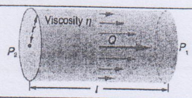
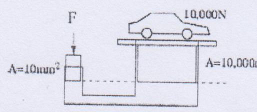
Question (4) Put [√] or [x] with correct   **Oral (10 Mark)**

1) The pressure p at any point is the normal force F per unit area A.	( )
2) As the temperature increases, the viscosities of all liquids increase.	( )
3) Isotopes are nuclides that have same A and different Z and N.	( )
 4) Poiseuille's Law is $Q = (P_2 - P_1)r^4/8\eta l$	( )
5) The laminar flow (for thin fluids) has a large η.	( )
6) Low Reynolds numbers, as the turbulent flow dominates.	( )
7) SI unit of density is kg.m^3.	( )
8) β^- Decay is radioactive parent nucleus transforms a proton into a neutron.	( )
9) Sensory neurons receive stimuli from sensory organs that monitor the external and internal environment of the body.	( )
10) Positive lithium ion is more electrons than protons and positive net charge	( )

BEST WISHES   **Instructor: Dr. Ghada Salaheldin**

12	………… The bonds between atoms get weakened and as a result new chemicals are formed a) Chronic Exposure b) Somatic Effects c) Radiation Damage d) Genetic Effects
13	Blood is pumped from the heart at a rate of 5.0 L/min into the aorta (of radius 1.0 cm). Determine the speed of blood through the aorta. The speed of blood through the aorta is……. a) 0.37m/s b) 0.27 m/s c) 0.17m/s d) 0.07m/s
14	The dimensions of viscosity η in (**SI**) are………… a) kg $m^{-1}s^{-1}$ b) g $cm^{-1}s^{-1}$ c) kg m s^{-1} d) kg m s
15	Flow rate Q is given by the following equation………. a) s/m^3 b) m^3/s c) $m^3.s$ d) $s.m^3$
16	Spontaneous disintegration of nuclides is called………… a) Radioactivity b) Electron capture c) Excitation d) Ionizing
17	In neurons are typically found in higher concentrations outside the cell. a) Na^+ and Cl^- b) K^+ and Cl^- c) K^+ and HCO_3^- d) Na^+ and HCO_3^-
18	The solid, liquid, and gas phase regions all meet a) The critical point b) The triple point c) The internal energy d) Thermal equilibrium
19	The human body emits electromagnetic radiation according to the body's temperature. Estimate λ_{max} for the human body. a) $9.4 \times 10^{-6} m$ b) $8.4 \times 10^{-6} m$ c) $9.4 \times 10^{-2} m$ d) $8.4 \times 10^{-2} m$
20	During depolarization voltage gated potassium ion channels open due to an electrical stimulus a) True b) False

Question (3) In the following multiple-choice questions, please select the correct answer **(30 Mark)**

1	What is the change in the temperature on the Fahrenheit scale if an iron piece is heated from 30 °C to 75 °C? a) 45 ^{0}F b) 91 ^{0}F c) 54 ^{0}F d) 81 ^{0}F
2	The equation of continuity in a more general form becomes......... a) $n_1A_1v_1 = n_2A_2v_2$ b) $A_1v_1 = A_2v_2$ c) $n_2A_1v_1 = n_1A_2v_2$ d) $A_1v_2 = A_2v_1$
3	High Reynolds numbers indicates that the .... a) Viscosity b) Laminar flow c) Turbulent flow d) Poiseuille's law
4	The transformation from a solid to a liquid.......... a) Melting b) Vaporization c) Freezing d) Condensation
5	Bernoulli's equation can be derived from the conservation of: a) Energy b) Mass c) Angular momentum d) Pressure
6	Which of the following options represents the condition of an ideal fluid? I. Fluid is non-viscous. II. Fluid's density is constant. III. Fluid moves with high-speed. IV. Fluid has no internal frictional force. a) I and II b) I and III c) I, II and III d) I, II and IV
7	If the exposed cell is related to reproduction, the damage to its DNA can lead to developmental problems in the offspring of the person. a) Genetic Effects b) Somatic Effects c) Radiation Damage d) Chronic Exposure
8	What is the fluid flow of air moving at 2 m/s through an area of 5m^2? a) 10 m^3/s b) 20 m^3/s c) 2.5 m^3/s d) 0.4 m^3/s
9	A container is filled with oil and fitted on both ends with pistons. The area of the left piston is 10 mm^2; that of the right piston 10000 mm^2. What force must be exerted on the left piston to keep the 10000-N car on the right at the same height? a) 10 N b) 100 N c) 10,000 N d) 10^6 N 
10	How much heat is needed to raise the temperature of 2 kg of aluminum from 20°C to 60°C, if the specific heat of aluminum is 0.9 J/g °C a) 27 kJ b) 72 J c) 72 kJ d) 27 J
11	The peak of Mount is 7000 m above sea level. Estimate the pressure in the atmosphere at this location [y_0 =1.0 ×10^4 m, P=1.01×10^5 Pa). The pressure in the atmosphere is .... a) 2.42×10^4 Pa b) 2.03×10^5 Pa c) 5.02×10^4 Pa d) 3.42×10^4 Pa

Question (2) **(5 Mark)**

a) **Prove** and **Define** the Bernoulli principle?

b) A Consider the flow of blood through the large artery that extends from the heart to the lungs. The radius of this artery is typically 2.0 mm, and it is about 10 cm long. ($\eta = 0.0027$ N.s/m^2)

i. If the pressure difference across the ends of the artery is 500 Pa, **what is the average speed of the blood**?

ii. Now suppose this artery becomes somewhat narrower, as often happens with age. If the radius is reduced to 1.25 mm, **what pressure difference** is required to maintain the same average speed as in part (a)? **(5 Mark)**

Undergraduate
Final Exam(50%)
3rd semester 2024-2025
Summer Course: Biophysics
Code:P323
Time:3 Hour /Date: 1-9-2025

Faculty of Science
Department of Physics

Assiut University

Question (1)

a) **Explain with a diagram** "Action Potential in Axons" **(5 Mark)**

b) For the frog skeletal muscle, typical values for the intracellular and extracellular concentrations for the major ion species (in millimoles per liter) are as follows.

Species	Intracellular	Extracellular
Na^+	12	145
K^+	155	4
Cl^-	4	120

Assuming room temperature (20 °C) and typical values of permeability coefficient for the frog skeletal muscle ($P_{Na} = 2*10^{-8}$ cm/s, $P_k = 2*10^{-6}$ cm/s, and $P_{Cl} = 4*10^{-6}$ cm/s), **calculate** the equilibrium resting potential for this membrane, **using the Goldman equation.** [R=8.314 J $K^{-1}mol^{-1}$, F= 96.485 C/mol] **(5 Mark)**

5- If the total partition function for the N number of distinguishable Maxwell particles is

$$Z_N = (Z_{sp})^N = V^N \left(\frac{2\pi m}{\beta h^2}\right)^{3N/2}$$

a) From the definition of Helmholtz free energy find the general equation for an ideal gas.

b) From the definition internal energy for an ideal gas find the law of equal distribution of energy over freedom degrees.

6- A system with two particles within volume V. Either particle can exist in any of the three quantum levels with energies, $\varepsilon_1 = 0$, $\varepsilon_2 = 1$, $\varepsilon_3 = 2$. Calculate the partition function if:

a) The particles follow the Maxwell-Boltzmann statistic.

b) The particles follow the Bose-Einstein statistic.

c) The particles follow the Fermi-Dirac statistic.

7- Using the following equation, find the distribution function of the Bose-Einstein statistic if the number of cells and particles is large.

$$\Omega_{BE} = \prod_j \frac{(n_j + g_j - 1)!}{n_j!\,(g_j - 1)!}$$

Hint:

1- $\delta\left(ln\left(\frac{x+a}{x}\right)\right) = \frac{-a}{x(x+a)}$ and $\delta\left(ln\left(\frac{x+a}{a}\right)\right) = \frac{1}{(x+a)}$

2- The number of cells and particles is large so put $n_j + g_j - 1 \approx n_j + g_j$ after using Lagrange coefficients equation.

End of Questions

Good Luck

Dr. Hadeer El-Hawary

Second question: Answer ONLY SIX of the following (five degrees each)

1- A simple system consisting of six particles N = 6 and levels given by:

$$\varepsilon_i = i \times 10^{-20}\, J, \quad i = 0, 1, 2, 3, 4$$

If we can arrange the particles to fulfill the condition that the total energy $U = 4 \times 10^{-20}\, J$, calculate the number of microscopic states that satisfy these conditions. Find the distribution that reduces the Helmholtz free energy at room temperature (298.1 K).

2- From the classical Maxwell-Boltzmann statistical distribution equation,

$$n_i = N\frac{e^{-\beta\varepsilon_i}}{Z_{sp}}$$

Prove that:

$$S = k_B\left[N\ln(Z_{sp}) + U\beta\right]$$

3- An ideal system, to which Maxwell-Boltzmann's statistic applies, consists of two identical and distinguishable particles in a vessel of size V. Each particle can exist in energy levels 0, 1ε, 2ε and $g_1 = 2, g_2 = 1, g_3 = 1$. Calculate:

a) The total number of microstates,

b) Partition function,

c) Mean energy.

4- A system consisting of three energy levels: $\varepsilon_1 = 0,\ \varepsilon_2 = 100\, k_B,\ \varepsilon_3 = 200\, k_B$ and $g_1 = 1,\ \ g_2 = 3,\ \ g_3 = 5$ at temperature T=100 K, Calculate:

a) The partition function.

b) Relative population for each level.

c) Average energy.

Assiut University
Faculty of Science
Department of Physics
Summer semester 2024-2025
Date: 27/08/2025

Physics Program (Level 3)
Course: Statistical Physics
Code: P313
Final Exam (50 Marks)
Time: 3 hours

The final exam is in 4 pages (50 degree)

First question: Choose the correct answer (One degree for each point)

1) An electron is bound in one-dimensional infinite well of width $L = 6 \times 10^{-10} m$. Find the energy value in the second excited state.			
A. 632 eV	B. 0.632 eV	C. 1422 eV	D. 1.422 eV
2) The equations of motion for a body in phase space (p, q) is called a ……..			
A. ellipse	B. phase space	C. biaxial plane	D. canonical equation
3) An electron is confined to a one-dimensional potential box. The distance between energy levels of the second excited state and third excited state is ….			
A. $5\,E_1$	B. $7\,E_1$	C. $9\,E_1$	D. $16\,E_1$
4) What is the value of the entropy of the unit moles of the system state (4,3,2,1,0)?			
A. $0.785 JK^{-1}mol^{-1}$	B. $78.5 JK^{-1}mol^{-1}$	C. $785 JK^{-1}mol^{-1}$	D. $7.85 JK^{-1}mol^{-1}$
5) The relationship between the partition function of the total indistinguishable particles Z_N and the partition function of the single particle of Z_{sp} is given by:			
A. $Z_N = Z_{sp}/N!$	B. $Z_N = (Z_{sp})^N/N!$	C. $Z_N = (Z_{sp})^N$	D. $Z_N = Z_{sp}/N$
6) "Arrangement of distinguishable particles during a defined state of the system" is the definition of …			
A. microstate	B. macrostate	C. system state	D. probability
7) The number of total microstates at $T \to 0$ is …			
A. 0	B. 1	C. < 1	D. $\gg 1$
8) Which relation is true ?			
A. $\Omega_{total} = \Omega_1 \times \Omega_2$	B. $S_{total} = S_1 \times S_2$	C. $\Omega_{total} = \Omega_1 + \Omega_2$	D. $S_{total} = S_1 - S_2$
9) The e^{α} coefficient in classic Maxwell-Boltzmann statistical distribution is a function of ….			
A. volume	B. temperature	C. Both A &B	D. None of mentioned
10) The classical mechanics becomes appropriate at ….			
A. low density gas	B. low temperature	C. light molecule mass	D. All of mentioned
11) The adiabatic relation between pressure and temperature of gas is…..			
A. $P^{1-\gamma}T^{\gamma} = Const.$	B. $P^{\gamma-1}T^{\gamma} = Const.$	C. $P^{1+\gamma}T^{\gamma} = Const.$	D. $P^{\gamma+1}T = Const.$

12) A diatomic gas trapped in a cylinder with a moving piston. In the initial case it was $T_i = 450\,K$, $P_i = 6\,atm$, $V_i = 2\,m^3$, If the gas is adiabatic expanded to pressure $P = 3\,atm$, calculate the work, W=...

A. $539\,kJ$	B. $5.4\,kJ$	C. $187 kJ$	D. $4.36\,kJ$

13) An ice cube of mass 200 g has a temperature of -15 °C dropped in a lake of water at a temperature of 15 °C. Calculate the change in entropy of the ice cube when the system reaches thermal equilibrium.

A. 15.9 J/K	B. 314 J/K	C. 298 J/K	D. 152.9 J/K

14) Calculate the wavelength associated with an electron with energy 2500 eV.

A. $2.5 \times 10^{-11} nm$	B. $2.7 \times 10^{-11}\,nm$	C. $0.0246\,nm$	D. $0.0275\,nm$

15) A particle moves inside a three-dimensional box (L_x, L_y, L_z) ,where $(L_x = L_y = L_z = L)$, and (n_x, n_y, n_z) takes the values (4,2,4). What is the degenerate degree value?

A. 1	B. 3	C. 4	D. 6

16) From the first law of thermodynamics equation $dU = TdS - PdV$, for ideal gas. Using Maxwell's relations, what is the value of $(\frac{\partial U}{\partial V})_T$?

A. nRT	B. nC_V	C. $T\frac{nR}{V}$	D. Zero

17) An electron is confined to a one-dimensional potential box of length L from original point. The potential is the maximum at $x = \cdots$

A. L	B. $L/2$	C. $L/3$	D. $L/4$

18) Which of the following has the greatest energy, while (n_x, n_y, n_z) equal to...

A. (6,3,2)	B. (4,4,2)	C. (5,4,3)	D. (4,4,4)

19) What is the number of microstates of the system state (2,3,2,4,1)?

A. 5405400	B. 368600	C. 151351200	D. 1300230

20) The real probability of the system state (2,3,2,4,1) is ....

A. 2.3	B. 1.69	C. 0.31	D. 23

Plank's constant (h)	$6.626 \times 10^{-34}\,J.s$	Boltzmann's constant (k_B)	$1.38 \times 10^{-23}\,JK^{-1}$
Electron mass (m_e)	$9.1 \times 10^{-31} kg$	Universal gas constant (R)	$8.314 J/mol.K$
Electron charge (e)	$1.6 \times 10^{-19} C$	Avogadro's number	6.022×10^{-23}
The specific heat capacity of a gas at constant pressure diatomic ideal gas	$\left(\frac{7}{2}\right) R \quad J/mol.K$	The specific heat capacity of a gas at constant volume diatomic ideal gas	$\left(\frac{5}{2}\right) R \quad J/mol.K$
The specific heat of ice	$2220 J/kg\,K$	The specific heat of water	$4190 J/kg\,K$
		Latent heat of ice	$333\,kJ/kg$