# MIZORAM PUBLIC SERVICE COMMISSION

## COMPETITIVE EXAMINATIONS FOR RECRUITMENT TO THE POST OF INSPECTOR OF LEGAL METROLOGY UNDER FOOD, CIVIL SUPPLIES & CONSUMER AFFAIRS DEPARTMENT, GOVERNMENT OF MIZORAM, DECEMBER, 2018

## PHYSICS

## PAPER - II

Time Allowed : 2 hours Full Marks : 200

*All questions carry equal marks of two (2) each.*
*Attempt all questions.*

**1.** A cylinder of radius $R$ and length $L$ is placed in a uniform electric field $E$ parallel to the cylinder axis. The total flux for the surface of the cylinder is given by

(a) $2\pi R^2 E$ (b) $\pi R^2 E$

(c) $\pi R^2 L$ (d) Zero

**2.** Electric field at a point is independent of distance from the charge for

(a) A point charge (b) An electric dipole

(c) A line charge of infinite length (d) A plane infinite sheet of charge

**3.** Total electric flux coming out of a unit positive charge put in air is

(a) $\varepsilon_o$ (b) $4\pi\varepsilon_o$

(c) $(4\pi\varepsilon_o)^{-1}$ (d) $\varepsilon_o^{-1}$

**4.** S.I. unit of electric flux is

(a) Volt × metre (b) Joule per coulomb

(c) Newton per coulomb (d) Weber

**5.** A sphere of radius R has a uniform distribution of electric charge in its volume. At a distance $x$ from its centre $(x < R)$, the electric field is directly proportional to

(a) $x$ (b) $\frac{1}{x}$

(c) $\frac{1}{x^2}$ (d) $x^2$

**6.** The electric field due to an infinite cylinder of radius $R$ and having charge $Q$ per unit length at a distance $r(r < R)$ from its axis is

(a) $\propto r$ (b) $\propto r^2$

(c) $\propto r^3$ (d) $\propto r^{-1}$

**7.** A parallel plate capacitor is immersed in an oil of dielectric constant 3. The field between the plates is

(a) Increased proportional to $\sqrt{3}$ (b) Decreased proportional to $\frac{1}{\sqrt{3}}$

(c) Increased proportional to 3 (d) Decreased proportional to $\frac{1}{3}$

**8.** The capacity of a parallel plate capacitor is *C*. Its capacity when the separation between the plates is halved will be

(a) $2C$ (b) $\frac{C}{2}$

(c) $\frac{C}{4}$ (d) remains unaffected

**9.** The respective radii of the two spheres of a spherical condenser are 3 cm and 1 cm. The dielectric constant of the medium between them is 2. The capacity of the condenser will be

(a) 24 *pF* (b) 240 *pF*

(b) 13.3 *pF* (d) 133.3 *pF*

**10.** One plate of parallel plate capacitor is smaller than other, then charge on smaller plate will be

(a) Less than other

(b) More than other

(c) Equal to other

(d) Will depend upon the medium between them

**11.** A parallel plate capacitor is made by stacking *n* equally spaced plates connected alternately. If the capacitance between any two plates is *C*, then the resultant capacitance is

(a) *C* (b) *nC*

(c) $(n - 1)C$ (d) $(n + 1)C$

**12.** An alternating *e.m.f.* is applied to purely capacitive circuit. The phase relation between *e.m.f.* and current flowing in the circuit is

(a) *e.m.f.* is ahead of current by p/2 (b) Current is ahead of *e.m.f.* by p/2

(c) Current lags behind *e.m.f.* by p (d) Current is ahead of *e.m.f.* by p

**13.** In a series LCR circuit, resistance R=10W and the impedance Z=20W. The phase difference between the current and the voltage is

(a) $30^o$ (b) $45^o$

(c) $60^o$ (d) $90^o$

**14.** Power factor is maximum in an LCR circuit when
($X_L$ = inductor impedance, $X_C$ = capacitor impedance)

(a) $X_L = X_C$ (b) $X_L = 0$

(c) $X_C = 0$ (d) $X_L = R$

**15.** For high frequency, a capacitor offers

(a) More reactance (b) Less reactance

(c) Zero reactance (d) Infinite reactance

**16.** The direction of induced e.m.f. during electromagnetic induction is given by

(a) Faraday's law (b) Lenz's law

(c) Maxwell's law (d) Ampere's law

**17.** The ratio of intensities of two waves is 1:9. If these waves produce interference, the ratio of maximum to the minimum intensities will be

(a) 1:4 (b) 4:1

(c) 1:3 (d) 3:1

**18.** A point object is placed at the focus $F$ of a double concave lens of focal length $f$. Its image will be formed at a point

(a) Between the point $F$ and the lens

(b) At a distance between $f$ and $2f$ from the lens

(c) At a distance more than $2f$ from the lens

(d) At infinity

**19.** An object of height 1.5 cm is placed on the axis of a convex lens of focal length 25 cm. A real image is formed at a distance of 75 cm from the lens. The size of the image will be

(a) 4 cm (b) 3 cm

(c) 0.4 cm (d) 0.3 cm

**20.** Laser beams are used to measure long distance because

(a) They are monochromatic (b) They are highly polarized

(c) They are coherent (d) They have high degree of parallelism

**21.** As a result of interference of two coherent sources of light, energy is

(a) Increased

(b) Redistributed and the distribution does not vary with time

(c) Decreased

(d) Redistributed and the distribution changes with time

**22.** The path difference for destructive interference is

(a) $n\lambda$ (b) $n(\lambda+1)$

(c) $\frac{(n+1)\lambda}{2}$ (d) $\frac{(2n+1)\lambda}{2}$

**23.** In Young's double slit experiment, if the slit widths are in the ratio 1:9, then the ratio of the intensity at minima to that at maxima will be

(a) 1:1 (b) 1:9

(c) 1:4 (d) 1:3

**24.** In Fresnel's biprism $(\mu = 1.5)$ experiment the distance between source and biprism is $0.3m$ and that between biprism and screen is $0.7m$ and angle of prism is $1^{o}$. The fringe width with light of wavelength $6000\,D$ will be

(a) 1 cm (b) 0.011 cm

(c) 2 cm (d) 4.111 cm

**25.** If Fresnel's biprism experiment is held in water instead of in air, then what will be the effect on fringe width

(a) Decrease (b) Increase

(c) No effect (d) Vanish

**26.** Principle of laser is

(a) Spontaneous emission (b) Stimulated emission

(c) Induced emission (d) Both (b) & (c)

**27.** In the Bohr's hydrogen atom model, the radius of the stationary orbit is directly proportional to ($n$ = principal quantum number)

(a) $n^{-1}$ (b) $n$

(c) $n^{-2}$ (d) $n^2$

**28.** In Thomson's experiment if the value of q/m is the same for all positive ions striking the photographic plate, then the trace would be

(a) Straight line (b) Parabolic

(c) Circular (d) Elliptical

**29.** In Bainbridge mass spectrograph, a potential difference of $1000V$ is applied between two plates distant 1 $cm$ apart and magnetic field of $B$=1$T$. The velocity of undeflected positive ions in m/s from the velocity selector is

(a) $10^7$ m/s (b) $10^4$ m/s

(c) $10^5$ m/s (d) $10^2$m/s

**30.** The energy required to knock out the electron in the third orbit of a hydrogen atom is equal to

(a) $13.6eV$ (b) $\frac{13.6eV}{9}$

(c) $\frac{-13.6eV}{3}$ (d) $\frac{-13.6eV}{27}$

**31.** In any Bohr orbit of the hydrogen atom, the ratio of kinetic energy to potential energy of the electron is

(a) 1/2 (b) -1/2

(c) 2 (d) -2

**32.** Which of the transitions in hydrogen atom emits a photon of lowest frequency ( $n$ = quantum number)

(a) $n = 2$ *to* $n = 1$ (b) $n = 4$ *to* $n = 3$

(c) $n = 3$ *to* $n = 1$ (d) $n = 4$ *to* $n = 1$

**33.** The possible quantum number for 3$d$ electron are

(a) $n=3, l=1, m_l=+1, m_s=-\frac{1}{2}$ (b) $n=3, l=2, m_l=+2, m_s=-\frac{1}{2}$

(c) $n=3, l=1, m_l=-1, m_s=+\frac{1}{2}$ (d) $n=3, l=0, m_l=+1, m_s=-\frac{1}{2}$

**34.** Which of the following is quantized according to Bohr's theory of hydrogen atom

(a) Linear momentum of electron (b) Angular momentum of electron

(c) Linear velocity of electron (d) Angular velocity of electron

**35.** Nuclear binding energy is equivalent to

(a) Mass of proton (b) Mass of neutron

(c) Mass of nucleus (d) Mass defect of nucleus

**36.** Size of nucleus is of the order of

(a) $10^{-10}m$ (b) $10^{-15}m$

(c) $10^{-12}m$ (d) $10^{-19}m$

**37.** One requires energy $E_n$ to remove a nucleon from a nucleus and an energy $E_e$ to remove an electron from the orbit of an atom. Then

(a) $E_n = E_e$ (b) $E_n < E_e$

(c) $E_n > E_e$ (d) $E_n \geq E_e$

**38.** Which of the following pairs is an isobar

(a) ${}_1H^1$ and ${}_1H^2$ (b) ${}_1H^2$ and ${}_1H^3$

(c) ${}_6C^{12}$ and ${}_6C^{13}$ (d) ${}_{15}P^{30}$ and ${}_{14}Si^{30}$

**39.** For a nucleus to be stable, the correct relation between neutron number $N$ and proton number $Z$ is

(a) $N > Z$ (b) N = Z

(c) N < Z (d) N $\geq$ $Z$

**40.** Energy generation in stars is mainly due to

(a) Chemical reactions (b) Fission of heavy nuclei

(c) Fusion of light nuclei (d) Fusion of heavy nuclei

**41.** Fast neutrons can easily be slowed down by

(a) The use of lead shielding (b) Passing them through water

(c) Elastic collisions with heavy nuclei (d) Applying a strong electric field

**42.** Neutrino is a particle, which is

(a) Charged and has spin (b) Charged and has no spin

(c) Charge less and has spin (d) Charge less and has no spin

**43.** If M is the atomic mass and A is the mass number, packing fraction is given by

(a) $\frac{A}{M-A}$ (b) $\frac{M-A}{A}$

(c) $\frac{A-M}{A}$ (d) $\frac{M}{M-A}$

**44.** In a radioactive substance at $t=0$, the number of atoms is $8\times10^4$. Its half life period is 3 years. The number of atoms $1\times10^4$ will remain after interval

(a) 9 years (b) 6 years

(c) 12 years (d) 3 years

**45.** For the principal quantum number $n$, the possible number of electrons is

(a) 2 (b) $(2l + 1)$

(c) $2(2l + 1)$ (d) $2n^2$

**46.** If $m_l$ can have nine different values, $l$ is equal to

(a) 3 (b) 4

(c) 5 (d) 9

**47.** For a crystal system, $a = b = c, \alpha = \beta = \gamma \neq 90^o$, the system is

(a) Tetragonal system
(b) Cubic system
(c) Orthorhombic system
(d) Rhombohedral system

**48.** Potassium has a bcc structure with nearest neighbor distance 4.525 $D$ . Its molecular weight is 39. Its density in $kg/m^3$ is

(a) 907
(b) 494
(c) 600
(d) 200

**49.** In a crystal, the atoms are located at the position of

(a) Maximum potential energy
(b) Minimum potential energy
(c) Zero potential energy
(d) Infinite potential energy

**50.** Crystal structure of NaCl is

(a) FCC
(b) BCC
(c) Both of the above
(d) Simple Cubic

**51.** What is the coordination number of sodium ions in the case of sodium chloride structure?

(a) 6
(b) 8
(c) 4
(d) 12

**52.** Atomic radius of FCC is

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

**53.** The distance between the body centred atom and a corner atom in sodium ($a$ = 4.225 $D$ ) is

(a) 3.66 $D$
(b) 3.17 $D$
(c) 2.99 $D$
(d) 2.54 $D$

**54.** Volume of the primitive cell of reciprocal lattice of BCC is

(a) $2\left(\frac{2\pi}{a}\right)^3$
(b) $4\left(\frac{2\pi}{a}\right)^3$
(c) $8\left(\frac{2\pi}{a}\right)^3$
(d) $\left(\frac{2\pi}{a}\right)^3$

**55.** The first Brillouin zone of a simple cubic lattice is

(a) Rhombic decahedron
(b) Truncated octahedron
(c) Parallelepiped
(d) Cube

**56.** The free electron model of metals based on classical statistics led to semi-quantitative agreement with

(a) Drupe law
(b) Weidman-Franz law
(c) Drupe-Lorentz law
(d) None of these

**57.** In Debye's theory of specific heat of solids, the atomic oscillators obey

(a) MB statistics (b) FD statistics

(c) BE statistics (d) All of these

**58.** The atomic specific heat of a solid is

(a) $3R$ at all temperatures

(b) $3R$ at high temperatures and zero at low temperatures

(c) $3R$ at high temperatures and proportional to $T^3$ at low temperatures

(d) Proportional to $T^3$ at all temperatures

**59.** Reciprocal lattice to BCC lattice is

(a) BCC (b) FCC

(c) Simple Cubic (d) Octahedron

**60.** For a set of direct lattice vectors ***a, b, c*** and their corresponding reciprocal lattice ***a*, b*, c****, which of the following set of relations is true

(a) *a*.a=1 and b*.c=0* (b) *a*.a=1 and b*.b=0*

(c) *a*.c=1 and b*.a=0* (d) *c*.a=0 and b*.b=0*

**61.** According to Einstein's theory of specific heats, the frequency of Einstein's oscillator is ( $\theta_E$ = *Eintstein temperature*)

(a) $\frac{k\theta_E}{h}$ (b) $\frac{k\theta_E}{\hbar}$

(c) $\frac{2k\theta_E}{\hbar}$ (d) $\frac{4k\theta_E}{\hbar}$

**62.** Which of the following statement is false

(a) According to Debye theory, the specific heat is the same as in classical theory at high temperature above Debye temperature

(b) According to Debye theory, at very low temperature the specific heat is directly proportional to $T^3$

(c) Einstein's theory fails to agree with observed experimental data at high temperature

(d) Einstein's theory fails at low temperature

**63.** According to Planck's theory, the average energy of an oscillator having frequency $\nu$ at a temperature $T$ is given by

(a) $\frac{h\nu}{e^{h\nu/kT}-1}$ (b) $\frac{h\nu}{e^{h\nu/kT}+1}$

(c) $\frac{h\nu}{e^{h\nu/2kT}-1}$ (d) $\frac{h\nu}{e^{h\nu/2kT}+1}$

**64.** At low temperatures $T \ll \theta_D$ , Debye temperature, the heat capacity of a monoatomic lattice in one dimension is proportional to

(a) $\frac{T}{\theta_D}$ (b) $\frac{T}{2\theta_D}$

(c) $\frac{T}{5\theta_D}$ (d) $\frac{T}{3\theta_D}$

**65.** According to Eintein's theory, a crystalline body in a state of thermally excited elastic vibration may be treated as a system of $N$ distinguishable independent quantum harmonic oscillators of the same angular frequency $\omega$, the average energy is given by

(a) $\frac{3N\hbar\omega}{e^{-\hbar\omega/kT}-1}$ (b) $\frac{N\hbar\omega}{e^{-\hbar\omega/kT}-1}$

(c) $\frac{N\hbar\omega}{e^{-\hbar\omega/kT}+1}$ (d) $\frac{3N\hbar\omega}{e^{-\hbar\omega/2kT}-1}$

**66.** Reciprocal lattice to FCC lattice is

(a) Rhombohedral (b) Simple cubic

(c) BCC (d) Truncated octahedron

**67.** The packing in HCP structure is

(a) ABCABC (b) ABABAB

(c) ACACAC (d) ACBACB

**68.** The number of atoms per unit cell in a cubic diamond is

(a) 4 (b) 6

(c) 7 (d) 8

**69.** If c = the velocity of light, which of the following is correct?

(a) $\mu_o\varepsilon_o = c$ (b) $\mu_o\varepsilon_o = c^2$

(c) $\mu_o\varepsilon_o = \frac{1}{c}$ (d) $\mu_o\varepsilon_o = \frac{1}{c^2}$

**70.** A vertical wire carries a current upwards. The magnetic field at a point due north of the wire is directed

(a) upward (b) due south

(c) due west (d) due east

**71.** A long straight conductor carrying a current lies along the axis of a ring. The conductor will exert a force on the ring if the ring

(a) carries a current (b) has uniformly distributed charge

(c) has non-uniformly distributed charge (d) none of the above

**72.** A flat coil of *n* turns, area A and carrying a current *i* is placed in a uniform magnetic field of magnitude B. The plane of the coil makes an angle $\theta$ with the direction of the field. The torque acting on the coil is

(a) $BinA\sin\theta$ (b) $\frac{nAi}{B}\sin\theta$

(c) $BinA\cos\theta$ (d) $Bin^2A\cos\theta$

**73.** A converging lens forms a real image I on its optic axis. A rectangular glass slab of refractive index $\mu$ and thickness *t* is introduced between the lens and I. I will move

(a) away from the lens by $t(\mu-1)$ (b) towards the lens by $t(\mu-1)$

(c) away from the lens by $t(1-\frac{1}{\mu})$ (d) towards the lens by $t(1-\frac{1}{\mu})$

**74.** A ray of light incident on a slab of transparent material is partly reflected from the surface and partly refracted into the slab. The reflected and refracted rays are mutually perpendicular. The incident ray makes an angle $i$ with the normal to the slab. The refractive index of the slab is

(a) $\tan^{-1}(i)$ (b) $\cot^{-1}(i)$

(c) $\sin^{-1}(i)$ (d) $\cos^{-1}(i)$

**75.** A ray of light travels from an optically denser to rarer medium. The critical angle for the two media is $c$. The maximum possible deviation of the ray will be

(a) $\pi - c$ (b) $\pi - 2c$

(c) $2c$ (d) $\frac{\pi}{2} + c$

**76.** The light reflected by a plane mirror may form a real image,

(a) if the rays incident on the mirror are converging

(b) if the rays incident on the mirror are diverging

(c) if the object is placed very close to the mirror

(d) under no circumstances

**77.** An air bubble is inside water. The refractive index of water is 4/3. At what distance from the air bubble should a point object be placed so as to form a real image at the same distance from the bubble?

(a) $2R$ (b) $3R$

(c) $4R$ (d) The air bubble cannot form a real image

**78.** A thin lens of refractive index 1.5 has a focal length of 15 cm in air. When the lens is placed in a medium of refractive index 4/3, its focal length will become

(a) 30 cm (b) 45 cm

(c) 60 cm (d) 75 cm

**79.** A convex lens of focal length 40 cm, a concave lens of focal length 40 cm and a concave lens of focal length 15 cm are placed in contact. The power of this combination in diopters is

(a) +1.5 (b) -1.5

(c) +6.67 (d) -6.67

**80.** A boy of height 1 m stands in front of a convex mirror. His distance from the mirror is equal to its focal length. The height of his image is

(a) 0.25 m (b) 0.33 m

(c) 0.5 m (d) 0.67 m

**81.** A ray of light is incident normally on one of the faces of an equilateral prism of refractive index 1.5. The angle of deviation is

(a) $30^0$ (b) $45^0$

(c) $60^0$ (d) $75^0$

**82.** In a compound microscope, maximum magnification is obtained when the final image

(a) is formed at infinity

(b) is formed at the least distance of distinct vision

(c) coincides with the object

(d) coincides with the objective lens

**83.** The penetrating powers of α, β and γ radiation, in decreasing order, are

(a) γ, α, β (b) γ, β, α

(c) α, β, γ (d) β, γ, α

**84.** In a radioactive series, $^{238}_{92}U$ changes to $^{206}_{82}Pb$ through $n_1$ α-decay processes and $n_2$ β-decay processes.

(a) $n_1=8, n_2=8$ (b) $n_1=6, n_2=6$

(c) $n_1=8, n_2=6$ (d) $n_1=6, n_2=8$

**85.** Let *u* denote one atomic mass unit. One atom of an element of mass number *A* has mass exactly equal to *A u*

(a) for any value of *A*

(b) only for *A*=1

(c) only for *A*=12

(d) for any value of *A* provided the atom is stable

**86.** Let T be the mean life of a radioactive sample. 75% of the active nuclei present in the sample initially will decay in time

(a) 2T (b) $\frac{1}{2}(ln2)T$

(c) 4T (d) $2(ln2)T$

**87.** Three- fourths of the active nuclei present in a radioactive sample decay in $\frac{3}{4}s$. The half-life of the sample is

(a) 1s (b) $\frac{1}{2}s$

(c) $\frac{3}{4}s$ (d) $\frac{3}{8}s$

**88.** A sample of radioactive material is used to provide desired doses of radiation for medical purposes. The total time for which the sample can be used will depend

(a) only on the number of times radiation is drawn from it

(b) only on the intensity of doses drawn from it

(c) on both (a) and (b)

(d) neither on (a) nor on (b)

**89.** When white light (violet to red) is passed through hydrogen gas at room temperature, absorption lines will be observed in the

(a) Lyman series (b) Balmer series

(c) both (a) and (b) (d) neither (a) nor (b)

**90.** White X-rays are called 'White' because

(a) they are produced most abundantly in X-ray tubes

(b) they are electromagnetic waves and hence have a nature similar to white light

(c) they can be converted to visible light using coated screens, and they affect photographic plates, just like light

(d) they have a continuous range of wavelengths

**91.** The decay constant of a radioactive sample is $\lambda$. Its half-life is $T_{1/2}$ and mean life is T.

(a) $T_{1/2} = \frac{1}{\lambda}, T = \frac{ln2}{\lambda}$ (b) $T_{1/2} = \frac{ln2}{\lambda}, T = \frac{1}{\lambda}$

(c) $T_{1/2} = \lambda ln2, T = \frac{1}{\lambda}$ (d) $T_{1/2} = \frac{\lambda}{ln2}, T = \frac{ln2}{\lambda}$

**92.** Whenever a hydrogen atom emits a photon in the Balmer series,

(a) it may emit another photon in the Balmer series
(b) it must emit another photon in the Lyman series
(c) the second photon, if emitted, will have the wavelength of about 122 nm
(d) it may emit a second photon, but the wavelength of this photon cannot be predicted

**93.** The number of lattice points in a primitive cell are

(a) 1 (b) 1/2
(c) 2 (d) 3/2

**94.** The number of atoms present in the unit cell of hcp structure is

(a) 2 (b) 4
(c) 6 (d) 7

**95.** Which of the following metals crystallizes in fcc structure?

(a) aluminium (b) zinc
(c) sodium (d) caesium chloride

**96.** The number of ions in the unit cell of CsCl crystal is

(a) 1 (b) 2
(c) 3 (d) 4

**97.** The Miller indices of the plane parallel to the x and y axes are

(a) (1 0 0) (b) (0 1 0)
(c) (0 0 1) (d) (1 1 1)

**98.** Because of which property of the crystal, x-rays can be diffracted from the crystals.

(a) random arrangements of atoms (b) colour of the crystals
(c) periodic array of atoms (d) none of these

**99.** Which one of the following statements is correct?

(a) x-rays are electromagnetic radiation of long wavelength
(b) x-rays produced in a gas tube are different from those in Coolidge tube
(c) the wave length of the scattered x-rays by a material is longer than that of the incident beam
(d) x-ray spectral lines are produced when fast moving electrons are retarded by a material

**100.** X-rays consist of

(a) negatively charged particles (b) electromagnetic radiation
(c) positively charged particles (d) a stream of neutrons

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