5 Marks)**

i- Put (✓) or (✗): **(2.5 Marks)**

1-	Rutherford's model destroyed by the electromagnetic theory.	( )
2-	According to Max Plank, oscillator can emit radiation by dropped to any lowest energy state where the amount of energy emitted is $\Delta\varepsilon = nhf$.	( )
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.	( )

ii- In Compton Effect, an incident X-ray with a wavelength $\lambda = 5 \times 10^{-11}\ m$ is incident on a calcite target. Find the wavelength of the X-ray scattered at a 30° angle. **(5 Marks)**

iii- 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 Marks)**

Question (4): **(12.5 Marks)**

i- Put (✓) or (✗): **(2.5 Marks)**

1-	The Rutherford model failed to explain the hydrogen atom's spectrum.	( )
2-	Two events occur at different time are simultaneous.	( )
3-	The proper time is always the shortest time interval.	( )
4-	The conservation law of momentum is invariant under Lorentz transformation.	( )
5-	Maxwell's equations are invariant under Galilean transformation.	( )

ii- A photon releases a photoelectron with an energy of 2 eV from a metal which has a work function of 2 eV. What is the smallest possible value for the energy of this photon?

(5 Marks)

iii- Define the proper length, and derive the length contraction relation. **(5 Marks)**

Question (5): **(12.5 Marks)**

i- Choose the correct statement: **(2.5 Marks)**

1-	If the momentum of an electron were doubled, how would its wavelength change?				
	(a) No change.		(b) It would be halved.		
	(c) It would double.		(d) It would be quadrupled.		
2-	For the hydrogen atom, which series describes electron transitions to the n=1 orbit "the lowest energy electron orbit"? Is it the:				
	(a) Lyman series		(b) Balmer series		
	(c) Paschen series		(d) Pfund series		
3-	The results of Rutherford's experiment, in which alpha particles were fired toward thin metal foils, were surprising because:				
	(a) Some of the alpha particles were reflected almost straight backward.				
	(b) Two alpha particles emerged from the foil for every alpha that entered.				
	(c) Beta particles were created.				
	(d) Some alpha particles were destroyed in collisions with the foil.				
4-	Muons are particles 200 times heavier than electrons. A muon and electron have identical kinetic energies. What can you say about their wavelengths λ?				
	(a) Both have the same wavelength λ, i.e., $\lambda_{muon} = \lambda_{electron}$.				
	(b) $\lambda_{muon} > \lambda_{electron}$		(c) $\lambda_{muon} < \lambda_{electron}$		
	(d) The muons do not have a de Broglie wavelength.				
5-	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	

ii- Determine the longest and shortest wavelengths observed in the Paschen series for hydrogen. **(5 Marks)** iii-When Lorentz transformations are reduced to the Galilean transformations? Prove that.

(5 Marks)

Electron chaege e	$1.6x10^{-19}$C		Plank's constant h	6.626×10^{-34} Joul.sec
Electron mass m_e	$9.1x10^{-31}$kg		Light velocity c	$3x10^{8}$ m.sec^{-1}
Proton mass m_p	$1.672x10^{-27}$ kg		Coulomb constant k	$9x10^{9}$J.m.C^{-2}
Wien's displacement constant a	2.8977×10^{-3} m·K		Ionization energy of the hydrogen atom E_o	13.6 eV
Rydberg constant R	1.097×10^{7} m^{-1}			

WITH MY BEST WISHES ***Hesham Al-Attar***

Physics Department
Faculty of Science
Assiut University
كلية العلوم
جامعة أسيوط

Physics 271P – Physical Optics & Optical Fibers

THIS TEST HAS THIRTEEN PAGES

DURATION OF TEST: THREE HOURS

Answer All Questions from Part I & II.

Part I: Multiple Choice: *Circle the one best answer to each question* : (20 Points)

1. Fully constructive interference between two sinusoidal waves of the same frequency occurs only if they:
   A. travel in opposite directions and are in phase
   B. travel in opposite directions and are 180° out of phase
   C. travel in the same direction and are in phase
   D. travel in the same direction and are 180° out of phase

2. Huygens' construction can be used only:
   A. for light
   B. for an electromagnetic wave
   C. for transverse waves
   D. for all of the above

3. Consider (I) the law of reflection and (II) the law of refraction. Huygens' principle can be used to derive:
   A. only I B. only II C. both I and II D. neither I nor II

4. Units of "optical path length" are:
   A. m^{-1} B. m C. m/s D. Hz/m

5. Interference of light is evidence that:
   A. the speed of light is very large
   B. light is a transverse wave
   C. light is electromagnetic in character
   D. light is a wave phenomenon

6. The reason there are two slits, rather than one, in a Young's experiment is:
   A. to increase the intensity
   B. one slit is for frequency, the other for wavelength
   C. to create a path length difference
   D. one slit is for $\overline{E}$ fields, the other is for $\overline{B}$ fields

7. 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. a fourth of a wavelength
B. a half a wavelength
C. a wavelength
D. none of the above

8. In a Young's double-slit experiment the center of a bright fringe occurs wherever waves from the slits differ in phase by a multiple of:

A. $\pi/4$
B. $\pi/2$
C. π
D. 2π

9. Waves from two slits are in phase at the slits and travel to a distant screen to produce the third side maximum of the interference pattern. The difference in the distance traveled by the waves is:

A. half a wavelength
B. a wavelength
C. three halves of a wavelength
D. three wavelengths

10. Waves from two slits are in phase at the slits and travel to a distant screen to produce the second minimum of the interference pattern. The difference in the distance traveled by the waves is:

A. half a wavelength
B. a wavelength
C. three halves of a wavelength
D. two wavelengths

11. A monochromatic light source illuminates a double slit and the resulting interference pattern is observed on a distant screen. Let d = center-to-center slit spacing, a = individual slit width, D = screen-to-slit distance, and *L* = adjacent dark line spacing in the interference pattern. The wavelength of the light is then:

A. dL/D
B. Ld/a
C. da/D
D. LD/a

12. Light from a small region of an ordinary incandescent bulb is passed through a yellow filter and then serves as the source for a Young's double-slit experiment. Which of the following changes would cause the interference pattern to be more closely spaced?

A. Use slits that are closer together
B. Use a light source of lower Intensity
C. Use a light source of higher intensity
D. Use a blue filter instead of a yellow filter

13. In a Young's double-slit experiment, light of wavelength 500nm illuminates two slits that are separated by 1 mm. The separation between adjacent bright fringes on a screen 5m from the slits is:

A. 0.10 cm
B. 0.25 cm
C. 0.50 cm
D. 1.0 cm

14. In a Young's double-slit experiment, the separation between slits is d and the screen is a distance D from the slits. $D \gg d$ and λ is the wavelength of the light. The number of bright fringes per unit width on the screen is:

A. $d/D\lambda$
B. $D\lambda/d$
C. $D/d\lambda$
D. λ/Dd

15. In a Young's experiment, it is essential that the two beams:

A. have exactly equal intensity
B. be exactly parallel
C. travel equal distances
D. come originally from the same source

16. In a Young's double-slit experiment, a thin sheet of mica is placed over one of the two slits. As a result, the center of the fringe pattern (on the screen) shifts by an amount corresponding to 30 dark bands. The wavelength of the light in this experiment is 480nm and the index of the mica is 1.60. The mica thickness is:

A. 0.090mm B. 0.012mm C. 0.014mm D. 0.024mm

17. Monochromatic light, at normal incidence, strikes a thin film in air. If λ denotes the wavelength in the film, what is the thinnest film t in which the reflected light will be a maximum?

A. $t \ll \lambda$ B. $t = \lambda/4$ C. $t = \lambda/2$ D. $t = 3\lambda/4$

18. A soap film is illuminated by white light normal to its surface. The index of refraction of the film is 1.50. Wavelengths of 480nm and 800nm and no wavelengths between are be intensified in the reflected beam. The thickness of the film is:

A. 1.5×10^{-5} cm B. 2.4×10^{-5} cm C. 3.6×10^{-5} cm D. 4.0×10^{-5} cm

19. In a thin film experiment, a wedge of air is used between two glass plates. If the wavelength of the incident light in air is 480 nm, how much thicker is the air wedge at the 16th dark fringe than it is at the 6th?

A. 2400nm B. 4800nm C. 240nm D. 480nm

20. If two light waves are coherent:

A. their amplitudes are the same
B. their frequencies are the same
C. their wavelengths are the same
D. their phase difference is constant

21. To obtain an observable double-slit interference pattern:

A. the light must be incident normally on the slits
B. the light must be monochromatic
C. the light must consist of plane waves
D. the light must be coherent

22. The rainbow seen after a rain shower is caused by

A. diffraction B. interference C. refraction D. polarization

23. Sound differs from light in that sound:

A. is not subject to diffraction
B. is a torsional wave rather than a longitudinal wave
C. is a longitudinal wave rather than a transverse wave
D. is always monochromatic

24. Radio waves are readily diffracted around buildings whereas light waves are negligibly diffracted around buildings. This is because radio waves:

A. are plane polarized

B. have much longer wavelengths than light waves

C. have much shorter wavelengths than light waves

D. are nearly monochromatic (single frequency)

25. Diffraction plays an important role in which of the following phenomena?

A. The sun appears as a disk rather than a point to the naked eye

B. Light is bent as it passes through a glass prism

C. A cheerleader yells through a megaphone

D. A farsighted person uses eyeglasses of positive focal length

26. When a highly coherent beam of light is directed against a very fine wire, the shadow formed behind it is not just that of a single wire but rather looks like the shadow of several parallel wires. The explanation of this involves:

A. refraction B. diffraction C. reflection D. interference

27. When the atmosphere is not quite clear, one may sometimes see colored circles concentric with the Sun or the Moon. These are generally not more than a few diameters of the Sun or Moon and invariably the innermost ring is blue. The explanation for this phenomena involves:

A. reflection B. refraction C. interference D. diffraction

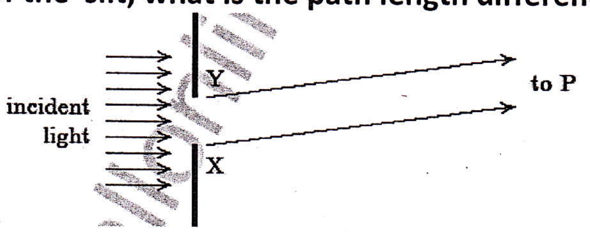
28. The diagram shows a single slit with the direction to a point P on a distant screen shown. At P, the pattern has its maximum nearest the central maximum. If X and Y are the edges of the slit, what is the path length difference (PX) - (PY)?

A. $\lambda/2$

B. λ

C. $3\lambda/2$

D. 2λ



29. When 450-nm light is incident normally on a certain double-slit system the number of interference maxima within the central diffraction maximum is 5. When 900nm light is incident on the same slit system the number is:

A. 2 B. 3 C. 5 D. 9

30. In a double-slit diffraction experiment the number of interference fringes within the central diffraction maximum can be increased by:

A. decreasing the slit width

B. decreasing the wavelength

C. decreasing the slit separation

D. increasing the slit width

31. In Newton's Ring experiments, the diameter of dark rings is proportional to

A. Odd Natural numbers

B. Natural Number

C. Even Natural Number

D. Square root of natural number

32. A wavelength is commonly measured in which one of the following units?

A. Radians B. Angstroms C. Electron volts D. Seconds

33. Extended source is needed in

A. Young's double slit experiment B. Bi prism Experiment

C. Newton's Ring Experiment D. None of them

34. The phenomenon of diffraction can be understood using

A. Huygens principle B. Fraunhofer

C. Uncertainty principle D. Fresnel Interference

35. What is the name of the process whereby waves travel around corners and obstacles in their paths?

A. Reflection B. Refraction C Interference D. Diffraction

36. In Fraunhofer diffraction, the incident wave front should be

A. elliptical B. Plane C. Spherical D. Cylindrical

37. A slit of width 'a' is illuminated by white light. For what value of 'a' will the first minimum for red light fall at an angle of 30° wavelength of red light is 6500 A°

A. 1.1×10^{-3} cm B. 1.4×10^{-4} cm C. 1.3×10^{-4} cm D. 1.6×10^{-4} cm

38. The wave nature of light is demonstrated by which of the following?

A. The photoelectric effect B. Color

C. The speed of light D. Diffraction

39. A grating has 6000 lines per cm. How many orders of light of wavelength 4500 A° can be seen?

A. 1 B. 2 C. 3 D. 4

40. In Fresnel diffraction

A. source of light is kept at infinite distance from the aperture
B. source of light is kept at finite distance from the aperture
C. Convex lens used
D. aperture width is selected so that it can acts as a point source

41. The electromagnetic waves do not transport

A. Momentum B. Information C. Energy D. Charge

42. In the diffraction pattern using circular aperture , when the screen is brought towards the aperture

A. the intensity of the screen is gradually increases.
B. the intensity of the screen is gradually decreases
C. the light is found to focus only to a fixed distance
D. Many points are observed where greater intensity is found

43. To find prominent diffraction, the size of diffraction object should be

A. Greater than wavelength of light used.

B. Comparable to order of wavelength of light.

C. Less than wavelength of light used.

D. None of these.

44. In a Young's double slit experiment, the central point on the screen is

A. First dark and then bright

B. Bright

C. Dark

D. First bright and then dark

45. In plane transmission grating, the angle of diffraction for second order maxima for wavelength 5×10^{-5} cm is 30°. Calculate the number of lines in one centimeter of the grating surface.

A. 1000 lines/cm B. 5000 lines/cm C. 500 lines/cm D. 10000 lines/cm

46. What is the highest order spectrum which may be seen with monochromatic light of wavelength 500nm by means of diffraction grating with 5000 lines/cm?

A. 2 B. 4 C. 8 D. 16

47. The first reflecting telescope was built by:

A. Galileo B. Copernicus C. Tyco Brahe D. Isaaç Newton

48. Optical fiber works on the

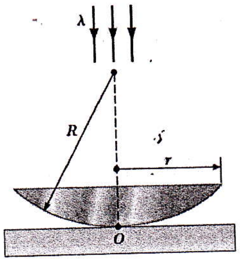
A. principle of refraction

B. total internal reflection

C. scattering

D. interference

49. In a Newton's-rings experiment, a plano-convex glass lens having diameter D is placed on a flat plate as shown in Figure. When λ light is incident normally, m bright rings are observed with the last one right on the edge of the lens. What is the radius R of curvature of the convex surface of the lens?



A. $R = D^2/4R(m + 1/2\ )\lambda$

B. $R = D/4R(m + 1/2\ )\lambda$

C. $R = D\ /\ R(m + 1/2\ )\lambda$

D. $R = 4D/R(m + 1/2\ )\lambda$

50. A beam of X-rays of wavelength λ is diffracted by a plane of rock salt. The glancing angle for the second-order diffraction is:

A. $\theta = sin^{-1}\ (\lambda\ /\ 2d)$

B. $\theta = sin^{-1}\ (2\lambda\ /\ d)$

C. $\theta = sin^{-1}\ (\lambda d)$

D. $\theta = sin^{-1}\ (\lambda\ /\ d)$

Part II: True or False questions (10 Points)

Tick the correct answer:

	True	False
1. Young's Double Slit Experiment illustrates the wave nature of light.		
2. When two waves of the same wavelength meet peak to peak they interfere destructively to form a wave with a larger amplitude		
3. Fully constructive interference between two sinusoidal waves of the same frequency occurs only if they travel in opposite directions and are in phase		
4. Fully destructive interference between two sinusoidal waves of the same frequency and amplitude occurs only if they travel in the same direction and are 180° out of phase.		
5. Standing waves are produced by the interference of two traveling sinusoidal waves, each of frequency 100 Hz. The distance from the second node to the fifth node is 60 cm. The wavelength of each of the two original waves is 30 cm.		
6. Huygens' construction can be used only for an electromagnetic wave.		
7. Consider (I) the law of reflection and (II) the law of refraction. Huygens' principle can be used to derive neither I nor II .		
8. Units of "optical path length" are m/s.		
9. Interference of light is evidence that light is a wave phenomenon.		
10. In a Young's double-slit experiment the center of a bright fringe occurs wherever waves from the slits differ in phase by a multiple of π		
11. A monochromatic light source illuminates a double slit and the resulting interference pattern is observed on a distant screen. Let d = center-to-center slit spacing, a = individual slit width, D = screen-to-slit distance, and l = adjacent dark line spacing in the interference pattern. The wavelength of the light is then dl/D.		
12. In a Young's double-slit experiment, light of wavelength 500nm illuminates two slits that are separated by 1 mm. The separation between adjacent bright fringes on a screen 5m from the slits is 0.25 cm.		

	True	False
13. In a double slit experiment with slits 1.0×10-5 m apart, light casts the first bright band 3.0×10-2 m from the center of a screen 0.65 m away. The wavelength of this light is 390 nm.		
14. The distance between the slits in a double-slit setup compared to the distance to the screen from the slits is very large.		
15. In a Young's double-slit experiment, the separation between slits is d and the screen is a distance D from the slits. D≫d and λ is the wavelength of the light. The number of bright fringes per unit width on the screen is d/Dλ.		
16. If two coherent sources are vibrating in phase then we have constructive interference at any point P whenever the path difference is mλ, m= 0, 1, 2...		
17. The device which produces highly coherent sources is Laser.		
18. Coherence is a measure of capability of producing inter-ference by wave.		
19. Two sources of light are said to be coherent, when they give light waves of same wavelength and constant phase difference.		
20. According to wave theory, intensity of light is directly proportional to square of amplitude. According to wave theory, intensity of light is directly proportional to square of amplitude.		
21. Laser light is coherent, because it consists of coordinated (parallel) waves of exactly same wavelength Laser light is coherent, because it consists of coordinated (parallel) waves of exactly same wavelength.		
22. In Young's double slit experiment, the minimum amplitude is obtained when the phase difference of super-imposing waves is zero.		
23. Speed of light changes as it across the boundary of two media.		
24. Optical fibers can carry much more information and much higher data rates.		
25. Fiber optic cables have a core that carries light to transmit data.		

Part III: 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:

2. Young's experiment is performed with orange light (λ=620 nm) from a krypton arc. If the fringes are measured with a micrometer eyepiece at a distance 100 cm from the double slit, it is found that 25 of them occupy a distance of 12.87 mm between centers. Find the distance between the centers of the two slits.

Solution:

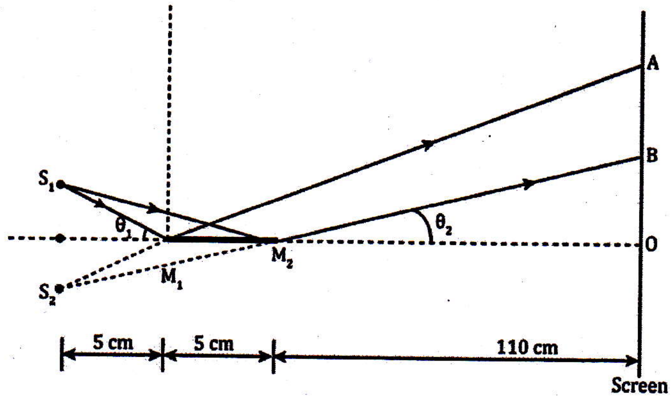
3. Two waves traveling together along the same line are given by

$$E_1 = E_o \sin(\omega t) \ , \quad E_2 = E_o \sin(\omega t + \varphi)$$

Find (a) the resultant amplitude, and (b) the initial phase angle of the resultant.

Solution:

4. A Lloyd's mirror of length 5 cm is illuminated with monochromatic light of wavelength λ(=600nm) from a narrow 1 mm slit in its plane and 5 cm plane from its near edge. Find the fringe width on a screen 120 cm from the slit and width of interference pattern on the screen.



Solution:

5. A plane wave is described by the equation: $y = 3\,cos(x/4 - 10t - \pi/2)$. Calculate the maximum velocity of the particles of the medium due to this wave and the acceleration of these particles?

Solution:

END OF EXAM