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Application No:
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Exam Date: **06-Oct-2020**
Exam Time: **15:00-18:00**
Examination: **1. Course Code - M.A./M.Sc./M.C.A.**
2. Field of Study - PHYSICS (SPSM)

SECTION 1 - SECTION 1

Question No.1 (Question Id - 2)
What is the decimal value of binary 1011.11 ?
(A) ◯ 14.50
(B) ◯ **11.75 (Correct Answer)**
(C) ◯ 16.25
(D) ◯ 9.25

Question No.2 (Question Id - 14)
An ideal gas is kept at constant pressure 'P'. The root mean square speed V_{rms} of the gas is doubled by heating at constant volume. Calculate the pressure of the ideal gas after heating.

(A) ◯ 2P
(B) ◯ **4P (Correct Answer)**
(C) ◯ 6P
(D) ◯ 8P

Question No.3 (Question Id - 42)
The convex surface of a plano-convex glass lens with curvature radius 40 cm comes into contact with a glass plate. A certain ring observed in reflected light has a radius 2.5 mm. Watching the given ring, the lense was gradually removed from the plate by distance of 5 μm. What has the radius of that ring become equal to ?

(A) ◯ 6.00 mm
(B) ◯ 4.50 mm
(C) ◯ 3.00 mm
(D) ◯ **1.50 mm (Correct Answer)**

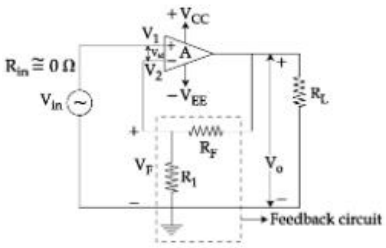
Question No.4 (Question Id - 18)
How much heat must be absorbed by ice of mass m = 700 gm at -15°C to take it to the liquid state at 10°C ?
Given parameters.
Specific heat of ice(-15°C) = 2220 J/kg.K
water = 4187 J/kg.K
Heat of fusion of water 333 kJ/kg.
(A) ◯ 233 kJ Approx
(B) ◯ 30 kJ Approx
(C) ◯ **286 kJ Approx (Correct Answer)**
(D) ◯ 256 kJ Approx

Question No.5 (Question Id - 36)
The resistance of a semiconductor decreases on heating. This is because :

(A) ◯ the material becomes harder on heating.
(B) ◯ parallel channels of current flow become available.
(C) ◯ **more electrons become available for conduction. (Correct Answer)**
(D) ◯ the effective mass of an electron reduces on heating.

Case Study - 6 to 8 (Question Id - 45)

The 741C op-amp having the following parameters is connected as a non-inverting amplifier (figure 1) with R_1 = 1 kΩ and R_F = 20 kΩ ;
Open loop voltage gain (A) = 2×10^5
Open loop resistance of the op-amp = 2 MΩ
Supply voltage = ±15 V
Output voltage swing = ±13 V



Question No.6 (Question Id - 46)
The value of closed loop voltage gain (A_F) is :

(A) ○ **20.99 (Correct Answer)**
(B) ○ 30.11
(C) ○ 60.33
(D) ○ 90.66

Question No.7 (Question Id - 47)
What is the value of input resistance of the op-amp with feedback (R_{iF}) ?

(A) ○ 16.5 MΩ
(B) ○ **19.0 GΩ (Correct Answer)**
(C) ○ 96 GΩ
(D) ○ 133 GΩ

Question No.8 (Question Id - 48)
Total output offset voltage with feedback (V_{OOT}) is :

(A) ○ ± 7.15 mV
(B) ○ ± 71.5 mV
(C) ○ **± 1.36 mV (Correct Answer)**
(D) ○ ± 715 mV

Question No.9 (Question Id - 3)

The eigen value of the orthogonal matrix $B = \frac{1}{6}\begin{bmatrix} 1 & 2 & 2 \\ 2 & 1 & -2 \\ 2 & -2 & 1 \end{bmatrix}$ is :

(A) ○ 4, 4, -4
(B) ○ 3/2, 3/2, -3/2
(C) ○ 2, 2, -2
(D) ○ **1/2, 1/2, -1/2 (Correct Answer)**

Question No.10 (Question Id - 19)
Let's take a carnot engine that operates between the boiling and freezing points of water. The engine performs 1200 J of work per cycle in 0.5 sec. Find the energy delivered as heat to the low temperature reservoir energy cycle.

(A) ○ 1200 J approx.
(B) ○ 3377 J approx.
(C) ○ 4477 J approx.
(D) ○ **3277 J approx. (Correct Answer)**

Question No.11 (Question Id - 16)

A steel wire of original diameter 20.0 mm is subject to a tensile load up to fructure. Its diameter at fructure is 16.0 mm. Find its ductility.

(A) ○ 40%
(B) ○ **36% (Correct Answer)**
(C) ○ 32%
(D) ○ 28%

Question No.12 (Question Id - 21)

A sphere of radius R carries polarization $\vec{P}(r) = k\vec{r}$ where k is constant and r is vector from centre. What would be the volume bound charge density of sphere ?

(A) ○ $3kr^2$
(B) ○ **-3k (Correct Answer)**
(C) ○ $-\frac{k}{r^2}$
(D) ○ $\frac{\pi k}{4} R^4$

Question No.13 (Question Id - 13)

If W_1 is the work done by an ideal gas at constant temperature 'T' to expand from a volume V_1 to a volume $2V_1$. Let W_2 be the work done by the same ideal gas at the same temperature to expand from V_2 to $4V_2$. Calculate the ratio W_2/W_1 ?

(A) ○ 1
(B) ○ **2 (Correct Answer)**
(C) ○ 3
(D) ○ 4

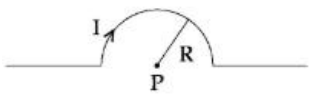
Question No.14 (Question Id - 20)

Let's assume that water is flowing with speed of 12 cm/sec through a horizontally placed tube of radius 2 cm. Find the speed of water flow under similar conditions, in case the radius of tube is doubled.

(A) ○ 2 cm/sec
(B) ○ **3 cm/sec (Correct Answer)**
(C) ○ 12 cm/sec
(D) ○ 6 cm/sec

Question No.15 (Question Id - 25)

Calculate magnetic field at centre P of a semi-circle carrying current I and radius R.



(A) ○ $\frac{\mu_0 I}{2R}\left[\frac{1}{2}+\frac{1}{\pi}\right]$
(B) ○ $\frac{\mu_0 I}{2\pi R}$
(C) ○ $\boxed{\frac{\mu_0 I}{4R}}$ **(Correct Answer)**

(D) ○ $\frac{\mu_0 I}{\pi R}$

Question No.16 (Question Id - 43)

In Michelson's interferometer the light source composed of two wavelengths 600 nm and 600.6 nm. In the process of translational displacement of one of the mirrors the interference pattern vanished periodically. Find out the displacement of the mirror between two successive appearances of the sharpest pattern.

(A) ○ 30 mm
(B) ○ 3 mm
(C) ○ **0.3 mm (Correct Answer)**
(D) ○ 0.03 mm

Question No.17 (Question Id - 10)

Ultraviolet light of wavelength 350 nm and intensity 1.00 W/m^2 is directed at a potassium surface. Find the maximum kinetic energy of the photoelectrons. ($h = 6.62 \times 10^{-34}$ J.s and work function of potassium = 2.5 eV)

(A) ○ 0.3 eV
(B) ○ **1.0 eV (Correct Answer)**
(C) ○ 3.3 eV
(D) ○ 7.1 eV

Question No.18 (Question Id - 24)

Let's take a black total absorbing piece of cardboard of area A = 2.00 cm^2, which intercepts light with an intensity of 24 W/m^2 from sunlight.
Find the radiation pressure produced on the cardboard by the light.

(A) ○ 3×10^8 N/m^2
(B) ○ **8×10^{-8} N/m^2 (Correct Answer)**
(C) ○ 3×10^{-8} N/m^2
(D) ○ 8×10^8 N/m^2

Question No.19 (Question Id - 33)

An ideal gas undergoes an isothermal expansion (at temperature T) from volume V_1 to V_2. The entropy change per mole is :

(A) ○ $R\left(\frac{V_2}{V_1}\right)$
(B) ○ $R\left(\frac{V_1}{V_2}\right)$
(C) ○ $R \ln\left(\frac{V_2}{V_1}\right)$ **(Correct Answer)**
(D) ○ $R \ln\left(\frac{V_1}{V_2}\right)$

Question No.20 (Question Id - 35)

An electron gas is confined in a box of volume V. The number of electrons is N. The Fermi energy E_F at T = 0 K obeys :

(A) ○ $E_F \propto \left(\frac{N}{V}\right)^{1/3}$
(B) ○ $E_F \propto \left(\frac{N}{V}\right)^{2/3}$ **(Correct Answer)**
(C) ○

(D) ○ $E_F \propto \frac{N^{2/3}}{V^{1/3}}$

Question No.21 (Question Id - 8)

Consider an ideal gas at pressure P_1 and volume V_1 undergoing free expansion to volume $2V_1$. Then the gas is adiabatically expanded to a volume $16V_1$. Calculate the final pressure of the gas.

(A) ○ P_1

(B) ○ $\frac{P_1}{4}$

(C) ○ $\frac{P_1}{16}$

(D) ○ $\frac{P_1}{64}$ **(Correct Answer)**

Question No.22 (Question Id - 32)

A gas of particles obeys the Maxwell-Boltzmann distribution. The value of the average speed $< v >$ is :

(A) ○ $\sqrt{3}\sqrt{\frac{kT}{m}}$

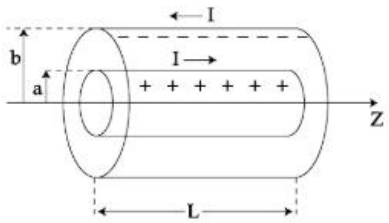
(B) ○ $\sqrt{\frac{kT}{m}}$

(C) ○ $\frac{2\sqrt{2}}{\sqrt{\pi}}\sqrt{\frac{kT}{m}}$ **(Correct Answer)**

(D) ○ $\frac{\sqrt{6}}{\sqrt{\pi}}\sqrt{\frac{kT}{m}}$

Case Study - 23 to 25 (Question Id - 49)

A long coaxial cable of Length 'L' consists of an inner conductor (radius a) and outer conductor (radius b). The inner conductor carries a uniform charge per unit length λ and a steady current I. The outer conductor has opposite charge and current as shown in following figure.



Question No.23 (Question Id - 50)

Find the total magnetic energy stored between the inner and outer conductor.

(A) ○ $\frac{\mu_0 I^2}{4\pi}\ln\left(\frac{b}{a}\right)$

(B) ○ $\frac{\mu_0^2 I^2 L}{2\pi}\ln\left(\frac{b}{a}\right)$

(C) ○ $\frac{\mu_0 I^2 L}{4\pi}\ln\left(\frac{b}{a}\right)$ **(Correct Answer)**

(D) ○ $\frac{\mu_0^2 I^2}{4\pi}L$

Question No.24 (Question Id - 51)

Find the electric field at any point r between the inner and outer conductor.

(A) ○ $\frac{\lambda}{2\pi r L \epsilon_0}$

(B) ○ $\frac{\lambda}{2\pi r \epsilon_0}$ **(Correct Answer)**

(C) ○ $\frac{\lambda}{4\pi\epsilon_0 r^2}$

(D) ○ $\frac{\pi\lambda a L}{4\epsilon_0 r^2}$

Question No.25 (Question Id - 52)

Calculate the energy transported by these magnetic and electric fields per unit time, per unit area at the surface of inner conductor.

(A) ○ $\frac{\lambda^2}{8\pi^2 a^2 \epsilon_0}$

(B) ○ $\frac{\mu_0 I\lambda}{4\pi^2 a^2 \epsilon_0}$

(C) ○ $\frac{\lambda}{I\,\mu_0^2 \epsilon_0}$

(D) ○ $\frac{I\lambda}{4\pi^2 a^2 \epsilon_0}$ **(Correct Answer)**

Question No.26 (Question Id - 31)

For a magnet, C_h and C_M are the specific heats at constant magnetic field (h) and magnetization (M), respectively. Which of the following statements is correct ?

(A) ○ **$C_h \geq C_M$ (Correct Answer)**

(B) ○ $C_h = C_M$

(C) ○ $C_h \leq C_M$

(D) ○ C_h may be greater or less than C_M, depending on the material.

Question No.27 (Question Id - 9)

In a one-dimensional infinite square well of length 'a', there are 6×10^9 electrons per meter. If all the lowest energy levels are filled, determine the energy of the most energetic electron.

($h = 4.136 \times 10^{-15}$ eV.s, $C = 3\times10^8$m/s, $m_e = 9.1\times10^{-31}$kg)

(A) ○ **3.38 eV (Correct Answer)**

(B) ○ 13.25 eV

(C) ○ 21.05 eV

(D) ○ 27.28 eV

Question No.28 (Question Id - 22)

Suppose a long wire of radius 'R' carries uniformly distributed current I. Find the magnetic field at point 'r' inside the wire.

(A) ○ $\frac{\mu_0 I}{2\pi R}$

(B) ○ $\frac{\mu_0 I}{2\pi r}$

(C) ○ $\frac{\mu_0 I r^2}{R^2}$

(D) ○

$\frac{\mu_0 Ir}{2\pi R^2}$ **(Correct Answer)**

Question No.29 (Question Id - 44)

A source of sonic oscillations with frequency 1700 Hz and a receiver is located on the same normal to a wall. Both the source and receiver are stationary, and the wall recedes from the source with velocity 6.0 cm/s. Find out the beat frequency registered by the receiver. The velocity of sound is 340 m/s.

(A) ○ **0.6 Hz (Correct Answer)**
(B) ○ 1.2 Hz
(C) ○ 1.8 Hz
(D) ○ 2.4 Hz

Question No.30 (Question Id - 38)

Determine $\vec{\nabla}.\left(\frac{\vec{r}}{r^n}\right)$, n>0 and $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$.

(A) ○ $\frac{3-n}{r^{\frac{n}{2}}}$
(B) ○ $\frac{3-n}{r^n}$ **(Correct Answer)**
(C) ○ $\frac{n-3}{r}$
(D) ○ $\frac{n-3}{r^{\frac{n}{2}}}$

Question No.31 (Question Id - 4)

A 24 V, 600 mW zener diode is to be used for providing a 24 V stabilized supply to a variable load. If input voltage is 32 V, calculate the series resistance R required and diode current when load resistance is 12000 Ω.

(A) ○ **320 Ω and 23 mA (Correct Answer)**
(B) ○ 650 Ω and 15 mA
(C) ○ 900 Ω and 2 mA
(D) ○ 1200 Ω and 8 mA

Question No.32 (Question Id - 5)

What will be the cohesive energy of copper (FCC), given the bond energy between two copper atoms is 56.8 kJ/mol ?

(A) ○ 92.6 kJ/mol
(B) ○ 112.5 kJ/mol
(C) ○ **340.8 kJ/mol (Correct Answer)**
(D) ○ 693.2 kJ/mol

Question No.33 (Question Id - 30)

A physical pendulum performs small oscillations about the horizontal axis with frequency ω_1 = 15.0 sec^{-1}. When a small mass m = 100 gram is fixed to the pendulum at a distance l = 20 cm below the axis, the oscillation frequency becomes equal to ω_2 = 10.0 sec^{-1}. Find out the moment of inertia (I) of the pendulum relative to the oscillation axis.
(where acceleration of gravity g =10 m/sec^2)

(A) ○ 0.80 $gram.m^2$
(B) ○ **1.60 $gram.m^2$ (Correct Answer)**
(C) ○ 2.40 $gram.m^2$
(D) ○ 3.20 $gram.m^2$

Question No.34 (Question Id - 34)

Consider the phase diagram of water in the pressure-temperature plane. Which of the following statements is **false** ?

(A) ○ It is possible to directly convert water vapour to ice.

(B) ○ It is possible to convert water vapour to water without a phase transition.

(C) ○ The triple point corresponds to the coexistence of three phases.

(D) ○ **All phase transitions are characterized by a latent heat. (Correct Answer)**

Question No.35 (Question Id - 23)

An electric field in free space is given by $\vec{E} = 100\cos(10^8 t + kx)\hat{e}_y$. Find the wavelength of propagating wave.

(A) ○ 10^8

(B) ○ 2π

(C) ○ $\frac{1}{3}$

(D) ○ **6π (Correct Answer)**

Question No.36 (Question Id - 17)

Calculate the maximum frequency of vibration in a one-dimensional lattice of identical atoms of mass 9.0×10^{-26} kg. If force constant of nearest neighbour interaction is 100 N/m.

(A) ○ 10.61×10^{10} Hz

(B) ○ **10.61×10^{12} Hz (Correct Answer)**

(C) ○ 10.61×10^{14} Hz

(D) ○ 10.61×10^{16} Hz

Question No.37 (Question Id - 6)

The wave functions of electrons in a one-dimensional potential box of dimension is given by $\Psi_n = A\sin\left(\frac{n\pi}{a}\right)x$

where n=1, 2, 3, ...

The value of A by normalizing the wave function to unity is :

(A) ○ $\sqrt{\frac{4}{a}}$

(B) ○ $\sqrt{\frac{2}{a}}$ **(Correct Answer)**

(C) ○ $\sqrt{\frac{a}{4}}$

(D) ○ $\sqrt{\frac{a}{2}}$

Question No.38 (Question Id - 28)

Find the unit normal to the surface defined by $xy^3z^2 = 4$ at (-1, -1, 2).

(A) ○ $-4i - 12j + 4k$

(B) ○ $\frac{-1}{\sqrt{11}}\left(\hat{i} + 3\hat{j} - \hat{k}\right)$ **(Correct Answer)**

(C) ○ $4i + 4j + 4k$

(D) ○ $-i + 3j + k$

Question No.39 (Question Id - 11)

A material whose K absorption edge is 0.15 Å is irradiated with 0.08 Å X-rays. What is the maximum

kinetic energy of photoelectrons that are emitted from the K shell ?
(h = 4.136 x 10^{-15} eV.s)

(A) ○ 11.3 keV
(B) ○ 25.3 keV
(C) ○ **72.3 keV (Correct Answer)**
(D) ○ 81.3 keV

Question No.40 (Question Id - 39)

If $x = \sqrt{-1}$, what is the value of x^{2x} ?

(A) ○ $\frac{\pi}{e^2}$
(B) ○ e^{π}
(C) ○ $e^{-\pi/2}$
(D) ○ **$e^{-\pi}$ (Correct Answer)**

Question No.41 (Question Id - 7)

The resistivity of Si at 300 K is 3.16 x 10^3 ohm-m. The mobility of electrons and holes in Si are 0.14 m^2/V-sec and 0.06 m^2/V-sec respectively. The intrinsic carrier density is :

(A) ○ 0.05 x $10^{19}/m^3$
(B) ○ **1.00 x $10^{16}/m^3$ (Correct Answer)**
(C) ○ 4.01 x $10^{13}/m^3$
(D) ○ 6.02 x $10^{12}/m^3$

Question No.42 (Question Id - 12)

In a Compton experiment an electron attains a kinetic energy of 0.200 MeV when an X-ray of energy 0.500 MeV strikes it. Determine the wavelength of the scattered photon if the electron is initially at rest.
(h = 4.136 x 10^{-15} eV.s)

(A) ○ 9 x 10^{-12} Å
(B) ○ 21 x 10^{-9} Å
(C) ○ 43 x 10^{-6} Å
(D) ○ **41 x 10^{-3} Å (Correct Answer)**

Question No.43 (Question Id - 37)

In a photoelectric experiment, light of wavelength 700 nm is incident on a metal of work function 2 eV. The maximum kinetic energy of emitted photoelectrons is :

(A) ○ 1 eV
(B) ○ 0.66 eV
(C) ○ 0.33 eV
(D) ○ **There is no photo-emission (Correct Answer)**

Question No.44 (Question Id - 27)

Suppose in a sphere, the electric field inside at some point r is found to be $\vec{E} = kr^2 \hat{r}$ where k is constant. Find the charge density ρ.

(A) ○ 2 $k\epsilon_0 r$
(B) ○ 4 $k\epsilon_0 r^3$
(C) ○ **4 $k\epsilon_0 r$ (Correct Answer)**
(D) ○ $\frac{3k}{4\pi}\frac{1}{r}$

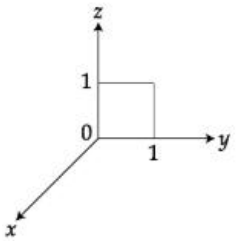
Question No.45 (Question Id - 15)

In a pure macroscopic, perfect crystal the major contribution to thermal resistance at normal temperature is from :

(A) ○ Boundary scattering
(B) ○ **Umklapp process (Correct Answer)**
(C) ○ Impurity scattering
(D) ○ Harmonic vibration of lattice atom

Question No.46 (Question Id - 29)

Suppose there is a vector $\vec{v}=4yz\hat{y}+(3xy+2z^2)\hat{z}$. Calculate $\int(\bar{\nabla}\times\bar{v}).d\vec{a}$ for given square surface area in following figure. The $d\vec{a}$ is elementary surface area with direction along $+x$ axis.



(A) ○ **-2 (Correct Answer)**
(B) ○ 3*x*-2
(C) ○ $-\frac{1}{2}$
(D) ○ -7

Question No.47 (Question Id - 1)

Boolean function Y=(A+B)(A'(B'+C'))'+A'(B+C). What is the simplified form of Y ?

(A) ○ **A+B+C (Correct Answer)**
(B) ○ (A'+B'+C')
(C) ○ (AB+BC+AC)
(D) ○ ABC

Question No.48 (Question Id - 40)

The Laplace transform of $\cos^2 t$ is :

(A) ○ $\frac{1}{2}\left[\frac{s^2}{s^2+4}+\frac{1}{2}\right]$
(B) ○ $\frac{1}{2}\left[\frac{s}{s^2+4}+\frac{1}{s}\right]$ **(Correct Answer)**
(C) ○ $\left[\frac{2}{s^2+4}+\frac{1}{2}\right]$
(D) ○ $\left[\frac{s^2}{s^2+4}+\frac{1}{s}\right]$

Question No.49 (Question Id - 41)

Let's take three vectors

$\vec{A} = 6\hat{i} + 4\hat{j} + \hat{k}$

$\vec{B} = \hat{i} + 4\hat{j} + 2\hat{k}$

$\vec{C} = 7\hat{i} + X\hat{j} + 3\hat{k}$

Find the value of 'X' when these vectors are co-planar.

(A) ○ 7

(B) ○ **8 (Correct Answer)**

(C) ○ 6

(D) ○ 9

Question No.50 (Question Id - 26)

Find the electric field inside a solid sphere which carries a charge density proportional to the distance from its origin, ρ = kr where k is constant.

(A) ○ $\frac{\pi k r^4}{\epsilon_0}$

(B) ○ $\boxed{\frac{kr^2}{4\epsilon_0}}$ **(Correct Answer)**

(C) ○ $\frac{kr^2}{3\epsilon_0}$

(D) ○ $\frac{k}{4\pi\epsilon_0 r}$

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