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Assiut University
Faculty of Science - Chemistry Department
Physical Chemistry Examination for 2nd Level Applied Industrial Chemistry Students (203 IC)

Date: 14/5/2025
Time: 2 hours
Physical Chemistry Examination for 2nd Level Applied Industrial Chemistry Students (203 IC)

Answer the following questions:

Part I: Catalysis: (17 Marks)

Answer Two Only from the following:

- 1) Derive the relation between the reaction rate and the ionic strength of solution
- 2) Derive the rate equation of a bimolecular homogeneous catalytic reaction:



- 3) Discuss the main postulates of heterogeneous catalytic reaction.

Part II: Solid state Chemistry: (17 Marks)

Answer the Following Questions:

1- Put (✓) or (✕) for the following sentences:

- (i) Ionic crystal exhibits high strength and low melting points. ()
- (ii) The freedom of the valence electrons to move through a metal given rise to high electrical conductivity. ()
- (iii) If the reflection of all lattice positions through a point brings a coincidence of point there is a center of symmetry. ()
- (iv) When the two substances are quite different chemically but have the same structure, they are said to be isostructural. ()
- (v) Chemical imperfection results from addition of the impurities. ()
- (vi) The amorphous materials are the atoms being packed in a little random fashion. ()

2- Explain how are the electrons and holes created within Ge parent structure by the addition of P and B.

3- Write short notes on two only from the following:

- (i) Point defects
- (ii) Slip dislocation
- (iii) Schottky and Frenkel defects

Part III: Chemical Kinetics: (17 Marks)

Answer the following questions:

Question (1): Mark (✓) for the correct sentence and (x) for the wrong one. (1 Mark for each one)

1	In most reactions the increase in reaction rate is linear with the increase in temperature.
2	Unit for k depends on the overall order of the reaction.

Q2: Choose (T) for true statements or (F) for False statements (1Mark each) for the following statements . (15 mrks)

No.	Sentences	T	F
1	Oscillatoria sp. belongs to cyanophyta while Codium sp. to Chlorophyta		
2	Chlamydomonas sp. reproduced vegetatively by longitudinal binary fission		
3	Microcystis sp. is prokaryote while Rivularia sp. is eukaryotic microorganism		
4	Zygnema sp. is unbranched filaments with spiral form chloroplasts.		
5	Multiplication by fragmentation plays an important role in the case of filamentous cyanobacterial sp.		
6	Heterocyst play an important role in asexual reproduction of cyanobacteria		
7	Pamdorina sp. belongs to Myxophycophyta whlie Spirogyra sp.to Chlorophyta		
8	Species of codiales do not form separating walls and the entire organism is Coenocytic.		
9	Microcystis sp. produce very harmfull toxins		
10	The prominent phase of the Codium sp Life Cycle is haploid.		
11	Euglena sp. Are Important for formation of petroleum deposits		
12	The plant body of diatoms consists of two overlapping halves called valves.		
13	Fucoxanthin, diatoxanthin and diadinoxanthin and are the commen pigment in cyanophyta		
14	Diatomite, The cell wall material of diatoms. Suitable for filters production		
15	Iodine can produce from phaeophyta but its production from algae was costless		

Q3 : Write short notes on two only from the following (20 marks)

- 1- General character of phaeophyta and the life cycle of Fucus with drawing
- 2- Economic and harmfull aspects of algae
- 3- Compare between sexual reproduction of Chara and Spirogyra (with drawing)

Best wishes , Prof,Awatief F. Hifney



Answer the following Questions

Q1: Choose the correct answer of the following: **(15 marks)**

1. Algae belonging to Oscillatoriales have filamentous with heterocyst
a. intercalary b. basal c. No d. a&B
2. Cell wall of Eugleoides composed from
a. Calcium carbonate b. Cellulose c. glycogen d. Euglena have no cell wall
3. Chlamydomonas sp. and Spirogyra Sp. are Chlorophyta while belongs to Cyanophyta
a. Chroococcus b. Microcystis c. Zygnema d. A&b
4. The secretion of by cyanophyta caused a death of some farm animals
a. exotoxins b. endotoxins c. Carragenin d. exotoxins and endotoxins
5. Sexual reproduction is not found in
a. Spirogyra b. Nostoc c. Chlorophyta d. b&C e. Diatoms
6. Reserve food material of Cyanophyta is.....
a. Oil b. Glycogen c. Starch d. Phycocyanin
7. Alginate can be extracted and found in cell wall of
a. Phaeophyta b. Rhodophyta c. Chlorophyta d. Euglenophyta
8. Alternation of generation are found in sp. Of
a. Cyanophyta b. Codiales c. Charles d. Cladophorales
9. Non filamentous form of cyanobacteria belongs to
a. Chroococcales b. Codiales c. Nostocales d. Euglenophyta
10. Most of show gliding or creeping, rotator movements
a. Cyanophyta b. Chlorophyta c. Nostocales d. Euglenophyta

- c- Explain how old quantum mechanics successfully explained the characteristics of X-ray spectrum. (5 Marks)

Electron charge e	$1.6 \times 10^{-19} \text{ C}$	Planck's constant h	$6.626 \times 10^{-34} \text{ Joule.sec}$
Electron mass m_e	$9.1 \times 10^{-31} \text{ kg}$	Light velocity c	$3 \times 10^8 \text{ m.sec}^{-1}$
Proton mass m_p	$1.672 \times 10^{-27} \text{ kg}$	Coulomb constant k	$9 \times 10^9 \text{ J.m.C}^{-2}$
Wien's displacement constant	$2.8977 \times 10^{-3} \text{ m.K}$	Ionization energy of the hydrogen atom E_0	13.6 eV
Rydberg constant R	$1.097 \times 10^7 \text{ m}^{-1}$		

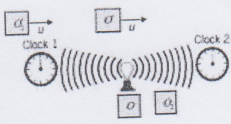
(12.5 Marks)

Question (5):

(2.5 Marks)

a- Choose the correct statement:

Please write your selections (a or b or ...) in the blank column to the right of the table.

1-	A large constant force is used to accelerate an object from rest to a high speed. In which form of Newton's second law—relativistic or classical nonrelativistic—does the object take a longer time to reach a speed of $0.9c$?			
	(a) Relativistic.		(b) Nonrelativistic.	
	(c) Same for both.		(d) impossible to measure	
2-	Two clocks, equidistant from O and at rest in the reference frame of O, start running when they receive a flash of light from the light source midway between them. According to O, the two clocks are synchronized (they start at the same time). According to O', who is moving with velocity u relative to O, clock 2 starts ahead of clock 1 by an amount $\Delta t'$. Suppose there is a second observer O_2 at rest with respect to O at a location midway between the light source and clock 2. Will O_2 conclude that the two clocks are synchronized? 			
	(a) Yes		(b) No	
	(c) Depends on location of O_2		(d) impossible to measure	
3-	In a certain collision process, particles A and B collide, and after the collision particles C and D appear (C and D are different from A and B). Which quantities are conserved in this collision?			
	(a) only linear momentum and kinetic energy			
	(b) only mass and kinetic energy			
	(c) only linear momentum and total relativistic energy			
4-	Two particles each of mass m are moving at speed $v = 0.866c$ directly toward one another. After the head-on collision, all that remains is a new particle of mass M . What is the mass of this new particle?			
	(a) $M = 2m$	(b) $M = 4m$	(c) $M = m$	(d) $M = 1.5m$
5-	Photoelectrons stopping potential depends on			
	(a) frequency of incident light and nature of the cathode material.			
	(b) only the intensity of the incident light.			
	(c) only the frequency of the incident light.			
	(d) only the nature of cathode material.			

b- Electrons in a particle accelerator are accelerated in two stages. The first stage accelerates the electrons from rest to a speed of $u = 0.99c$, that is, a 99% increase. The second stage accelerates the electrons from $0.99c$ to $0.999c$, increasing by only 0.9%.

i- Find the amount of energy that the first stage supplied to the electrons.

ii- How much energy did the second stage supply the electrons to increase their speed by just 0.9%?

(5 Marks)

- c- Electromagnetic radiation with a wavelength of $5.7 \times 10^{-12} \text{ m}$ is incident on stationary electrons. At what scattering angle, radiation that has a wavelength of $6.57 \times 10^{-12} \text{ m}$ is detected? (5 Marks)

Question (4):

(12.5 Marks)

a- Choose the correct statement:

(2.5 Marks)

Please write your selections (a or b or ...) in the blank column to the right of the table.

1-	If it requires energy U to accelerate a rocket from rest to $0.5 c$, the energy needed to accelerate that rocket from $0.5 c$ to c would be			
	(a) $0.5 U$	(b) U	(c) $2 U$	(d) infinite
2-	For a material object, such as a rocket ship, the possible range of γ_v is			
	(a) $0 \leq \gamma_v \leq 1$	(b) $1 \leq \gamma_v$	(c) $0 < \gamma_v < \infty$	(d) $-\infty < \gamma_v < \infty$
3-	Suppose a rocket traveling at 99.99% of the speed of light measured relative to the earth makes a trip to a star 100 light years from earth (meaning that it would take light 100 years to make the trip). During this rocket trip			
	(a) People on earth would age essentially 100 years.			
	(b) People on earth would age less than 100 years.			
	(c) The astronauts in the rocket would age more than 100 years.			
	(d) The astronauts in the rocket would age less than 100 years.			
	(e) The astronauts in the rocket would age essentially 100 years.			
4-	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) none of the preceding	
5-	Compton shift depends on which of the following?			
	(a) incident radiation		(b) nature of scattering substance	
	(c) angle of scattering		(d) amplitude of frequency	

b- Define the proper mass, and prove that the proper mass of any particle moving with speed of light c "such as photon" is zero.

(5 Marks)

c- Write Bohr's hypotheses for his atomic model. Using these assumptions:

- i- Estimate the radius of the stable hydrogen atom.
- ii- Prove that the distance between any two successive energy levels increases by increasing the quantum number n . (5 Marks)

14	An electron in a hydrogen atom transitions from $n=3$ to $n=2$. The energy of the photon emitted is:			
	(a) 0.5 eV	(b) 2 eV	(c) 3 eV	(d) 10 eV
15	For a material object, such as a rocket ship, the possible range of γ is:			
	(a) $0 \leq \gamma \leq 1$	(b) $1 \leq \gamma$	(c) $0 < \gamma < \infty$	(d) $-\infty < \gamma < \infty$
16	Suppose a rocket is moving at 99.9% of the speed of light measured relative to the earth. Makes a trip to a star 100 light years from earth (assuming that it would take light 100 years to reach the star). During this rocket trip:			
	(a) People on earth would age essentially 100 years.			
	(b) People on earth would age less than 100 years.			
	(c) The astronauts in the rocket would age more than 100 years.			
	(d) The astronauts in the rocket would age less than 100 years.			
	(e) The astronauts in the rocket would age essentially 100 years.			
17	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) decreasing			
	(c) remains the same			
	(d) none of the preceding			
18	Compton shift depends on which of the following?			
	(a) incident radiation			
	(b) nature of scattering substance			
	(c) angle of scattering			
	(d) amplitude of frequency			

19. Define the proper mass, and prove that the proper mass of any particle moving with speed of light "such as photon" is zero.

(12.5 Marks)

Question (3):

(2.5 Marks)

a- Choose the correct statement:

Please write your selections (a or b or ...) in the blank column to the right of the table.

1-	An electron moves through the lab at 99% the speed of light. The lab reference frame is S and the electron's reference frame is S'. In which reference frame is the electron's proper mass larger?	
	(a) Frame S, the lab frame	(b) Frame S', the electron's frame
	(c) It is the same in both frames.	(d) impossible to measure
2-	A high-speed train passes a train platform. Anthony is a passenger on the train, Miguel is standing on the train platform, and Carolyn is riding a bicycle toward the platform in the same direction as the train is traveling. Choose the proper order of how long each of these observers measures the train to be, from longest to shortest.	
	(a) Carolyn, Miguel, Anthony.	(b) Miguel, Carolyn, Anthony.
	(c) Miguel, Anthony, Carolyn.	(d) Anthony, Carolyn, Miguel.
	(e) Anthony, Miguel, Carolyn.	(f) Carolyn, Anthony, Miguel.
3-	Suppose a rocket traveling at 99.99% of the speed of light measured relative to the earth makes a trip to a star 100 light years from earth (meaning that it would take light 100 years to make the trip). During this rocket trip	
	(a) People on earth would age essentially 100 years.	
	(b) People on earth would age more than 100 years.	
	(c) People on earth would age less than 100 years.	
	(d) The astronauts in the rocket would age more than 100 years.	
	(e) The astronauts in the rocket would age essentially 100 years.	
4-	What is the effect of doubling the accelerating voltage across an x-ray tube?	
	(a) the wavelengths of the characteristic lines are halved	
	(b) the minimum wavelength of the X-rays is halved	
	(c) the X-rays are most probably less penetrating	
	(d) the intensity of the X-ray beam is doubled	
5-	Rayleigh-Jean's law holds good for which of the following?	
	(a) shorter wavelength	(b) longer wavelength
	(c) high temperature	(d) high energy

- b- As the outlaws escape in their getaway car, which goes $0.75c$, the police officer fires a bullet from the pursuit car, which only goes $0.5c$ (as shown in the Fig.). The muzzle velocity of the bullet (relative to the gun) is $c/3$. Does the bullet reach its target (a) according to Galileo, (b) according to Einstein?



(5 Marks)

c- Prove that:

- i. All inertial observers will agree that two events are simultaneous if they occur in the same place.
- ii. They may disagree as to the order of the two events that occur at two different points in space. (5 Marks)

10	James's reference frame is S' . In which reference frame is the light speed larger?	
	(a) Frame S, the lab frame	(b) Frame S', the electron's frame
	(c) It is the same in both frames	(d) impossible to measure
11	A high-speed train passes a train platform. Anthony is a passenger on the train, Miguel is standing on the train platform, and Carolyn is riding a bicycle toward the platform in the same direction as the train is traveling. Choose the proper order of how long each of these observers measures the train to be, from longest to shortest.	
	(a) Carolyn, Miguel, Anthony	(b) Miguel, Carolyn, Anthony
	(c) Miguel, Anthony, Carolyn	(d) Anthony, Carolyn, Miguel
	(e) Anthony, Miguel, Carolyn	(f) Carolyn, Anthony, Miguel
12	Suppose a rocket traveling at 0.99% of the speed of light measured relative to the earth makes a trip to a star 100 light years from earth (meaning that it would take light 100 years to make the trip). During this rocket trip:	
	(a) People on earth would age essentially 100 years.	
	(b) People on earth would age more than 100 years.	
	(c) People on earth would age less than 100 years.	
	(d) The astronauts on the rocket would age more than 100 years.	
	(e) The astronauts on the rocket would age essentially 100 years.	
13	What is the effect of doubling the accelerating voltage across an x-ray tube?	
	(a) the wavelengths of the characteristic lines are halved	
	(b) the maximum wavelength of the X-rays is halved	
	(c) the X-rays are about probably less penetrating	
	(d) the intensity of the X-ray beam is doubled	
14	High-light laser's laser beams good for which of the following?	
	(a) shorter wavelength	(b) longer wavelength
	(c) high temperatures	(d) high energy

15. As the optimal voltage by their jetway car, which goes at 75%, the police officer fires a bullet from the pursuit car, which only goes 5.5% (as shown in the Fig.). The muzzle velocity of the bullet (relative to the gun) is $v/3$. Does the bullet reach its target (a) according to Galileo, (b) according to Einstein? (2 Marks)

Question (2):

(12.5 Marks)

a- Match the following two Lists:

(2.5 Marks)

Answer	List-I	List-II
1-	Pair production and annihilation experiments	a Prove the de Broglie hypothesis for the wavelength of a particle with mass.
2-	Thomson, son of J. J. Thomson, electron diffraction experiment.	b Evidence for the wave nature of x-ray.
3-	Davissan and Germer experiment.	c Clear evidence of space quantization and the magnetic moments of electrons.
4-	J. J. Thomson, e/m experiment.	d Confirmed the quantized structure of the atom.
5-	The Franck-Hertz experiment.	e Prove that electron behaves as particles.
		f Proved that electric charge is quantized.
		g Prove the equivalence of mass and energy.

b- A light source of wavelength λ illuminates a metal and ejects photoelectrons with a maximum kinetic energy of 1.0 eV. A second light source with half the wavelength of the first ejects photoelectrons with a maximum kinetic energy of 4.0 eV. Determine the work function of the metal.

(5 Marks)

c- Define the proper time, and derive the time dilation relation.

(5 Marks)

Answer	Mark	Answer	Mark
1. Pair production and annihilation experiments	1	1. Prove the de Broglie hypothesis for the wavelength of a particle with mass.	1
2. Thomson and J. J. Thomson, electron diffraction experiments	1	2. Evidence for the wave nature of light.	1
3. Barkas and Chalmers experiments	1	3. Clear evidence of spin quantization and the magnetic moments of electrons.	1
4. J. J. Thomson α -ray experiment	1	4. Confirmed the quantized structure of the atom.	1
5. The Franck-Hertz experiment	1	5. Prove that electron behaves as particles.	1
		6. Prove that electric charge is quantized.	1
		7. Prove the equivalence of mass and energy.	1

2. A light source of wavelength λ illuminates a metal and ejects photoelectrons with a maximum kinetic energy of 1.0 eV. A second light source with half the wavelength of the first ejects photoelectrons with a maximum kinetic energy of 4.0 eV. Calculate the work function of the metal. (3 marks)



The exam is written in ten (10) pages

Answer four (4) only of the following questions:

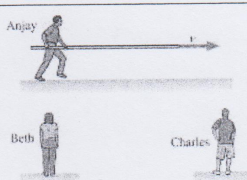
Question (1):

(12.5 Marks)

a- Choose the correct statement:

(2.5 Marks)

Please write your selections (a or b or ...) in the blank column to the right of the table.

1-	A spaceship leaves Earth and maintains a constant force by means of a nuclear engine. As the speed of the spaceship increases, an observer on Earth finds that relative to her the magnitude of the spaceship's acceleration is			
	(a) 0	(b) decreasing.	(c) constant.	(d) increasing.
2-	Molly flies her rocket past Nick at constant velocity v . Molly and Nick both measure the time it takes the rocket, from nose to tail, to pass Nick. Which of the following is true?			
	(a) Both Molly and Nick measure the same amount of time.			
	(b) Nick measures a shorter time interval than Molly.			
	(c) Molly measures a shorter time interval than Nick.			
	(d) impossible to measure.		(e) none of the above.	
3-	Beth and Charles are at rest relative to each other. Anjay runs past at velocity v while holding a long pole parallel to his motion. Anjay, Beth, and Charles each measure the length of the pole at the instant Anjay passes Beth. Rank in order, from largest to smallest, the three lengths L_A, L_B, and L_C. 			
	(a) $L_A > L_B = L_C$		(b) $L_A = L_B = L_C$	
	(d) $L_A < L_B = L_C$		(c) $L_A > L_B > L_C$	
	(e) $L_A = L_B > L_C$			
4-	In Compton scattering from stationary electrons the largest change in wavelength occurs when the photon is scattered through:			
	(a) 0°	(b) 45°	(c) 90°	(d) 180°
5-	Light of frequency 1.9 times the threshold frequency is incident on a photosensitive material. If the frequency is halved and intensity is doubled, the photocurrent becomes			
	(a) quadrupled	(b) doubled	(c) halved	(d) zero

b- A furnace has walls of temperature 3000°C . what the wavelength of maximum intensity emitted when a small door is opened? (5 Marks)

Q5)

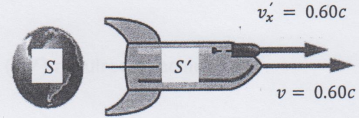
(6 Marks)

- 1) A proton with a mass of $m_p = 938 \frac{\text{MeV}}{c^2}$ is accelerated to a total energy $E = 5E_0$.
- Find its speed v in terms of c ?
 - Is the proton considered a relativistic or classical particle? Explain your reasoning?
 - Calculate its momentum p in $\frac{\text{GeV}}{c}$?
 - Find the kinetic energy in GeV ?
 - Determine the accelerating potential difference V in gigavolts (GV) required to achieve this energy?

Q4)

(6 Marks)

1) A spaceship (S') moving away from the earth (S) with velocity $v = 0.75c$ fires a missile in the direction of travel with a speed of $v'_x = 0.60c$ relative to the spaceship, where c is the velocity of light. What will be the approximate velocity of the missile (v_x) as observed from the earth?



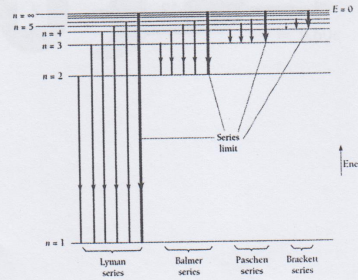
2) A rod has a proper length of $L_0 = 100\text{ m}$. What is its length L as measured in a frame moving at $0.8c$ parallel to the rod?

Q3)

(6 Marks)

The figure below shows the spectral series of Hydrogen. A hydrogen atom is in the $n = 3$ state absorbs a photon and the electron jumps to $n = 6$ state.

- What is the wavelength of absorbed photon (λ) in nm?
- How many photons might be emitted from this atom following this absorption?
- Compute the wavelengths ($\lambda_1 : 6 \rightarrow 5$), ($\lambda_2 : 6 \rightarrow 2$) and ($\lambda_3 : 5 \rightarrow 1$) of the emitted photons?
- Which photon (or photons) lies in the IR, visible or UV region of the spectrum?



Q2)**(6 Marks)**

1) The resolving power of a microscope depends on the wavelength used. If one wished to "see" something, a resolution of approximately a wavelength (λ) would be required. An electron microscope is used to resolve a virus of size $2 \times 10^{-9} \text{ m}$.

- Calculate the electron momentum required in $(\frac{\text{kg} \cdot \text{m}}{\text{s}})$ and in $(\frac{\text{eV}}{c})$?
- Find the kinetic energy of the electron in (eV) ?
- Determine the photon energy in (eV) needed for equivalent resolution and explain why electrons are preferred?

2) A photon's position is measured with uncertainty $\Delta x = 100 \text{ nm}$. If its de-Broglie wavelength is $\lambda = 500 \text{ nm}$, estimate the minimum uncertainty in its wavelength ($\Delta \lambda$)?

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

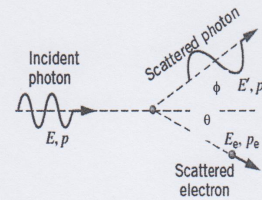
(24 Marks)

Q1)

(6 Marks)

An X-ray photon ($\lambda = 0.020 \text{ nm}$) scatters off an electron at $\phi = 60^\circ$.

- Find the scattered photon's wavelength (λ')?
- Calculate the electron's kinetic energy (E_e)?
- Calculate the electron's recoil angle (θ)?
- Verify momentum conservation by showing that $p = p' \cos \phi + p_e \cos \theta$ and $p' \sin \phi = p_e \sin \theta$?



2) A photon's position is measured with uncertainty $\Delta x = 100 \text{ nm}$. If its de-Broglie wavelength is $\lambda = 500 \text{ nm}$, estimate the minimum uncertainty in its wavelength ($\Delta \lambda$)?

23. The energy released in nuclear reactions comes from:

- a) breaking chemical bonds
- b) converting a small fraction of mass into energy
- c) friction between particles
- d) electron transitions

24. A particle's kinetic energy is equal to its rest energy when Lorentz factor (γ) equals

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

25. Relative to a stationary observer, a rod of length $L_0 = 10 \text{ m}$ is moving at $v = 0.6 c$. It would appear to the observer that the rod's length L is:

- a) 8 m
- b) 6 m
- c) 10 m
- d) 12 m

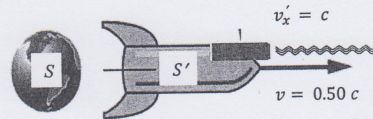
26. At what speed (v) does the Lorentz factor (γ) become 2?

- a) $\frac{1}{2} c$
- b) $\frac{\sqrt{3}}{2} c$
- c) $\frac{3}{4} c$
- d) $\frac{\sqrt{2}}{3} c$

27. The muon experiment confirms Special Relativity because:

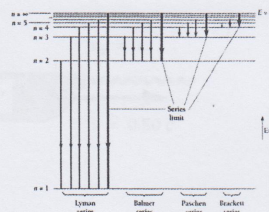
- a) Muons decay faster when moving.
- b) Muons survive longer due to time dilation and length contraction.
- c) Muons travel faster than light.
- d) Muons gain mass at high speeds.

28. A spaceship (S') moving away from the earth (S) with velocity $v = 0.50c$. If a light beam ($v'_x = c$) is emitted forward from the spaceship, its speed (v_x) as observed from the earth is:



- a) $1.5 c$
- b) c
- c) $0.50 c$
- d) $0.75 c$

12. The wavefunction of a particle in a 1d box is zero at the boundaries because:
 a) the particle has zero mass
 b) the potential is infinite outside the box
 c) the particle's velocity is zero
 d) the box is non-conducting
13. A particle in a one-dimensional box of width L has its first excited state ($n = 2$) de Broglie wavelength equal to:
 a) L
 b) $L/2$
 c) $2L$
 d) λ is not related to L
14. In regions where $|\Psi(x)|^2 = 0$:
 a) The particle has maximum kinetic energy
 b) The particle cannot be found
 c) The wavefunction is discontinuous
 d) The potential energy is zero
15. Which physicist formulated the Uncertainty Principle?
 a) Niels Bohr
 b) Albert Einstein
 c) Erwin Schrödinger
 d) Werner Heisenberg
16. If a particle's position is measured with high precision, what happens to the knowledge of its momentum?
 a) It becomes more precise
 b) It becomes less precise
 c) It remains unaffected
 d) It becomes exactly known
17. According to the Bohr model of hydrogen, the speed of the electron in the n -th orbit is proportional to $1/n$. If an electron jumps from $n=3$ to $n=1$, its orbital speed:
 a) increases by a factor of 3
 b) decreases by a factor of 3
 c) increases by a factor of 9
 d) decreases by a factor of 9
18. The red line in the visible hydrogen spectrum (H_α line) belongs to the:
 a) Lyman series
 b) Balmer series
 c) Paschen series
 d) Brackett series
19. The ratio of minimum wavelengths of Balmer to Lyman series will be:
 a) $\frac{4}{5}$
 b) $\frac{4}{1}$
 c) $\frac{2}{5}$
 d) $\frac{2}{1}$
20. If 1 kg of mass is entirely converted into energy, the energy released is approximately:
 a) $9 \times 10^{16} \text{ J}$
 b) $9 \times 10^{-16} \text{ J}$
 c) $3 \times 10^8 \text{ J}$
 d) $1.6 \times 10^{-19} \text{ J}$
21. If a particle's total energy is E and its rest mass energy is $m_0 c^2$, what is its kinetic energy?
 a) $\sqrt{E^2 - m_0^2 c^4}$
 b) $E + m_0 c^2$
 c) $E - m_0 c^2$
 d) $\frac{E - m_0 c^2}{c^2}$
22. The "twin paradox" arises because:
 a) traveling twin experiences acceleration, breaking symmetry between frames.
 b) time flows backward for one twin.
 c) length contraction affects biological aging.
 d) special relativity only applies to non-living objects.



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

1. Planck's Law resolved the ultraviolet catastrophe by introducing:

- a) Wave-particle duality b) Energy quantization
c) The photoelectric effect d) Relativistic effects

2. The photon is a massless particle of speed c , and a wavelength λ carries momentum p . Which of the following expressions for p is correct?

- a) $p = h/\lambda$ b) $p = \lambda/hc$
c) $p = \lambda/h$ d) $p = \lambda c/h$

3. In Compton scattering, the maximum increase in wavelength $\Delta\lambda_{\max}$ occurs when the photon is scattered through an angle of:

- a) 90° b) 180°
c) 0° d) 45°

4. In the photoelectric effect, if the frequency of incident light is exactly twice the threshold frequency ν_0 of the metal whose work function is ϕ , the maximum kinetic energy of the emitted electrons is:

- a) $h\nu_0$ b) $2h\nu_0$
c) $h\nu_0 - \phi$ d) $h\nu_0 + \phi$

5. Characteristic X-rays (K_α and K_β) are produced when:

- a) electrons are decelerated
b) electrons make transition between atomic energy levels
c) the target melts d) the tube current is reversed

6. Which application is most closely associated with X-ray diffraction?

- a) Observing absorption spectra b) Determining crystal structures
c) Detecting radioactivity d) Observing emission spectra

7. The active medium in a ruby laser is:

- a) a liquid dye b) a crystal of Al_2O_3 doped with Cr^{3+} ions
c) Germanium doped with arsenic d) pure nitrogen gas

8. Which process is responsible for producing coherent light in a laser?

- a) Spontaneous emission b) Stimulated emission
c) Absorption d) Scattering

9. The de-Broglie wavelength of a neutron compared to an electron with the same speed is:

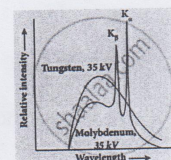
- a) longer b) shorter
c) equal d) undefined

10. The de Broglie wavelength of protons accelerated through voltage V is λ . If the acceleration voltage is reduced to $V/9$, the new wavelength is:

- a) 3λ b) $\lambda/3$
c) 9λ d) $\lambda/9$

11. Among the following particles which one will have the shortest wavelength, if all have the same speed:

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





Assiut University
Faculty of Science
Department of Physics
Second Semester (2024-2025)
Final Exam (50%)

Physics Program
Level: (2)
Date: June 3rd, 2025
Time: 3 hours



Course Title: Modern Physics

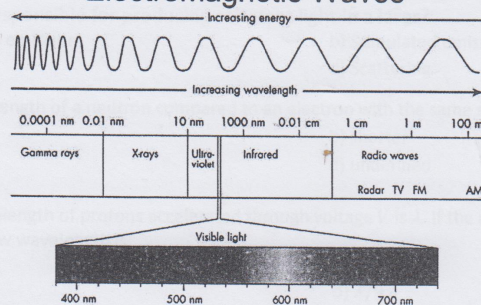
Teaching Staff: Prof. Dr. Salah A. Makhoulouf

Code: P 215

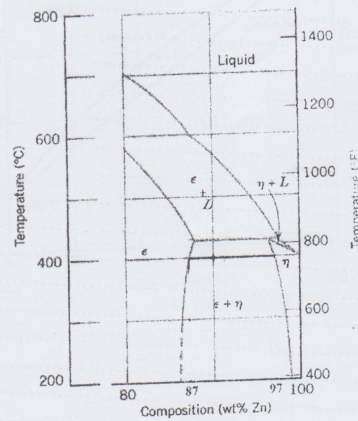
Constants & Conversion of units

Electron mass: $m = 9.11 \times 10^{-31} \text{ kg}$ & Proton mass: $m = 1.673 \times 10^{-27} \text{ kg}$
Electron charge: $e = 1.6 \times 10^{-19} \text{ C}$
Planck's constant: $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$ and $\hbar = 1.054 \times 10^{-34} \text{ J}\cdot\text{s}$
Avogadro's number: $N_A = 6.02 \times 10^{23} \text{ atom/mole}$
Speed of light: $c = 3 \times 10^8 \text{ m/s}$
Boltzmann's constant: $k_B = 1.38 \times 10^{-23} \text{ J/K}$
Compton wavelength: $\lambda_c = 2.426 \text{ pm}$
Rydberg Constant $R = 1.097 \times 10^7 \text{ m}^{-1}$
For hydrogen atom: Bohr radius $a_0 = 5.292 \times 10^{-11} \text{ m}$ & $E_{\text{ion}} = 13.6 \text{ eV}$
$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N m}^2$
$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$
$1 \text{ \AA} = 10^{-10} \text{ m}$ & $1 \text{ nm} = 10^{-9} \text{ m}$

Electromagnetic Waves

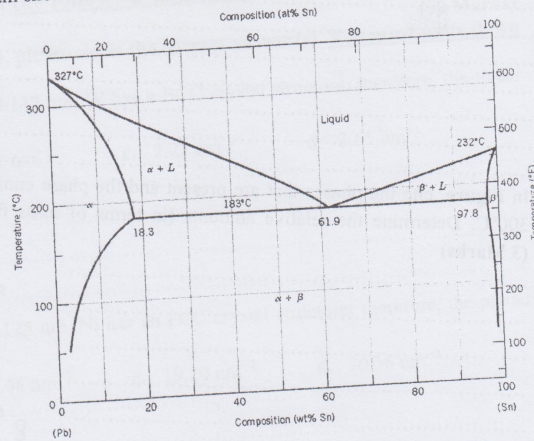


3. In Figure, cite the phases that are present and the phase compositions for 95 wt% Zn-5 wt% Cu at 300°C. Determine the relative amounts (in terms of mass fractions) of the phases for the alloys. (3 Marks)



Best wishes,

2. In Figure, for a 30 wt% Sn-70 wt% Pb alloy at 100°C, in below phase diagram: (4 Marks)
- What phase(s) is (are) present?
 - What is (are) the composition(s) of the phase(s)?
 - Calculate the relative amount of each phase present in terms of the mass fraction.
 - Describe in detail the phase diagram shown below and state the different equilibrium lines.



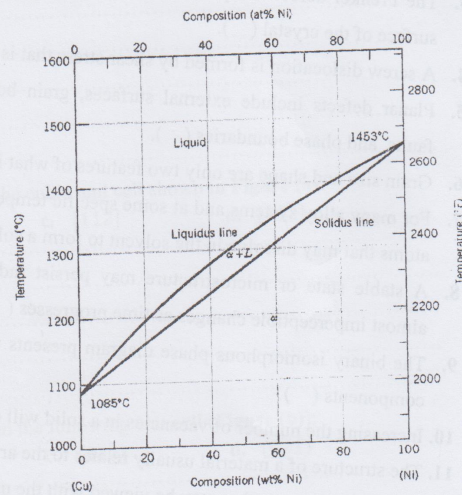
Question (III): Answer the following problems:

(11 Marks)

1. In Figure, a copper (Cu)-nickel (Ni) alloy of composition 60 wt% Ni-40 wt% Cu is slowly heated from a temperature of 1250°C, using the below phase diagram:

(4 Marks)

- At what temperature does the first liquid phase form?
- What is the composition of this liquid phase?
- At what temperature does the complete melting of the alloy occur?
- What is the composition of the last solid remaining before complete melting?



(9 Marks)

Question (II): Put (✓) or (×) for all the following sentences:

1. Ceramics are compounds of metallic and nonmetallic elements; they are most frequently oxides, nitrides, and carbides ().
2. Substances in which measured properties are independent of the direction of measurement are isotropic ().
3. The Frenkel defect is equivalent to a missing atom that leaves its original site and migrates to the surface of the crystal ().
4. A screw dislocation is formed by shear stress that is applied to produce the distortion ().
5. Planar defects include external surfaces, grain boundaries, twin boundaries, precipitates, stacking faults, and phase boundaries ().
6. Grain size and shape are only two features of what is termed the microstructure ().
7. For many alloy systems and at some specific temperature, there is a maximum concentration of solute atoms that may dissolve in the solvent to form a solid solution; this is called a solubility limit ().
8. A stable state or microstructure may persist indefinitely, experiencing only extremely slight and almost imperceptible changes as time progresses ().
9. The binary isomorphous phase diagram presents the complete liquid and solid solubility of the two components ().
10. Increasing the number of vacancies in a solid will decrease the rate of vacancy diffusion ().
11. The structure of a material usually relates to the arrangement of its internal components ().
12. Structural elements that may be viewed with the naked eye are termed "microscopic" ().
13. Interstitial diffusion in solids requires the presence of empty lattice sites (vacancies) ().
14. A composite is composed of two (or more) individual materials, which come from the categories: metals, ceramics, and polymers ().
15. The cubic system has the greatest degree of symmetry, but the orthorhombic system has the least symmetry ().
16. The primitive unit cell contains the same kind of atoms, while the Bravais lattice contains only one lattice point ().
17. The coordination number is the number of nearest-neighbor or touching atoms ().
18. The coordination number for FCC and HCP structure is 12 ().

92

13. Iron (Fe) and vanadium (V) both have the BCC crystal structure and V forms a substitutional solid solution in Fe for concentrations up to approximately 20 wt% V at room temperature. Determine the concentration in weight percent of V that must be added to Fe to yield a unit cell edge length of 0.289 nm. (Hint: $\rho_V = 6.11 \text{ g/cm}^3$, $\rho_{Fe} = 7.86 \text{ g/cm}^3$, $A_V = 50.94 \text{ g/mol}$, $A_{Fe} = 55.85 \text{ g/mol}$).

- a. 8 wt% b. 12.9 wt% c. 26 wt% d. 92 wt%

14. Determine the indices for the direction shown in the cubic unit cell shown in Figure (a):

- a. $[0\bar{1}\bar{1}]$ b. $[\bar{2}10]$ c. $[112]$ d. $[11\bar{2}]$

15. Determine the Miller indices for plane A shown in the following unit cell (Figure (b)):

- a. $(\bar{1}01)$ b. $(3\bar{2}4)$ c. $(32\bar{2})$ d. $(0\bar{2}\bar{1})$

Figure (a)

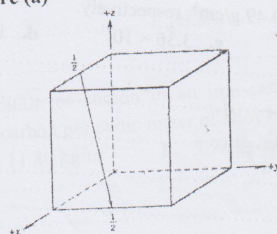
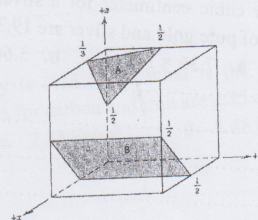


Figure (b)



10. An FCC iron-carbon alloy initially containing 0.3 wt% C is carburized at an elevated temperature and in an atmosphere that gives a surface carbon concentration constant at 1.0 wt%. If, after 60 h, the concentration of carbon is 0.35 wt% at a position 4.0 mm below the surface, determine the temperature at which the treatment was carried out. (Hint $\text{erf}(0.9) = 0.797$ & $\text{erf}(0.95) = 0.8209$):

a. 900 K b. 1280 K c. 1364 K d. 1468 K

11. For which set of crystallographic planes will a first-order diffraction peak occur at a diffraction angle (2θ) of 46.21° for BCC iron when monochromatic radiation having a wavelength of 0.0711 nm is used? (Hint $R=0.1241$ nm)

a. (011) b. (310) c. (200) d. (330)

12. Gold (196.97 g/mol) forms a substitutional solid solution with silver. 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/cm³, respectively.

a. 7.36×10^{21} b. 5.66×10^{21} c. 3.36×10^{21} d. 1.44×10^{21}

5. Rhodium has an atomic radius of 0.1345 nm, a density of 12.41 g/cm³, and an atomic weight is 102.91 g/mol, its crystal structure should be:
- a. SC b. FCC c. BCC d. HCP

6. Zinc has an HCP crystal structure, a c/a ratio of 1.856, and a density of 7.13 g/cm³. Compute the atomic radius for Zn (Hint M_w for Zn is 65.41 g/mol):
- a. 0.133 nm b. 0.142 nm c. 0.153 nm d. 0.167 nm

7. Molybdenum (Mo) has a BCC crystal structure and an atomic radius of 0.1363 nm. the interplanar spacing d_{111} equals:
- a. 0.1817 nm b. 0.1432 nm c. 0.1527 nm d. 0.1707 nm

8. Calculate the number of vacancies per cubic meter in iron at 850°C. The energy for vacancy formation is 1.08 eV/atom. Furthermore, the density and atomic weight for Fe are 7.65 g/cm³ and 55.85 g/mol, respectively, (K_B 8.62 × 10⁻⁵ eV/atom K):
- a. $1.18 \times 10^{24} \text{ m}^{-3}$ b. $1.18 \times 10^{-24} \text{ m}^{-3}$ c. $2.75 \times 10^{22} \text{ m}^{-3}$ d. $3.40 \times 10^{28} \text{ m}^{-3}$

9. The concentration of carbon in an iron-carbon alloy is 0.15 wt%. What is the concentration in kilograms of carbon per cubic meter of alloy? (densities for carbon and iron are 2.25 and 7.87 g/cm³)
- a. 11.80 kg/m³ b. 9.72 kg/m³ c. 7.33 kg/m³ d. 2.48 kg/m³



Answer all the following questions.

(30 Marks)

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.

1. The atomic radius for tungsten (W) is 0.137 nm, W has a BCC crystal structure, therefore, the linear density for the $[111]$ direction is:
a. 2.46 nm^{-1} b. 1.42 nm^{-1} c. 2.23 nm^{-1} d. 3.65 nm^{-1}
2. The atomic radius for nickel (Ni) is 0.125 nm, Ni has an FCC crystal structure; therefore, the planar density for the (111) plane is:
a. 16.00 nm^{-2} b. 18.48 nm^{-2} c. 19.20 nm^{-2} d. 20.56 nm^{-2}
3. At 300°C , the diffusion coefficient and activation energy for Cu in Si are $D(300^\circ\text{C}) = 7.8 \times 10^{-11} \text{ m}^2/\text{s}$, $Q_d = 41.5 \text{ kJ/mol}$. What is the diffusion coefficient at 350°C ? (Hint: $R = 8.314 \text{ J/mol.K}$)
a. $1.57 \times 10^{-10} \text{ m}^2/\text{s}$ b. $3.4 \times 10^{-8} \text{ m}^2/\text{s}$ c. $1.2 \times 10^{-20} \text{ m}^2/\text{s}$ d. $6.8 \times 10^{-6} \text{ m}^2/\text{s}$
4. Calculate the radius of a vanadium atom, given that V has a BCC crystal structure, a density of 5.96 g/cm^3 , and an atomic weight of 50.9 g/mol ($N_A = 6.022 \times 10^{23} \text{ atoms/mol}$).
a. 0.124 nm b. 0.132 nm c. 0.148 nm d. 0.156 nm

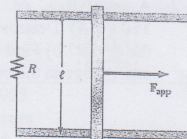
2- A series RLC AC circuit has $R = 425 \Omega$, $L = 1.25 \text{ H}$, $C = 3.5 \mu\text{F}$, $\omega = 377 \text{ rad/s}$, and $\Delta V_{\text{max}} = 150 \text{ V}$. A) Determine the inductive reactance, the capacitive reactance, and the impedance of the circuit? b) Find the maximum current in the circuit? c) Find the phase angle between the current and voltage in the circuit?

3- An electron moves through a uniform electric field $E = (2.5i + 5j) \text{ V/m}$ and a uniform magnetic field ($B = 0.4k \text{ T}$). Determine the acceleration of the electron when it has a velocity ($v = 10i \text{ m/s}$)?

4- A current of 0.1 A circulates around a coil of 100 turns and having a radius equal to 5 cm . Find the magnetic field set up at the center of the coil?

5- A proton moving with a velocity, $2.5 \times 10^7 \text{ m/s}$, enters a magnetic field of intensity 2.5 T making an angle 30° with the magnetic field. Find the force on the proton?

- 22- Consider the arrangement shown in the figure. Assume that $R=6.0\ \Omega$, $l = 1.20\text{ m}$, and a uniform 2.5 T magnetic field is directed into the page. At what speed the bar should be moved to produce a current of 0.5 A in the resistor?



- a) 1.0 m/s b) 100 m/s c) 10 m/s d) 0.1 m/s

- 23- When the magnitude of the force per unit length between two long parallel wires that carry identical currents and are separated by 1 m is $2 \times 10^{-7}\text{ N/m}$, the current in each wire is defined to be:

- a) 1 A b) Zero c) 0.1 A d) 2 A

- 24- For two long straight parallel wires separated by a distance a and carrying currents $I_1=6\text{ A}$ and $I_2=2\text{ A}$ in the same direction, where the magnetic force on each wire is F_1 and F_2 . Which is true?

- a) $F_1 = F_2$ b) $F_1 = F_2/3$ c) $F_1 = 3F_2$ d) $F_1 = 2F_2$

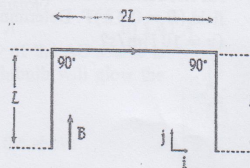
- 25- A charge q is moving in a magnetic field, then the magnetic force does not depend upon:

- a) charge b) mass c) velocity d) magnetic field

- 26- Gauss's law of magnetism states that the net magnetic flux through any closed surface equals:

- a) Infinity b) 1 weber c) zero d) BA

- 27- A straight wire is bent into the shape shown. Determine the net magnetic force on the wire when the current I travels in the direction shown in the magnetic field B ?



- a) $2ILB$ in $+z$ direction
b) $2ILB$ in $-z$ direction
c) $4ILB$ in $+z$ direction
d) $4ILB$ in $-z$ direction

2- Answer the following questions:

- 1- A 2.00-nF capacitor with an initial charge of $5.1\ \mu\text{C}$ is discharged through a $1.3\text{-k}\ \Omega$ resistor.
- a) What is the maximum current in the resistor?
- b) Calculate the current in the resistor $9\ \mu\text{sec}$ after the resistor is connected across the terminals of the capacitor?
- c) What charge remains on the capacitor after $8\ \mu\text{s}$?

- 11- In RLC circuit, the phase angle is positive, when the circuit is:
 a) more capacitive b) more inductive c) pure resistance d) all the above
- 12- At an instant of time during the oscillations of an LC circuit, the current is at its maximum value. At this instant, the voltage across the capacitor is:
 a) Minimum b) maximum c) Infinity d) no change
- 13- In a purely capacitive AC circuit, the current:
 a) may leads or lags the voltage depending on the frequency.
 b) leads the voltage by 90° c) lags the voltage by 90° d) is in phase with the current.

14- A coil has an inductance of 3.0 mH, and the current in it changes from 0.20 A to 1.50 A in a time of 0.20 s. Find the magnitude of the average induced emf in the coil during this time?

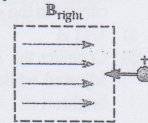
- a) 122 V b) 50 V c) 22.5 V d) 19.5 mV

15- The voltage and current in an ac circuit are given by:
 $V = 5 \sin(100\pi t - \frac{\pi}{6})$ $I = 4 \sin(100\pi t + \frac{\pi}{6})$

- a) Voltage leads the current by 30° c) Current leads the voltage by 30°
 b) Current leads the voltage by 60° d) Voltage leads the current by 60°

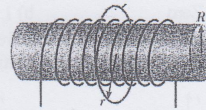
16- Determine the initial direction of the deflection of charged particles as they enter the magnetic fields as shown in Figure:

- a) No deflection b) into the page c) out off the page d) up ward



17- A long solenoid of radius R has n turns per unit length and carries a time-varying current given by $I = I_0 \cos \omega t$. Determine the electric field induced outside the solenoid at a distance r from its axis? ($r > R$)

- a) $E = \text{zero}$ c) $E = \frac{\mu_0 n I_0 \omega R^2}{2r} \sin \omega t$
 b) $E = \frac{\mu_0 n I_0 \omega r}{2} \sin \omega t$ d) $E = \frac{\mu_0 n I_0 \omega r}{2} \sin \omega t$



18- A plane loop of wire of area A is placed in a region where the magnetic field is parallel to the plane, and B varies with time according to $B = B_0 e^{-at}$. Find the induced emf in the loop?

- a) $\epsilon = AB_0 e^{-at}$ b) $\epsilon = \text{zero}$ c) $\epsilon = aAB_0 e^{-at}$ d) $\epsilon = e^{-at}$

19- A current of 0.1 A circulates around a coil of 100 turns and having a radius equal to 5 cm. Determine the magnetic field set up at the center of the coil?

- a) $4\pi \times 10^{-5} \text{ tesla}$ b) $8\pi \times 10^{-5} \text{ tesla}$ c) $4 \times 10^{-5} \text{ tesla}$ d) $2 \times 10^{-5} \text{ tesla}$

20- Substance contains permanent atomic magnetic moments that tend to align parallel to each other even in a weak external magnetic field.

- a) Paramagnetic b) Ferromagnetic c) Diamagnetic c) Ferrimagnetic

21- The emf induced in a circuit is directly proportional to the time rate of change of magnetic flux through the circuit, is defined as:

- a) Faraday's law b) Gauss's law c) Maxwell's law d) Ampere's law



Course: Electricity, AC and Magnetism
Code: P261
Final Exam (50 Marks)

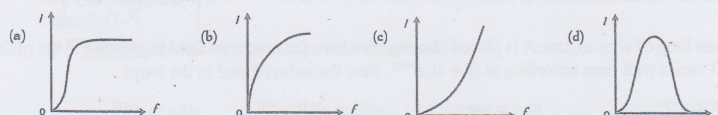
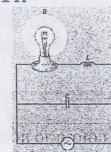
Exam date: /5/2025
Exam Time: 3 hours
2nd semester 2024-2025

Permittivity of the free space ϵ_0 $8.85 \times 10^{-12} \text{ F/m}$	Permeability of the free space μ_0 $4\pi \times 10^{-7} \frac{\text{weber}}{\text{A.m}}$	Charge of electron or proton $\mp 1.6 \times 10^{-19} \text{ C}$
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The exam is written in (4) pages

1st Question: Choose the correct answer

- Capacitors are charge and discharge in Manner
a) Linear b) exponential c) square d) none of the above
- The voltage output of an AC source is given by the expression: $\Delta V = (200 \text{ V}) \sin \omega t$. Find the rms current in the circuit when this source is connected to a 100Ω resistor?
a) 1.41 A b) 1.41 A c) 1.41 A d) 1.41 A
- Consider the AC circuit in the following figure. The frequency of the AC source is adjusted while its voltage amplitude is held constant. The lightbulb will glow the brightest at:
a) high frequencies c) low frequencies
b) the brightness will be same at all frequencies. d) none of the above
- The self-inductance of a straight conductor equals:
a) Zero b) 1 H c) Infinity d) $\mu_0 A/l$
- An ac source of variable frequency f is connected to an RLC series circuit. Which one of the graphs in figure represents the variation of current I in the circuit with frequency f ?



- In a transformer, the coefficient of mutual inductance between the primary and the secondary coil is 0.2 henry. When the current changes by 5 ampere/second in the primary, the induced e.m.f. in the secondary coil will be:
a) 500 V b) 100 V c) 10 V d) 1 V
- The power factor is maximum in an RLC circuit at:
a) $R = 0$ b) $X_C = 0$ c) $X_L = 0$ d) $X_L = X_C$
- The unit $\text{T} \cdot \text{m}^2/\text{s}$ is equivalent to:
a) Ambere b) joule c) Weber d) volt
- The factor ωL has the same units as:
a) Resistance b) Inductance c) Capacitive d) Electric field
- As the resistance R decreases, the resonance curve:
a) becomes broader b) becomes narrow c) remains the same d) becomes linear

A series RLC circuit has a resistance of $R = 45.0 \, \Omega$ and an impedance of $Z = 75.0 \, \Omega$.

- (a) (4 marks) Calculate the phase angle ϕ between the current and the applied voltage.

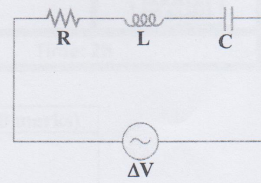


Fig. Q3-III

- (b) (3 marks) What average power is delivered to this circuit when $\Delta V_{\text{rms}} = 210 \, \text{V}$?

End of the exam.
I wish you the best of luck.

7. Answer the following problems: (21 Marks: 7 marks for each problem)

I. Referring to Fig. Q3-I, the switch S is connected to point a, for a long time. After the switch is thrown to point b, Find:

(a) (3 marks) the frequency of oscillation of the LC circuit.

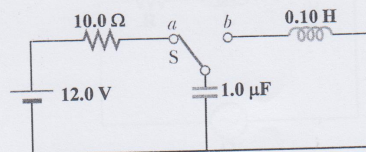


Fig. Q3-I

(b) (2 marks) the maximum current in the inductor.

(c) (2 marks) the total energy the circuit possesses at $t = 3.0$ s?

II. The circuit shown in Fig. 3-II is in a uniform magnetic field that is directed perpendicularly into the page and is decreasing in magnitude at the rate 150 T/s . Find the current in the circuit (in Amperes).

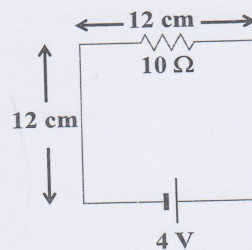


Fig. Q3-II

A long solenoid with cross-sectional area $A_1 (=10 \text{ cm}^2)$, length $L_1 (=80 \text{ cm})$ and number of turns $N_1 (=1000 \text{ turns})$ is surrounded at its center with a coil of cross-sectional area $A_2 (=11 \text{ cm}^2)$, length $L_2 (=50 \text{ cm})$ and $N_2 (=10 \text{ turns})$. Calculate the mutual inductance M .

- a) $5 \mu\text{H}$
- b) $25 \mu\text{H}$
- c) 10 mH
- d) 1 mH

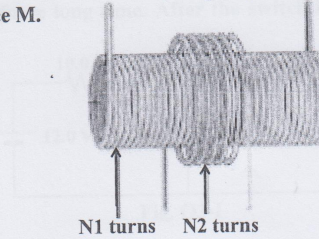


Fig. Q2-4

5. A $1.2 \mu\text{F}$ capacitor in a flash camera is charged by a 1.5 V battery. When the camera flashes, this capacitor is discharged through a resistor. The time constant of the circuit is 10 ms . What is the value of the resistance?

- a) $8.0 \times 10^{-2} \Omega$
- b) 0.12Ω
- c) $12 \text{ k}\Omega$
- d) $8.3 \text{ k}\Omega$

6. An $8 \mu\text{F}$ capacitor is connected to the terminals of a 60 Hz AC source whose rms voltage is 150 V . Find the current in the circuit.

- a) 2.22 A
- b) 1.11 A
- c) 0.45 A
- d) 0.14 A

Circle the correct choice and show your answer. (18 Marks: 3 marks for each problem)

1. A conducting rectangular loop of width 20 cm and length 15 cm moving with a velocity 15 m/s through a uniform magnetic field ($B = 0.1 \text{ T}$) directed into the page as shown in Fig. Q2-1. Find the magnitude and direction of the induced current in the conducting loop of total resistance 0.5Ω .

- a) 0.11 A, counter-clockwise
- b) 2.22 A, counter-clockwise
- c) 0.225 A, clockwise
- d) 0.45 A, clockwise

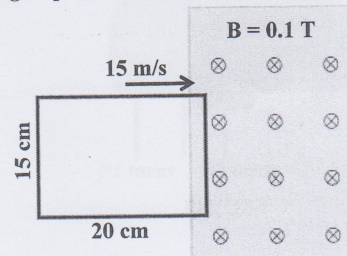


Fig. Q2-1

2. The induced emf in a single loop of wire has a magnitude of 1.48V when the magnetic flux is changed from $0.850 \text{ T}\cdot\text{m}^2$ to $0.110 \text{ T}\cdot\text{m}^2$. How much time is required for this change in flux?

- a) 0.01 ms
- b) 0.1 s
- c) 0.5 s
- d) 1 s

3. A DC motor of internal resistance 6.0Ω is connected to a 24-V power supply. The current is 1.0 A at full speed. What is the back emf when the motor is running at full speed?

- a) zero
- b) 6.0 V
- c) 18 V
- d) 24 V

rapid exponential decay in just a few cycles of the charge on the plates of capacitor in an RLC circuit might be due to:

- a. a large inductance
- b. a large capacitance
- c. a small capacitance
- d. a large resistance

7. What happens when an insulation fault occurs in the ground fault interrupter (GFI) of Fig. Q1-7?

- a. $i_1 = i_2$ and the net flux in the sensing coil is zero.
- b. $i_1 = i_2$ and the net flux in the sensing coil is no longer zero.
- c. $i_1 \neq i_2$ and the net flux in the sensing coil is zero.
- d. $i_1 \neq i_2$ and the net flux in the sensing coil is no longer zero.

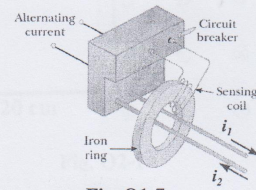


Fig. Q1-7

8. The impedance of a series RLC circuit at resonance is

- a. larger than
- b. less than R
- c. equal to R
- d. impossible to determine

9. In Fig. (Q1-9), which of the following phasor diagrams represents the case of: $X_L > X_C$ (X_L and X_C are inductive and capacitive reactance)

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

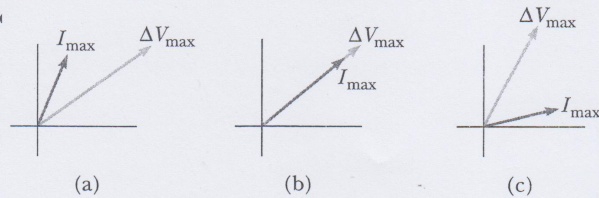


Fig. Q1-9

10. In an RLC series circuit, the source voltage is leading the current at a given frequency f . If the frequency f is lowered slightly, then the circuit impedance will:

- a. increase
- b. decrease
- c. remain the same
- d. need to know the amplitude of the source voltage

11. A high-Q circuit responds only to of frequencies than a low-Q circuit.

- a. wider range
- b. broader range
- c. the same range
- d. none of the above



Q1 (11)	Q2 (18)	Q3 (21)	Total (50 marks)

الاختبار مكون من 6 صفحات

Q1: Circle the correct answer for the following questions: (11 Marks: one mark for each problem)

1. In Fig. Q1-1, as the current I increases in the outer conducting loop, what is the direction of the induced current in the inner conducting loop?

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

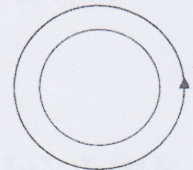


Fig. Q1-1

2. If both the resistance R and the inductance L in an RL series circuit are doubled the new inductive time constant τ_L will be:

- a. twice the old
- b. four times the old
- c. one-fourth the old
- d. unchanged

3. 1weber is the same as:

- a. 1V.s
- b. 1T.s
- c. 1T/m
- d. 1T/m²

4. The units of motional emf are:

- a. volt/second
- b. volt.meter/second
- c. tesla/second
- d. tesla.meter²/second

5. take in energy by work and transfer it out by electrical transmission.

- a. Electric generators
- b. Dry batteries
- c. Motors
- d. Fuel cells

25) Calculate the transmission and reflection coefficient of amplitude for a wave travels from one medium to another if the mass of the unit length (μ) of the second medium is 4 times that of the first medium.

26) Deduce the heard frequency by a stopped observer when the source is moving:

- i) toward the observer.
- ii) away from the observer.

23) Represent by equations and drawing the Gaussian function for the following waves:

- (i) non-traveling wave. (ii) traveling wave by a distance of 2m in the left direction.

24) Proof that the equation $y = A \cos(x + vt)$ is a solution or not a solution for the wave equation.

10	11	12	13	14	15	16

III- Four Marks for each

21) Show by drawing the forces acting on a displaced mass suspended at the end of vertical spring.

Then, prove that the equation $m \frac{d^2x}{dt^2} = -kx$ describes the mass vibration.

22) Prove that the relation between energy and time in a damped harmonic motion is $E(t) = E_0 e^{-\gamma t}$

10- If an equation of motion is given by: $ma = -kx - bv + F_0$, then what is the expression for amplitude of motion?

- a) $\frac{a}{(1 - \omega^2/\omega_0^2)}$ b) $\frac{a\omega_0^2}{[(\omega_0^2 - \omega^2)^2 + \omega^2\gamma^2]^{1/2}}$
 c) $A_0 e^{-\gamma t}$ d) $a\omega_0/\gamma$

11. In a damped SHM of a spring mass system. If the time taken is 4 s for the amplitude to become half its initial value. What is the damping factor γ ?

- a) $\frac{\ln 4}{2}$ b) $\frac{\ln 4}{4}$ c) $\frac{\ln 2}{2}$ d) $\frac{\ln 2}{4}$

12- A spring of constant 100 N/m and mass of 4 kg moves in SHM under external force without damping. If $F_0 = 10$ N, determine the amplitude of oscillation at external frequency of 2 rad s^{-1}

- a) 0.0166 m b) 0.166 m c) 1.166 m d) 2.166 m

13- In LCR circuit consists of $L = 5 \text{ H}$, $C = 5 \mu\text{F}$ and $R = 10 \Omega$. The system is

- a) undamping b) critically damped c) heavy damped d) light damped

14- A transverse wave traveling along a string is described by the function

$y = 2 \cos(0.2x + 30t)$, where x and y are in meters and t is in seconds. Find the wavelength in meters.

- a) 10π b) 6π c) 4π d) 2π

15- In the last question, the velocity of the wave is

- a) 250 m/s b) 200 m/s c) 150 m/s d) 100 m/s

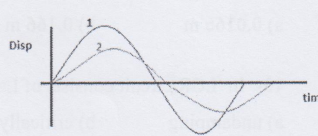
16- An observer is in a car moving north at a speed of 20 m/s. An ambulance travels to the south at a speed of 30 m/s, its siren emits sound at frequency of 210 Hz. What will be the frequency as heard by the observer? The speed of sound in air is 330 m/s.

- a) 245 Hz b) 181 Hz c) 204 Hz d) 217 Hz

10	11	12	13	14	15	16

I- ONE Mark for each

ضع الحروف التي تشير الى الاجابات الصحيحة في الجدول (وضح تماماً الحروف)

1. A force of constant 4N/m is acting on a particle of mass 1kg. What is the time period of oscillations?
a) 2π s b) $\pi/2$ s c) π s d) $2\pi/\sqrt{2}$ s
 2. A mass 100 g is suspended from the end vertical spring of constant 50 N/m. If the mass is released, find the extension in the spring. ($g = 10 \text{ m/s}^2$)
a) 0.04 m b) 0.03 m c) 0.02 m d) 0.01
 3. The displacement versus time graphs of 2 simple harmonic motions (SHM) are given below. Which parameter is the same for both?
a) Angular frequency b) Amplitude
c) Maximum speed d) Phase constant
- 
- 4- What is the maximum kinetic energy of a particle in SHM with mass of 2kg, $\omega = \pi \text{ rad/s}$, $A=1\text{m}$.
a) 1.57 J b) 6.28 J c) 3.14 J d) 9.87 J
 5. A sprig is performing a SHM. If its amplitude is doubled keeping the mass and force constant the same, total energy will become how many times the initial value?
a) 4 b) 2 c) 1 d) $\frac{1}{2}$
 6. The velocity (v), the frequency (f) and the wavelength of a wave (λ) relate as
a) $v = \lambda f$ b) $\lambda = v/f$ c) $f = \lambda/v$ d) $f = \lambda v$

II- TWO Marks for each

7. The maximum velocity and maximum acceleration of a body moving in a simple harmonic motion are 2m/s and 4m/s^2 respectively. What will be the angular velocity?
a) 4 rad/sec b) 3 rad/sec c) 2 rad/sec d) 1 rad/sec
8. Calculate the inertia of a uniform rod of mass 3 kg and length $l = 2 \text{ m}$ about an end.
a) 6 kg m^2 b) 4 kg m^2 c) 3 kg m^2 d) 2 kg m^2
9. A circuit contains a capacitor of capacitance of 10^{-6} F and an inductor of 10^{-4} H . The frequency of electrical oscillation will be
a) $(10^5/2\pi) \text{ Hz}$ b) $(2\pi \cdot 10^5) \text{ Hz}$ c) $(10^{-5}/2\pi) \text{ Hz}$ d) $(2\pi \cdot 10^{-5}) \text{ Hz}$

1	2	3	4	5	6	7	8	9