Assiut University	**Vibration and Waves**	**Final exam**
Faculty of Science	**212 Phys**	**12/6/2022**
Department of Physics		**Time Allow: 3 hours**

I- ONE Mark for each

1- In SHM, what is the phase difference between displacement and acceleration?

a) 2π b) π c) $\pi/2$ d) 0

2- A particle is undergoing SHM with amplitude 20 cm. The maximum speed it achieves is 3m/s. Find the angular frequency.

a) 15 rad/s b) 10 rad/s c) 5 rad/s d) 1 rad/s

3- 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) 8 rad/sec

4- Amass 0.1 kg g is suspended from the end of vertical spring of constant 50 N/m. If the mass is released down, find the extension in the spring. (g = 10 m/s^2)

a) 0.01 m b) 0.02 m c) 0.04 m d) 0.05

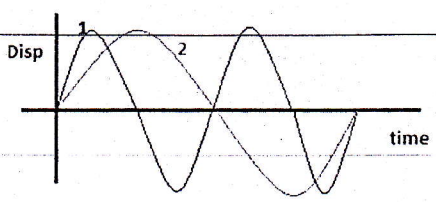
5- The velocity of a particle (v) moving with simple harmonic motion, at any instant is given by

a) $\omega^2\sqrt{A^2-x^2}$ b) $\omega\sqrt{x^2-A^2}$ c) $\omega^2\sqrt{x^2-A^2}$ d) $\omega\sqrt{A^2-x^2}$

6- A particle is initially at the center and going towards the left. Let T be the period of the SHM it is undergoing. What will be its position and velocity at time 3T/4, if it starts from the center at t=0?

a) at center, maximum speed towards left
b) At right extreme, zero velocity
c) at center, maximum speed towards right
d) Mid-way between center and -A

7- What is the relation between the periods of the two given SHMs.



a) $4T_1 = T_2$
b) $T_1 = 2T_2$
c) $2T_1 = T_2$
d) $T_1 = 4T_2$

8- What is the maximum kinetic energy of a particle in SHM with mass of 2kg, $\omega = \pi$ rad/s, A=1m.

a) 1.57 J b) 6.28 J c) 3.14 J d) 9.87 J

9- 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) ½

10- A physical pendulum has a length 1.5 m. What is its period if g =10m/s^2.

a) 0.4 b) 1.4 c) 2.4 d) 3.4

11- 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 Hz b) 10 Hz c) $(10^5 /2\,\pi)$ Hz d) $(10 /2\,\pi)$ Hz

12- If the summation of forces on a body is given by: $\Sigma F = -kx - bv + F_0$, then what is the expression for amplitude of motion?

a) $A_0 e^{\gamma t/2}$ b) $A_0 e^{-\gamma t/2}$ c) $A_0 e^{-2\gamma t}$ d) none of these

13- 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. its initial value What is the damping factor γ ?

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

14- In the last question, what is the time taken for the energy to become 1/3 of its initial value?

a) 3.17 s b) 4.17 s c) 5.17 s d) 6.17 s

15- A spring of mass 0.06 kg moves in SHM under external force without damping. If $F_0 = 0.12$ N, determine the amplitude of oscillation at external frequency of 2 rad s^{-1}

a) 3.02 m b) 2.02 m c) 1.02 m d) 0.02 m

16- In the last question, the phase difference between the displacement and the force is

a) 0 b) $\pi/2$ c) π d) infinity

17- A mass hangs from the end of a spring. The system is damped by a light oil so that the ratio of amplitudes of consecutive oscillations is 1.25, it is found that 10 complete oscillations takes 20 s. Determine the damping factor γ of the system.

a) 4.223 b) 2.223 c) 1.223 d) 0.223

18- In LCR circuit consists of L= 5 H, C = 5 F and R =10 Ω. The system is

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

19- A transverse wave traveling along a string is described by the function $y = 2 \cos (0.2\,x + 30\,t)$, where x and y are in meters and t is in seconds. Find the wavelength in meters.

a) $10\,\pi$ b) $6\,\pi$ c) $4\,\pi$ d) $2\,\pi$

20- 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

II- TWO Marks for each

21- An LC circuit contains a capacitor initially charged with $2x10^{-5}$ C. If the period is $1.57x10^{-3}$ s. The maximum current when the circuit is closed will be.

a) $8x10^{-4}$ A b) $1.27x10^{2}$ A c) $3.14x10^{-8}$ A d) $8x10^{-2}$ A

22- A spring of constant 12 N m^{-1} and mass of 0.03 kg moves in SHM under external force. If F_0 = 0.15 N and a damping force b =0.06 kg s^{-1}. Determine the amplitude of oscillation at external frequency of 4 rad s^{-1}

a) 0.636 m b) 0.436 m c) 0.236 m d) 0.036 m

23- A damped oscillation, mass is 2 kg and spring constant is 500 N/m and damping coefficient is 1 kg/s. If the mass is displaced by 20 cm from its mean position and released. What will be the value of its energy after 4 s.

a) 1.35 J b) 2.35 J c) 3.35 J d) 4.35 J

24- In LCR circuit consists of L= 0.09 Henry, C = 0.04 Farad and R = 5 Ω. If the amplitude of the applied voltage is 12 V. Find the amplitude of the voltage across the capacitor at resonance frequency.

a) 2.6 V b) 3.6 V c) 4.6 V d) 5.6 V

25- An observer is in a car moving to north with speed of 21m/s. An ambulance travels to south at speed of 30 m/s, its siren emits sound at frequency of 190 Hz. What will be the frequency as heard by the observer? Speed of sound in air is 330m/s.

a) 422.3 Hz b) 322.3 Hz c) 222.3 Hz d) 122.3 Hz

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

16	17	18	19	20

21	22	23	24	25

III- Four Marks for each

26) 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.

27) Two simple pendulums, each of length 0.8 m and mass of 4 kg are coupled by a horizontal spring of constant 30 N/m. One of the masses is moved to 6 mm and the other mass is moved to 3 mm, then masses released from rest. (i) Calculate the normal modes of vibrations.

(ii) Calculate the displacements as functions of time.

28) Deuce the first and second normal modes of transverse vibration for a system consists of two masses-string of length ℓ connected by third string of the same length.

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

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

Assiut University
Faculty of Science
Department of Physics

Undergraduate
Final Exam
2nd semester

Course: *Introduction to Modern Physics*
Code: P 225
Time: 2 Hours
Date:13/06/2022

The exam is in 5 pages (50 degree)

First question: Choose the correct answer: **(25 Marks)**

1) The work function for tungsten metal is 4.52 eV. The cutoff wavelength for tungsten is			
A. 356 nm	B. 274 nm	C. 456 nm	D. 417 nm
2) At what wavelength does a room temperature (T = 20 °C) object emit the maximum thermal radiation?			
A. 9.89 μm	B. 7.56 μm	C. 11.78 μm	D. 4.98 μm
3) Of the following, Compton scattering from electrons is most easily observed for:			
A. microwaves	B. infrared light	C. visible light	D. x rays
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) In a photoelectric effect experiment at a frequency above cut off, the stopping potential is proportional to:			
A. the energy of the least energetic electron before it is ejected			
B. the energy of the most energetic electron before it is ejected			
C. the energy of the most energetic electron after it is ejected			
D. the electron potential energy at the surface of the sample			
6) Which of the following is NOT true for electromagnetic waves?			
A. they consist of changing electric and magnetic fields			
B. they travel at different speeds in a vacuum, depending on their frequency			
C. they transport energy			
D. they transport momentum			
7) Threshold wavelength for a metal having work function W_0 is λ_o. What is the threshold wavelength for the metal having work function $2W_0$?			
A. $4\lambda_o$	B. $2\lambda_o$	C. $\lambda_o/2$	D. $\lambda_o/4$

Best wishes

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8) What is the black body or an ideal radiator?

A. the body which transmits all the radiations incident upon it
B. the body which absorbs all the radiations incident upon it
C. the body which reflects all the radiations incident upon it
D. none of the above

9) Work function of three metals A, B, and C are 4.5 eV, 4.3 eV, and 3.5 eV respectively. If the light of wavelength 4000 Å is incident on the metals, then

A. photoelectrons are emitted from A.
B. photoelectrons are emitted from B.
C. photoelectrons are emitted from C.
D. photoelectron will not be emitted from all the surfaces.

10) Which phenomenon best supports the theory that matter has a wave nature?

A. electron momentum
B. photon momentum
C. electron diffraction
D. photon diffraction

11) Which of the following has maximum penetrating power?

A. ultraviolet radiation
B. microwaves
C. x-rays
D. radio waves

12) If K.E. of free electron is doubled, its de Broglie wavelength will change by factor

A. 0.5
B. 1.414
C. 0.707
D. 2

13) In electromagnetic waves the phase difference between electric and magnetic field vectors are

A. (a) Zero
B. (b) $\pi/4$
C. (c) $\pi/2$
D. (d) π

14) Pair production occurs only when the energy of the photon is at least equal to

A. 1.02 KeV
B. 1.02 eV
C. 1.02 MeV
D. 0.51 MeV

15) The compton effect can be explained based on

A. wave nature of light
B. quantum theory of light
C. ray optics
D. wave optics

16) Calculate the de-Broglie wavelength of an electron which has been accelerated from rest on application of a potential of 400 volts.

A. 0.165nm
B. 0.061 nm
C. 0.052 nm
D. 0.61 nm

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17) The minimum energy required to remove an electron is called

A. stopping potential
B. kinetic energy
C. work function
D. none of these

18) The stopping potential value is 2 V when the light source is kept at 40 cm. When the source is kept at 40 cm away, the stopping potential will be

A. 0.6 V
B. 0.3 V
C. 2 V
D. 2.4 V

19) Stefan-Boltzmann law states that the energy radiated per unit area per unit time by the black body is

A. directly proportional to the square of the temperature of the black body
B. inversely proportional to the square of the temperature of the black body
C. directly proportional to the fourth power of the temperature of the black body
D. inversely proportional to the fourth power of the temperature of the black body

20) For an X-ray tube operating at a peak voltage of 70 kV. What is the maximum energy of the emitted photons?

A. 1.1×10^{-14} J
B. 4.4×10^{23} J
C. 1.1×10^{-19} J
D. 4.4×10^{26} J

21) what is the shortest-wavelength x-ray photon emitted in an x-ray tube subject to 50 kV?

A. 0.025 nm
B. 0.015 nm
C. 0.01 nm
D. 0.005 nm

22) The threshold wavelength of photoelectric emission of a metal is 4000 Å. Then the minimum energy required to eject photoelectron is

A. 4.96 e V
B. 3.1 e V
C. 49.6 e V
D. 31 e V

23) Which of the following bodies will not be able to emit radiation continuously?

A. a body with very high temperature placed in air medium
B. a body with temperature 0°C placed in air medium
C. a body with temperature 0°C placed in a vacuum
D. none of the above

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24) 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

25) 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. Pachen series D. Phond series

Second question: Circle T for the true statement and F for the false one: (25 Marks)

26) Heisenberg's uncertainty principle says, "It impossible to measure simultaneously the position and the momentum of a particle".

27) Bohr's corresponding principle says, "the smaller quantum number, the closer quantum physics approaches classical physics".

28) According to Max Plank, oscillator can emit radiation by dropped to any lowest energy state where the amount of energy emitted is $\Delta E = nhf$.

29) In Compton scattering, scattered photon has smaller wavelength than the incident one.

30) No time lag between the illumination of the metal and the emission of the photoelectrons.

31) The probability of pair production increases only by decreasing the photon energy.

32) In blackbody radiation, as the temperature increases, the maximum of the curve shifts toward higher frequencies.

33) In photoelectric effect, the maximum kinetic energy of photoelectrons depends on the intensity of incident electromagnetic waves.

34) The pair production process, cannot occur in the vacuum.

35) In blackbody radiation, as the temperature increases, the maximum of the curve shifts toward higher frequencies.

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36) In photoelectric effect, the maximum kinetic energy of photoelectrons depends on the intensity of incident electromagnetic waves.
37) The minimum wavelength λ_{min} of X-rays depend on the kind of the metal target.
38) Visible Light rays cannot show Compton effect.
39) According to De Broglie, the larger of momentum of particle, the larger its wavelength.
40) Wien's law can fit the blackbody radiation curve in the shorter wavelength region.
41) The red line in Balmar series is produced as electron transition from n = 3 to n=2.
42) According to Thomson's atomic model, α–particles will scatter from thin gold foil through very large scattering angles.
43) Bohr considered that nucleus has a finite mass M and the electron and nucleus rotate about their center of mass.
44) De Broglie wavelength depends on momentum and on the size of the particle.
45) Davisson and Germer experiment did not prove the wavelike behavior of matter.
46) In photoelectric, the maximum kinetic energy of photoelectrons depends on the intensity of incident EM waves.
47) A gamma-ray photon with energy less than 1.02 MeV can be used in pair production.
48) In blackbody radiation, as the temperature increases, the total emitted radiant energy increases.
49) Photoelectron emission from a given metal does not take place unless the frequency of incident light is equal or greater than a certain minimum frequency f_o.
50) The emissivity for the blackbody depends on the material that make the blackbody.

Electron charge e	1.6×10^{-19} C	Plank's constant h	6.626×10^{-34} Joul.sec
Electron mass m_e	9.1×10^{-31} kg	Light velocity c	3×10^{8} m.sec^{-1}
Proton mass m_p	1.672×10^{-27} kg	Coulomb constant k	9×10^{9} J.m.C^{-2}
Bohr radius a_o	0.529×10^{-10} m	Mass of a hydrogen atom	1.672×10^{-27}kg
1 eV	1.602×10^{-19} J	Ionization energy of the hydrogen atom E_o	13.6 eV

Best wishes

Dr. Yasmin Mohamed Yousef Bakier.

Assiut University Faculty of Science Physics Department	**The Final Exam.** **for the Introduction To Physics of Metals& Alloys and Ceramics .P.256** **For the students of 2nd level Ph& Ph/chem and Ph/elect.**	**Allowable time:3 hours** **Date: 15/6/2022** **Total marks: 50 degree**

The exam. consists of two parts (50 marks)

Part I: Answer these two questions: (20 Marks)

Q.1: Put (T) or (F) in front of each sentences from the following:

[Hint: then, please put your answer in the table.1 below]

1 - The theoretical density (ρ) for different metals have the same crystal structure must have the same values. ( )

2- For all crystal structure systems the equivalent directions <100> are normal to the equivalent planes {100}. ( )

3-Substances in which the measured physical properties are independent of the direction of measurement are called isotropic materials. ( )

4-X-ray diffraction can take place from crystalline solid when the wavelength of x-ray beam is in the order of the interplanar spacings of this material. ( )

5 -Schottky defect is equivalent to missing atom leaves its original site and migrates to another site inside the lattice. ( )

6-The equilibrium number of vacancies Nv for a given quantity of metal increases linearly with increasing temperature. ( )

7- Hardness is a measure of a material,s resistance to localized plastic deformation. ( )

8-We can obtain fine grain casted metal if the nucleation rate is much higher than the growth rate.

9- In the isomorphous phase diagrams (like Cu-Ni), there are more than one solid phase present under the solidus line. ( )

10-Solubliities of impurities in ceramics is lower if ion radii and charges match.( )

Tabl.1

No.										
Ans.										

Q.2: **(10 Marks)**

Choose the correct answer for these statements from a,b.c and d:

[Hint: then, please put your answer in the table.2 below]

1-The physical properties of polycrystalline metallic alloys are those except :

a)-electrical conducting materials b)-have a medium range orde

c)-melt at definite temperature d)-can be casted on sand mold.

2-polymeric materials are characterized by:

a)- More electrical conductor than metals

b)- generally melt at high temperatures

C)-more ductile than metals

d)- Have a metallic bond type

3-The equivalent directions in cubic crystal structure have:

a)- The same [u v w] b)- The same linear density

c)- The same (hkl) d)- None of the above.

4-The ceramic materials are characterized by :

a)-Melted at definite temperature

b)-Hard and brittle.

c)- Generally has a cubic crystal structure

d)- Have a totally covalent bond.

5-For FCC unit cell, the planar density(PD) of the (110) plane has the same value as that of the :

a)- (011) b) - (111) c)- (001) d)- (220)

6- All those are some types of volume defects except:

a)- twin boundaries b)- second phase particles

c)- inclusions d)- precipitates

7-The rate of vacancy diffusion in a metallic material depends on :

a)- Number of interstitial atoms present.

b)-The atomic weight.

c)-The temperature.

d)-The activation energy to exchange positions.

8-Vicers Hardness number (HV) of a metal surface specimen depends on:

a)- The Load P used during the measurement.

b)- The diameter of the steel sphere used during the measurement.

c)-The density of the specimen.
d)-The type, structure and heat treatment of the metal specimen.

9-3-In the area between the liquidus line and solidus line in an isomorphous phase (Ge-Si) diagram there (is)are :

a)- L phase only b)- α +L phases
c)- α phase only d)- α+β phases

10- By using metallographic examination for metallic polycrystalline sample we can determine:

a)-Its dislocation density.
b)-Its average grain size.
c-)Its chemical composition.
d)-Its hardness number.

Tabl.2

No.										
Ans.										

Part II: **(30 Marks)**

Answer only Three from the following questions:

Use these constants when needed:

Avogadr,s number $N_a = 6.023 \times 10^{23}$ atom/mole

Boltzmann's constant $K = 1.38 \times 10^{-23}$ J/K

Q.3: **(10 Marks)**

3-a): Prove that the atomic packing factor (APF) for the HCP and FCC unit cells have the same values. (5 marks)

3-(b): (5 Marks)

1- define: The atomic radius – Frenkel defects- ductility- the phase

2-Calculate the radius of tantalum atom, given that Ta has a BCC crystal structure, a density of 16.6g/cm^3, and an atomic weight of 180.9g/mol.

Q.4: **(10 Marks)**

4-a)-Briefly discuss the factors that determine the degree to which atoms of two different metals can be dissolve in each other to make solid solution alloy. (give examples).
(5 Marks)

4-b)-Determine the composition, in atomic percent , of an alloy that consists of 97wt%aluminium and 3Wt%copper.(given that: A_{Cu}=63.55g/mole and A_{Al}=26.98 g/mole)
(5 Marks)

Q.5 **(10 Marks)**

5-a)- Give a mathematical expression for the followings: (5 Marks)

1-The toal solidification time (TST) according to Chvorinov,s Rule.

.....

2-The critical nucleus radius during homogeneous nucleation of pure metals.

.....

3-The Vicker,s Hardness number(HV) for metallic sample.

.....

4-Diffusion coefficient D in solids dependence on temperature.....

5-The average theoretical density (ρ_{ave}) for a two element metal alloy with concentrations C_1,C2 and densities ρ_1,ρ_2. .....

5-b)- **(5 Marks)**

A tensile stress is to be applied along the long axis of a cylindrical brass rod that has a diameter of 10mm.Determine the magnitude of the load required to produce a $2.5x10^{-3}$mm change in diameter if the deformation is entirely elastic. (given that the Poisson,s ratio for this alloy equals 0.34 and the elastic modulus E of the alloy equals $97x10^3$ MPa).

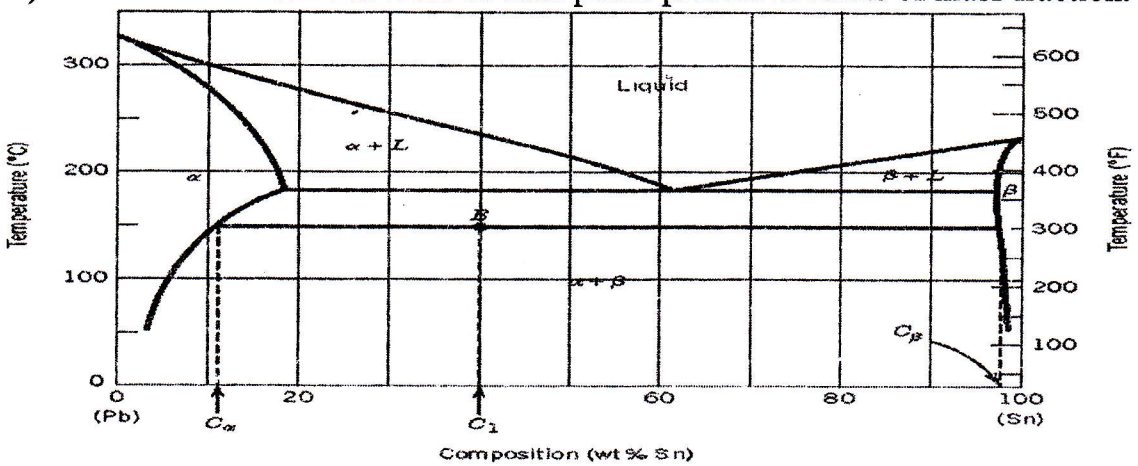
2.6: **(10 M0rks)**

6-a)- **(5 Marks)**

As shown in this figure below at the point B, For a 40 wt% Sn -60 wt% pb alloy at 150 °C.(Given that: Cα=10%, C_1=40% and C_β=98%)

a)- what phase (s) is (are) present? B)- what is (are) the composition(s).

c) calculate the relative amount of each phase present in terms of mass fraction.



6-b): **(5 Marks)**

The NaCl is ionic ceramic material have NaCl crystal structure, Calculate the theoretical density for this ceramic, consider the following parameters:

The formula unite n=4 $\sum A_c = A_{Na} = 22.99$ g/mole

$\sum A_A = A_{Cl} = 35.45$ g/mole $r_{Na}=0.102\times10^{-7}$cm, $r_{Cl}=0.1081\times10^{-7}$cm

$N_A=6.022\times10^{23}$formula unite /mol

With my best wishes

Prof. Dr. Atta . Y. Abdel-latief

Department of Physics - The Second Semester 2021/2022
The Final Exam of Thermodynamics (223P) – 2nd level students (Physics)
Date of the Exam: Wednesday 22/6/2022 – The Period: (9 – 12 Am)
Time: 3 Hours **The mark: 50** **Number of Papers: 2**

Q1: True and False Question (20 Marks - One Mark for Every Sentence)

1. When two objects are in thermal equilibrium with each other, they are at the same temperature.
2. The thermodynamic variables of the ideal gas are (P, V, T) only.
3. The behaviour of the real gases undergoes the equation of state when their density is high.
4. In Joule's experiment, 4.186 J from the mechanical energy raises the temperature of 1 g of water by 1°C.
5. During the phase change of the substance from one state to another, its temperature changes also.
6. The work done by or on a system in the thermodynamic processes does not depend on the path taken by the system from the initial state to the final state.
7. The heat energy transferred to a thermodynamic system equals the change in the internal energy of the system plus the work done by the system.
8. The total pressure exerted by a monoatomic ideal gas on the wall of the vessel is given by the equation $P = \frac{2}{3}\rho\left(\frac{1}{2}m\overline{v^2}\right)$, where ρ is the density of the gas molecules.
9. The internal energy of the monatomic ideal gas per unit volume equals $\frac{3}{2}P$.
10. When the temperature of n moles from an ideal gas changes by ΔT, the amount of the heat energy transferred to the gas at constant pressure is greater than the amount of the heat energy transferred to the gas at constant volume.
11. When an ideal gas undergoes an adiabatic process from an initial state (i) to a final state (f), the pressure and the temperature of the gas are related by the relation $P_i^{\gamma-1}T_i^{\gamma} = P_f^{\gamma-1}T_f^{\gamma}$,where $\gamma = C_P/C_V$.
12. When an ideal gas transfers from an initial state (i) to a final state (f) during an adiabatic process, the work done by or on the gas is $W = \frac{nR}{(\gamma-1)}[T_f - T_i]$.
13. The heat engine is a device operating in a cyclic process by using a working substance, and absorbs heat energy from a hot reservoir, and converts part from the energy to mechanical work, and expels the residual from that energy to a cold reservoir.
14. It is possible to construct a heat engine operating in a cyclic process, and converts all the heat energy absorbed from the hot reservoir to an equal amount from the mechanical work.
15. The heat energy can be transferred spontaneously from a cold object to a hot object without doing work.
16. The adiabatic free expansion of a gas is an irreversible process.
17. Carnot's theorem states that no real heat engine operating between two energy reservoirs can be more efficient than a Carnot engine that operates between the same two reservoirs.

18. The efficiency of the gasoline and diesel engines decreases as the compression ratio decreases.

19. The total change in entropy of a system along any reversible cycle is equal to zero.

20. The change in entropy for a system in the irreversible processes is always positive.

Use the following constants

$1\ atm = 1.013 \times 10^5\ Pa$ $\quad R = 8.314\ J/mol.\ K$ $\quad N_A = 6.022 \times 10^{23}\ mol.^{-1}$

$k_B = 1.38 \times 10^{-23}\ J/K$ $\quad c_{water} = 4186\ J/kg.\ ^oC$ $\quad g = 9.81\ m/s^2$

Q2: Multiple Choice Question (30 Marks - One Mark for Every Sentence)

21. The carbon dioxide gas transforms into a solid (dry ice) at approximately (−157°F). What is the value of temperature in degree Celsius at which this process takes place?
(A) −121°C (B) −105°C (C) −93°C

22. From what the system consists of in thermodynamics?
(A) It consists of a finite amount of liquid or gas placed in a closed or open vessel.
(B) It consists of a finite amount of liquid or gas placed in a closed vessel only.
(C) It consists of a finite amount of liquid or gas placed in an open vessel only.

23. The molar mass of the hydrogen gas is 1.008 g/mole. What is the mass of the hydrogen atom?
(A) 1.008×10^{-3} kg (B) 1.674×10^{-27} kg (C) 9.11×10^{-31} kg

24. A room of volume 60 m^3 is filled with atmospheric air its molar mass is 29 g/mole. What is the density of the air in the room at NTP?
(A) 1.206 kg/m^3 (B) 1.225 kg/m^3 (C) 1.258 kg/m^3

25. A pressure of 1×10^{-7} mm of Hg is achieved in an air vacuum system. How many gas molecules are present per liter volume if the temperature of the air is 293 K? (1 atm = 760 mm Hg)
(A) 1.6×10^{18} (B) 2.4×10^{16} (C) 3.3×10^{12}

26. At 25 m below the surface of the sea, where the density of the water is 1025 kg/m^3 and its temperature is 5°C, there is an air bubble having a volume of 1 cm^3. If the surface temperature of the sea is 20°C, what is the volume of the bubble just before it breaks the surface?
(A) 3.67 cm^3 (B) 2.34 cm^3 (C) 1 cm^3

27. Two similar vessels have a constant volume; the first contains one mole from a monatomic gas while the second contains one mole from a diatomic gas. Which of the following applies to the gases when their temperature is equal?
(A) The internal energy is higher in the monatomic gas than in the diatomic gas.
(B) The internal energy is higher in the diatomic gas than in the monatomic gas.
(C) The internal energy in the monatomic gas is the same as in the diatomic gas.

28. Water its temperature is 10°C falls from a waterfall of height 50 m. what is the maximum temperature of the water at bottom of the waterfall?
(A) 0.117°C (B) 10°C (C) 10.117°C

29. An iron ball of mass 0.5 kg and its temperature 300°C is thrown into a bucket containing 2 kg of water at a temperature 20°C. What is the temperature of the system at the thermal equilibrium? Knowing that the specific heat of iron is (0.107 cal/g. °C).
(A) 27.3°C (B) 28.6°C (C) 29.5°C

30. How much heat energy is required to freeze one gram of water at 100°C? [L_f(ice) = 80 cal/g].
(A) 80 cal (B) −100 cal (C) −180 cal

31. A sample of an ideal gas is compressed to a third of its original volume of (6 m^3) in a quasi-static process for which $P = \alpha V^2$ with α = 2 Pa/m^6. How much work is done to compress the gas?
(A) −138.7 J (B) 138.7 J (C) −144 J

32. In the adiabatic process, the first law of thermodynamics is in the form
(A) $Q = \Delta E_{int} + P\Delta V$ (B) $\Delta E_{int} = -W$ (C) $Q = nRT\ln(V_f/V_i)$

33. A gas is compressed at a constant pressure of 0.8 atm from 9 L to 2 L. During the process, the gas lost 400 J of heat energy. What is the change in the internal energy of the gas?
(A) −567.3 J (B) −400 J (C) 167.3 J

34. A 2 moles of an ideal gas is kept at 0°C during an expansion from 2 L to 4 L. What is the amount of heat energy transferred to the gas?
(A) 3147 J (B) –3147 J (C) 0

35. How much work is done by the steam when 1 mole of water at 100°C boils and becomes 1 mole of steam at 100°C and 1 atm? Assume that the steam behaves as an ideal gas, the molar mass of the water is 18 g/mole, and the density of the water is 1000 kg/m^3.
(A) −1.82 J (B) 0 (C) 3.1 KJ

36. Two moles of hydrogen gas is confined in a 5 L vessel at a pressure of 8 atm. What is the average translational kinetic energy of the gas molecules under these conditions?
(A) 2.52 $\times 10^{-21}$ J (B) 5.05 $\times 10^{-21}$ J (C) 10.1 $\times 10^{-21}$ J

37. The rms speed of a helium atom at a certain temperature is 1350 m/s. What is the rms speed of an oxygen molecule at this temperature? The molar mass of He is 4 g/mole and the molar mass of O_2 is 32 g/mole.
(A) 1350 m/s (B) 914 m/s (C) 447 m/s

38. Which of the following relations are correct for the monatomic ideal gas?
(A) $C_V(\gamma - 1) = R$ (B) $C_P(\gamma - 1) = R$ (C) $C_P(\gamma + 1) = R$

39. A 1 mole of a monatomic ideal gas is at an initial temperature of 300 K. The gas undergoes an isovolumetric process and absorbs 500 J of heat energy. It then undergoes an isobaric process and absorbs 200 J of heat energy. What is the work done by the gas?
(A) 80 J (B) 333 J (C) 413 J

40. How much work is required to compress 5 moles of air at 20°C and 1 atm to one-tenth of the original volume in an adiabatic process? Assume that the air behaves as an ideal gas with (γ =1.40).
(A) −9.2 kJ (B) −27.6 kJ (C) −46 kJ

41. According to Maxwell–Boltzmann speed distribution function, the average speed of the molecules in a gas is given by the relation
(A) $1.73\sqrt{\frac{k_B T}{m}}$ (B) $1.60\sqrt{\frac{k_B T}{m}}$ (C) $1.41\sqrt{\frac{k_B T}{m}}$

42. The heat energy input to an engine is equal to 3 times the work that it produces, what is the percent of the heat energy that is expelled to the cold reservoir?
(A) 66.6% (B) 33.3% (C) 100%

43. It is impossible to construct a heat pump that transfers the heat energy continuously from a cold object to a hot object without input work to the pump. This sentence is the text of

(A) The first law of thermodynamics (B) Kelvin–Planck form of the second law of thermodynamics
(C) Clausius form of the second law of thermodynamics

44. The system can be returned from the final state (i) to the initial state (f) along the same path of the PV diagram in
(A) the isobaric process (B) the reversible process (C) the adiabatic process

45. Which of the following Carnot engines has the highest efficiency?
(A) Engine A: T_h = 1000 K and T_c = 700 K (B) Engine B: T_h = 800 K and T_c = 500 K
(C) Engine C: T_h = 600 K and T_c = 300 K

46. What is the total change in entropy when 20 g of water is boiling at 100°C and converts to steam at 115°C? The latent heat of the water vaporization is (L_v =2.26 × 10^6 J/K), and the specific heat of the water steam is (2010 J/kg.°C).
(A) 121.2 J/K (B) 122.76 J/K (C) 1.59 J/K

47. The change in entropy during the isovolumetric reversible processes of an ideal gas is given by the relation
(A) $\Delta S = nC_V \ln(T_f/T_i) + nR \ln(V_f/V_i)$ (B) $\Delta S = nC_V \ln(T_i/T_f)$
(C) $\Delta S = nR \ln(V_f/V_i)$

48. One mole of a monoatomic ideal gas has a pressure P and a volume V, and expands to a pressure $2P$ and a volume $2V$. What is the change in entropy of the gas during this process?
(A) 23.05 J/k (B) 17.29 J/K (C) 5.76 J/K

49. When a hot object at a temperature T_h loses a heat energy Q to a cold object at a temperature T_c, the change in entropy of the system is
(A) $\Delta S = Q/T_c$ (B) $\Delta S = Q/T_h$ (C) $\Delta S = (Q/T_c) - (Q/T_h)$

50. A copper cylinder of mass 1 kg and its specific heat is 387 J/kg was taken at 900°C and dropped into 4 kg of water at 10°C. What is the change in entropy of the copper cylinder assuming that no heat energy is lost to the surrounding medium?
(A) 1149.22 J/K (B) −523.7 J/K (C) 625.52 J/K

End of the Exam

Good Luck

Assiut University
Faculty of Science
Physics Department

Course: Electricity and Alternating Current | **Exam Date: Monday, 6/6/2022**
Code: P226 | **Exam Time: 2 hours**
Final Exam (60 Marks) | **2nd Semester 2021-2022**

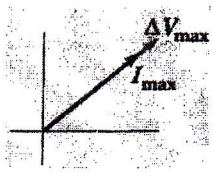
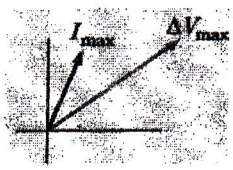
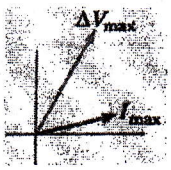
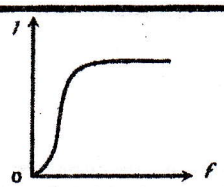
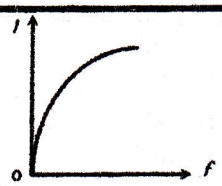
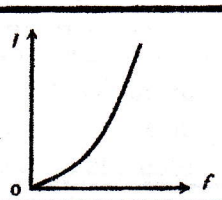
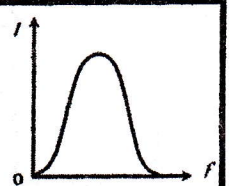
"يتم طمس (تسويد) الإجابة المختارة من قبل الطالب بإستخدام القلم الجاف فقط"

Permeability of free space (μ_0)	$4\pi \times 10^{-7}$ H/m

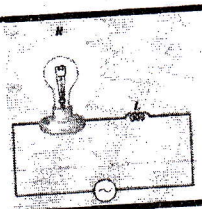
The exam is written in (6) pages

First part (I): Final Exam (50 Marks)

1st Question: Choose the correct answer (30 marks; 1 mark each)

1	Which phasor diagram represents capacitive reactance (X_C) = inductive reactance (X_L)?
	 (a)  (b)  (c) (d) None of the above
2	In a purely inductive AC circuit, L = 25.0 mH and the rms voltage is 150 V. If the frequency equal 60 Hz, the inductive reactance in the circuit will be:
	a) 1 kΩ b) 100 Ω c) 20 Ω d) 9.42 Ω
3	An AC source of variable frequency (f) is connected to an RLC series circuit. Which one of the graphs in the following figure represents the variation of current (I) in the circuit with frequency (f)?
	a)  b)  c)  d) 
4	A uniform 4.5 T magnetic field passes perpendicularly through the plane of a wire loop of 0.1 m^2. The magnetic flux that passes through the loop equals:
	a) 5.0 T m^2 b) 0.45 T m^2 c) 0.25 T m^2 d) 0.135 T m^2

5	An uncharged capacitor and resistor are connected in series to a battery. If ε=12 V, C=5.0 μ R=8×10^5 Ω. The current as functions of time is given by:
	a) $15\ e^{-t/4}$ μA b) $60\ (1 - e^{-t/4})$ μA c) $15\ (1 - e^{-t/4})$ μA d) $60\ e^{-t/4}$ μA
6	From the previous question (Q. 5): Consider a capacitor being discharged through a resistor R. After how many time constants is the charge on the capacitor one fourth of its initial value?
	a) $t = 4.0\ \tau$ b) $t = 1.39\ \tau$ c) $t = 0.63\ \tau$ d) $t = 1.37\ \tau$
7	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. The magnitude of the average induced emf in the coil during this time equals:
	a) 20 V b) 19.5 mV c) 10 V d) 50 V
8	At t=0, an emf of 500 V is applied to a coil that has an inductance of 0.8 H and a resistance of 30 Ω. The energy stored in the magnetic field when the current reaches half its maximum value is:
	a) 50 Joule b) 55.6 Joule c) 27.8 Joule d) 20 Joule
9	A series RL circuit with L=3.0 H and a series RC circuit with C=3.0 μF have equal time constants. If the two circuits contain the same resistance R. The value of R equals .....
	a) 1.0 kΩ b) 10 kΩ c) 100 kΩ d) 1000 kΩ
10	Calculate the inductance of an LC circuit that oscillates at 120 Hz when the capacitance is 8.0 μF?
	a) 0.22 H b) 20 mH c) 1 mH d) 50 mH
11	The voltage and current in an AC circuit are given by: $V = 5\sin(100\pi t - \frac{\pi}{6})$ and $I = 4\sin(100\pi t + \frac{\pi}{6})$; in this case:
	a) Voltage leads the current by 30° b) Current leads the voltage by 30° c) Current leads the voltage by 60° d) Voltage leads the current by 60°
12	The rms output voltage of an AC source is 200.0 V and the operating frequency is 100.0 Hz. The output voltage as a function of time equals:
	a) $\Delta V(t) = (283\ V)\sin(628t)$ b) $\Delta V(t) = (50\ V)\sin(628t)$ c) $\Delta V(t) = (200\ V)\sin(100t)$ d) $\Delta V(t) = (200\ V)\sin(200t)$

13	A 10 V-emf battery is connected in series with the following: a 2 μF capacitor, a 2 Ω resistor, an ammeter, and a switch, initially open; a voltmeter is connected in parallel across the capacitor. At the instant the switch is closed, what are the current and capacitor voltage readings, respectively?
	a) zero A, 10 V b) zero A, zero V c) 5 A, 0 V d) 5 A, 10 V
14	A sinusoidal voltage $\Delta V(t)=(40V)\sin(100t)$ is applied to a series RLC circuit with L=160 mH, C=99 μF, and R=68 Ω. Determine the phase angle?
	a) -51.3° b) -513° c) -50° d) 60°
15	The frequency of the AC source in the following figure is adjusted while its voltage amplitude is held constant. At what frequencies will the bulb glow the brightest?
	a) High frequencies b) Low frequencies c) The brightness will be the same at all frequencies. d) None of the above 
16	A series RLC circuit has components with following values: L=20.0 mH, C=100 nF, R=20.0 Ω. At the resonant frequency=3.56 kHz, the quality factor will be:
	a) 10 b) 20 c) 22.4 d) 50
17	A 10.0-mH inductor carries a current $I = I_{max}\sin\omega t$, with $I_{max} = 5.0$ A and $\frac{\omega}{2\pi} = 60.0$ Hz. What is the back emf as a function of time?
	a) $\varepsilon_{back} = (6\pi)\cos(120\pi t)$ b) $\varepsilon_{back} = 6\cos(120t)$ c) $\varepsilon_{back} = (6\pi)\cos(120\pi t)$ d) $\varepsilon_{back} = (6\pi)\cos(120\pi t)$
18	In RLC circuit, let R=7.60 Ω, L=2.20 mH, and C=1.80 μF. What is the critical resistance?
	a) 2 μF b) 0.2 μF c) 20 μF d) 200 μF
19	An emf of 24.0 mV is induced in a 500-turn coil at an instant when the current is 4.0 A and is changing at the rate of 10.0 A/s. What is the magnetic flux through each turn of the coil?
	a) 20 $mT.m^2$ b) 5.0 $T.m^2$ c) 10.0 $T.m^2$ d) 19.2 $\mu T.m^2$
20	The frequency in an AC series circuit is doubled. By what factor does this change the capacitive reactance?
	a) 1/2 b) 1/4

	c) 2 d) 4
21	What is the impedance of an AC series circuit that is constructed of a 10.0 Ω resistor along with 12.0 Ω inductive reactance and 7.0 Ω capacitive reactance?
	a) 37.0 Ω b) 27.7 Ω c) 27.1 Ω d) 11.2 Ω
22	What is the average power dissipation in an RLC series circuit in which R = 100 Ω, L = 0.1 H, and C = 10 μF driven at resonance by a 100 V (rms) source?
	a) 100 W b) 500 W c) 1000 W d) 2 W
23	The unit $T \cdot m^2/s$ is equivalent to:
	a) W b) V c) N/m d) Weber
24	The power factor of RLC circuit at resonance equals:
	a) 0.707 b) 1 c) zero d) 0.5
25	What is the time constant of RC circuit? If A capacitor in the circuit is charged to 60.0% of its maximum value in 0.9 s.
	a) 1 s b) 10 s c) 100 s d) 60 s
26	A varying current at the rate of 3 A/s in a coil generates an emf of 8 mV in a nearby coil. The mutual inductance of the two coils is given by:
	a) 2.66 mH b) 0.266 mH c) 26.6mH d) 226 mH
27	In a purely capacitive AC circuit, the voltage:
	a) leads the current by 90°. b) lags the current by 90°. c) may lead or lag the current depending on the frequency. d) is in phase with 70.7% of the current.
28	The voltage output of an AC source is given by the expression: $\Delta V = (200\ V) \sin \omega t$. Find the rms current in the circuit when this source is connected to a 100 Ω resistor?
	a) 1.41 A b) 100 mA c) 10 A d) 50 mA

29	Calculate the resistance in an RL circuit in which L=2.5 H and the current increases to 90.0% of its final value in 3.0 s?
	a) 20 Ω b) 1 k Ω c) 50 Ω d) 1.92 Ω
30	An inductor in the form of a solenoid contains 420 turns, is 16.0 cm in length, and has a cross-sectional area of 3.0 cm^2. Determine the self-inductance of inductor?
	a) 1 mH b) 20 mH c) 0.42 mH d) 40 mH

2nd Question: State True or False on the following statements **(20 marks; 1 mark each)**

Statement	True	False
31- The phase angle between the current and voltage of RLC circuit in series combination at resonance equal zero.		
32- The inductor affects the current exponentially.		
33- The unit of inductance is V/A.		
34- A fully charged capacitor, when its charge has decreased to half its original value, the stored energy is one-quarter its original value.		
35- 5 cm long solenoid having 10 Ω resistance and 5 mH inductance is joined to a 10 volt battery. At steady state the current through the solenoid will be zero.		
36- When an RLC series circuit is in resonance, its impedance is zero.		
37- The formula used to calculate the time constant in inductive circuit is L/R.		
38- The phase angle of an AC series circuit that is constructed of a 10.0 Ω resistor along with 12.0 Ω inductive reactance and 7.0 Ω capacitive reactance is 26.6°.		
39- The average power dissipation in a pure capacitance circuit is $\frac{1}{2}CV^2$.		
40- The self-inductance of a straight conductor is infinity.		
41- The unit of Ohm. Farad (Ω. F) is equivalent to Second (s).		
42- The impedance at the resonant frequency of a series RLC circuit with R = 90 Ω, L = 20 mH, and C = 0.02 μF is 90 Ω.		
43- 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 maximum.		
44- the charge and current in an LC circuit oscillate simple harmonically.		
45- A solenoid of length l meter has self-inductance L henry. If number of turns are doubled, its self-inductance remains the same.		
46- In a purely resistive ac circuit, the current is in phase with the emf.		
47- In the inductive circuit, the equilibrium value of the current is Infinity.		
48- The potential energy $\frac{1}{2}kx^2$ stored in a stretched spring is analogous to the electric potential energy $\frac{1}{2}CV^2$ stored in the capacitor.		
49- The phase angle is negative, when the circuit is more capacitive.		
50- When the capacitor is fully discharged, it stores no energy.		

Second Part (II) Oral Exam **(10 Marks)**

3rd Question: State True or False on the following statements **(10 marks; 1 mark each)**

Statement	True	False
51- Capacitors charge and discharge in exponential manner.		
52- The inductor affects the current exponentially.		
53- Inserting an iron core in a coil decreases its coefficient of self-induction.		
54- A coil has an inductance of 2.5 H and a resistance of 0.5 Ω. If the coil is suddenly connected across a 6.0-volt battery, then the time required for the current to rise 0.63 of its final value is 5 s.		
55- In a pure inductive circuit the emf of the applied AC voltage leads the current by 90°.		
56- In a series RLC circuit, operated with an AC source of angular frequency (ω), the total Impedance (Z) is $Z \equiv \sqrt{(\omega R)^2 + (\omega L - \omega C)^2}$		
57- The inductance of a coil depends on the geometry.		
58- Alternating current cannot be measured by DC ammeter.		
59- In a certain series resonant circuit, V_C = 125 V, V_L = 125 V, and V_R = 40 V. The value of the source voltage is 40 V.		
60- Resonance occurs in an AC series circuit when the capacitive reactance (X_C) equals zero.		

With my best regards

Dr. Amina Abozeed

Assiut University		**Term: 2nd 2021 - 2022**
Faculty of Science		**Date: June 4th, 2022**
Department of Physics		**Time: 3 hours**

Course Title: Modern Physics - Code: P215 – Final Exam (50 %)

Teaching Staff: Prof. Dr. Salah A. Makhlouf

Constants & Conversion of Units

Electron mass: $m = 9.11 \times 10^{-31}\ kg$
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: $k_B = 1.38 \times 10^{-23}\ J/K$
Rydberg Constant $R = 1.097 \times 10^{7}\ m^{-1}$
For hydrogen atom: Bohr radius $a_0 = 5.292 \times 10^{-11}\ m$ & $E_{ion} = 13.6\ eV$
$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N\,m^2$
$1\ eV = 1.6 \times 10^{-19}\ J$
$1\ \text{Å} = 10^{-10}\ m$ & $1\ nm = 10^{-9}\ m$

Marks of Q

Patrt I) Choose the correct option for the following questions (1 Mark each) **(26 Marks)**

1. As the temperature of black body is raised the wavelength corresponding to maximum intensity

a) shifts towards longer wavelength
b) shifts towards shorter wavelength
c) remain the same
d) shifts towards lower frequency

2. The photon processes the following three properties:

a) rest mass, energy and frequency
b) momentum, energy and frequency
c) energy, rest mass and momentum
d) frequency, rest mass and energy

3. A particle of mass $m\ (kg)$ and charge $q\ (Coul)$ is accelerated from rest through $V\ (Volts)$; then the de Broglie wavelength λ (m) associated with it is given by:

a) $\lambda = \frac{h}{\sqrt{mV}}$
b) $\lambda = \frac{h}{mV}$
c) $\lambda = \frac{h}{\sqrt{2qmV}}$
d) $\lambda = \frac{h}{\sqrt{2qV}}$

4. Compton effect proves the:

a) Photon theory of light
b) Dual nature of particles
c) Wave nature of light
d) Uncertain nature of light

5. Einstein's photoelectric equation is given by:

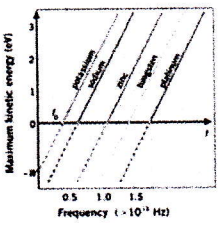
a) $\frac{1}{2}mv_{max}^2 = h\nu + \Phi$
b) $\frac{1}{2}mv_{max}^2 - h = \Phi$
c) $\frac{1}{2}mv_{max}^2 = h\nu - \Phi$
d) $\frac{1}{2}mv_{max}^2 = \Phi - h\nu$

6. In Compton scattering, the change in wavelength is maximum if

a) The angle of scattering is $90°$
b) The angle of scattering is $60°$
c) The angle of scattering is $180°$
d) The angle of scattering is 0

7. The graph shows maximum kinetic energy of emitted electrons against frequency (f) of incident light for several different metals. The threshold frequency is determined by:

a) the x-intercept.
b) the y-intercept.
c) the slope.
d) the area under the graph.



8. Pair production occurs only when the energy of the photon is at least equal to

a) $1.02\ GeV$
b) $1.02\ MeV$
c) $1.02\ keV$
d) $0.51\ MeV$

9. In an electron microscope, we use energetic particles because of

a) Penetrating power is high
b) Kinetic energy is large
c) Wavelength is very short
d) All the above reasons

10. If a material object moves with speed of light its mass (m) becomes:

a) equal to its rest mass
b) double of its rest mass
c) infinite
d) zero

Marks of Q

11. A free electron in motion along the $x - axis$ has a localized wave function. The uncertainty in its momentum is decreased if:

a) the wave function is made more narrow
b) the wave function is made less narrow
c) the wave function remains the same, but the energy of the electron is increased
d) the wave function remains the same, but the energy of the electron is decreased

12. A free electron and a free proton have the same kinetic energy. This means that, compared to the matter wave associated with the proton, the matter wave associated with the electron has:

a) a shorter wavelength and a greater frequency
b) a longer wavelength and a greater frequency
c) a shorter wavelength and the same frequency
d) a longer wavelength and the same frequency

13. A free electron and a free proton have the same momentum. This means that, compared to the matter wave associated with the proton, the matter wave associated with the electron:

a) has a shorter wavelength and a greater frequency
b) has a longer wavelength and a greater frequency
c) has the same wavelength and the same frequency
d) has the same wavelength and a greater frequency

14. A free electron and a free proton have the same speed. This means that, compared to the matter wave associated with the proton, the matter wave associated with the electron:

a) has a shorter wavelength and a greater frequency
b) has a longer wavelength and a greater frequency
c) has the same wavelength and a greater frequency
d) has a longer wavelength and a smaller frequency

15. A non-relativistic free electron has kinetic energy K. If its wavelength doubles, its kinetic energy is:

a) K/4 b) 4K
c) 2K d) K/2

16. 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 magnitude of its wave function
d) the square of the wavelength of its wave function

17. If the kinetic energy of a non-relativistic free electron doubles, the frequency of its wave function changes by the factor:

a) $1/\sqrt{2}$ b) 2
c) $1/2$ d) $\sqrt{2}$

18. The de Broglie wavelength λ of an electron in the n^{th} Bohr orbit is related to the radius R of the orbit as:

a) $n\lambda = 2R$ b) $n\lambda = \pi R$
c) $n\lambda = 2\pi R$ d) $n\lambda = 4\pi R$

Marks of Q

19. In the Bohr model:

a) Electrons move in circular orbits of definite radius.
b) Electrons move in elliptical orbits.
c) Electrons moving in the same orbit can have different energies.
d) Electrons can never jump from one orbit to another

20. An atom absorbs a photon, so that the electron's total energy increases by an amount equal to the photon energy. In the Bohr model, the electron moves to an orbit of larger radius. what happens to the orbital speed of the electron?

a) Increases
b) Decreases
c) Increases and then decreases
d) Stays the same

21. The relativistic energy (E_0) is equivalent to relativistic mass (m) given by

a) $E_0 c^2$
b) E_0/c^2
c) E_0/c
d) c^2/E_0

22. Relative to a stationary observer, a rod of length $1.0\ meter$ is moving at $0.8\ c$. It would appear to the observer that the rod's length is:

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

23. For confinement of electron in a box of width $L = 10^{-14}\ m$, the electron speed should be

a) $10^7 m/sec$
b) greater than the speed of light
c) zero
d) equal to the speed of light

24. Proton from outer space is moving towards earth with velocity $0.99c$ as measured in earth's frame. A spaceship, traveling parallel to the proton, measures proton's velocity to be $0.97c$. The approximate velocity of the spaceship, in the earth's frame is

a) $0.3c$
b) $0.2c$
c) $0.4c$
d) $0.5c$

25. Which of the following depends on the observer's frame of reference?

a) The mass of the proton
b) The length of a meter stick
c) The half-life of a muon
d) All of the given answers

26. A meson when at rest decays $2\ \mu s$ after it is created. If moving in the laboratory at $0.99c$, its lifetime according to laboratory clocks would be:

a) the same
b) $0.28\ \mu s$
c) $14\ \mu s$
d) $4.6\ \mu s$

27. According to relativity theory a particle of mass (m) with a momentum $(p) = 2mc$ has a speed of:

a) $2c$
b) $4c$
c) $c/2$
d) $0.89c$

Marks of Q

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

Q1) **(6 Marks)**

A sodium surface is illuminated with light having a wavelength of 300 nm. The work function for sodium metal is 2.46 eV.

a) Find the maximum kinetic energy $(KE)_{max}$ of the ejected photoelectrons in eV $units$?

b) Find the maximum wavelength λ_0 in nm $units$ that will cause photoelectrons to be emitted from sodium?

Marks of Q

Q2) **(6 Marks)**

The resolving power of a microscope depends on the wavelength (λ) used. If one wished to "see" an atom, a resolution of approximately a wavelength $\lambda = 1.00 \times 10^{-11} m$ would be required.

a) If electrons are used (in an electron microscope), what minimum momentum (p) is required for the electrons?

b) Use your answer of part (a) to calculate in $keV\ units$ the minimum non-relativistic and relativistic kinetic energy (KE) of the used electrons?

c) If photons are used, what minimum photon energy (E) in $keV\ units$ is needed to obtain the required resolution?

Marks of Q

Q3) **(6 Marks)**

In interstellar space, highly excited hydrogen atoms called Rydberg atoms have been observed.

a) Find the wavelength to which radio astronomers must tune to detect signals from electrons dropping from the $n = 273$ level to the $n = 272$ level?

b) What is the radius of the electron orbit for a Rydberg atom for which $n = 273$?

c) How fast is the electron moving in a Rydberg atom for which $n = 273$?

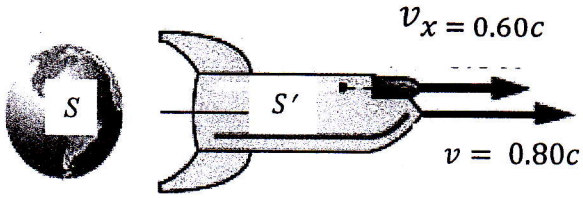
Marks of Q

Q4) **(6 Marks)**

A spaceship moving away from the Earth at a speed of $v = 0.80c$ fires a missile parallel to its direction of motion. The missile moves at a speed of $v_x' = 0.60c$ relative to the ship.

a) What is the speed v_x of the missile as measured by an observer on the Earth?

b) Compare the answer of part (a) with that obtained using Galilean transformation and comment on your answer?



Marks of Q

Q5) **(6 Marks)**

The proton has a mass $m = 1.673 \times 10^{-27} kg$

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

b) If its total energy (E) equals $(3E_0)$, show that the speed of the proton is $\frac{\sqrt{8}}{3}c$?

c) Determine the kinetic energy (KE) of the proton in units of GeV?

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