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 ENGINEERING

PAPER - I

Time Allowed : 2 hours Full Marks : 200

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

1. Given a force law $\vec{F} = Ar^2\hat{r}$, what are the dimensions of A?

(a) $[M][L][T]^{-2}$ (b) $[M][L]^{-2}[T]^{-2}$

(c) $[M][L]^{-1}[T]^{-2}$ (d) $[M][T]^{-2}$

2. If R is the radius of the Earth and g is the acceleration due to gravity, then the velocity required to escape from Earth's gravitational pull is

(a) $\sqrt{2gR}$ (b) $\sqrt{\frac{g}{R}}$

(c) $\sqrt{\frac{R}{g}}$ (d) $\sqrt{gR}$

3. When the work done in moving a particle round a closed loop in a field is zero, the forces in the field are called

(a) Zero forces (b) Non-conservative forces

(c) Conservative forces (d) Viscous forces

4. Lorentz transformation equations hold for

(a) Non-relativistic velocities only (b) Relativistic velocities only

(c) Both relativistic and non-relativistic velocities (d) Photons only

5. If the radius of the earth were to shrink, its mass remaining the same, the value of acceleration due to gravity at the pole and at the equator will

(a) Increase and decrease respectively (b) Decrease and increase respectively

(c) Increase at both places (d) Decrease at both places

6. In a frame where the particle is at rest, its total energy is $m_o c^2$, where m_o is the rest mass and c is the speed of light. If the particle moves with a velocity half that of the speed of light, then its total energy will be

(a) $m_o c^2$ (b) $2.2\, m_o c^2$

(c) $0.5\, m_o c^2$ (d) $1.15\, m_o c^2$

7. Kepler's third law states that the relationship between orbital period and semi-major axis of the orbit of a planet is $T^2=a^3$. To use this equation as written, T and a must be respectively expressed in

(a) Days and kilometers
(b) Years and kilometers
(c) Years and astronomical units
(d) Days and astronomical units

8. A spaceship of length 12 meters when at rest moves with a velocity 0.8c. For a stationary observer, length of the ship will be measured as

(a) 7.2 m
(b) 0.5 m
(c) 3.5 m
(d) 1.6 m

9. The time period of a simple pendulum on a freely moving artificial satellite is

(a) Zero
(b) 2 sec
(c) 3 sec
(d) Infinite

10. The intensity of gravitational field at the centre of a spherical shell is

(a) Gm/r^2
(b) g
(c) Zero
(d) Infinity

11. While Young's modulus E relates to change in length and bulk modulus K relates to change in volume, modulus of rigidity G relates to change in

(a) Weight
(b) Density
(c) Shape
(d) Temperature

12. At yield point of a copper wire

(a) The load hasn't exceeded the elastic limit yet; so, Hooke's law applies
(b) The load has already exceeded the elastic limit and the material has become plastic
(c) Even the plastic stage has passed and the wire has snapped already
(d) Like brass and bronze, copper has no yield point

13. Substances that elongate considerably and undergo plastic deformation before they break are known as

(a) Brittle substances
(b) Ductile substances
(c) Elastic substances
(d) Quasi-elastic substances

14. Bernoulli's principle shows that at points in a moving fluid where the potential energy change is very small

(a) The pressure is low where the velocity is low and similarly the pressure is high where the velocity is high
(b) The pressure is low where the velocity is high and conversely the pressure is high where the velocity is low
(c) Pressure becomes independent of the velocity of the moving fluid
(d) Pressure remain independent of the speed of the stationary fluid

15. In which one of the following cases will the liquid flow in a pipe be most streamlined

(a) Liquid of high viscosity and high density flowing through a pipe of small radius
(b) Liquid of high viscosity and low density flowing through a pipe of small radius
(c) Liquid of low viscosity and low density flowing through a pipe of large radius
(d) Liquid of low viscosity and high density flowing through a pipe of large radius

16. Water is flowing in a pipe of diameter 4 cm with a velocity 3 m/s. The water then enters into a tube of diameter 2 cm. The velocity of water in the other pipe is

(a) 3 m/s (b) 6 m/s

(c) 12 m/s (d) 8 m/s

17. The Reynolds number of a flow is the ratio of

(a) Gravity to viscous force (b) Gravity force to pressure force

(c) Inertia forces to viscous force (d) Viscous forces to pressure forces

18. Small liquid drops assume spherical shape because

(a) Atmospheric pressure exerts a force on a liquid drop

(b) Volume of a spherical drop is minimum

(c) Gravitational force acts upon the drop

(d) Liquid tends to have the minimum surface area due to surface tension

19. The potential energy of a molecule on the surface of liquid compared to one inside the liquid is

(a) Zero (b) Smaller

(c) Greater (d) The same

20. A mercury drop does not spread on a glass plate because the angle of contact between glass and mercury is

(a) Acute (b) Obtuse

(c) Zero (d) 90^{o}

21. The excess pressure due to surface tension in a spherical liquid drop of radius r is directly proportional to

(a) r (b) r^2

(c) r^{-1} (d) r^{-2}

22. Which of the following relations is true? (Where the symbols have their usual meaning)

(a) $3Y = K\left(1-\sigma\right)$ (b) $K = \dfrac{9\eta Y}{Y+\eta}$

(c) $\sigma = \left(6K+\eta\right)Y$ (d) $\sigma = \dfrac{0.5Y-\eta}{\eta}$

23. The Bulk modulus for an incompressible liquid is

(a) Zero (b) Unity

(c) Infinity (d) Between 0 to 1

24. A pendulum of length L supporting mass M swings back and forth with period P. If the mass is double, what is the new period?

(a) $\dfrac{1}{\sqrt{2}}P$ (b) $2P$

(c) P (d) $\sqrt{2}P$

25. Relative to its period on the earth, the period of a pendulum on the moon is

(a) Shorter (b) Longer

(c) The same as on the earth (d) Varies with time

26. The equation of a SHM is $y = 8\sin(2x - 40t)$, where the distances and time are in cm and second respectively. The speed of the wave is

(a) 2 cm/sec (b) 20 cm/sec

(c) 30 cm/sec (d) 40 cm/sec

27. If A is the amplitude, the distance travelled by a particle performing SHM during time interval equal to its periodic time is

(a) A (b) 2A

(c) 4A (d) Zero

28. The SHM of a particle is given by the equation $y = 3\sin\omega t + 4\cos\omega t$. The amplitude is

(a) 7 (b) 5

(c) 9 (d) 25

29. In case of a forced vibration, the resonance wave becomes very sharp when the

(a) Restoring force is small (b) Applied periodic force is small

(c) Quality factor is small (d) Damping force is small

30. The resultant of two rectangular SHMs of the same frequency and unequal amplitudes but differing in phase by $\frac{\pi}{2}$ is

(a) Simple harmonic (b) Elliptical

(c) Circular (d) Parabolic

31. A simple pendulum oscillates in air with time period T and amplitude A. As the time passés

(a) T and A both decrease (b) T increases and A is constant

(c) T increases and A decreases (d) T decreases and A is constant

32. A uniform spring of force constant k is cut into two pieces, the lengths of which are in the ratio 1:2. The ratio of the force constants of the shorter and the longer pieces is

(a) 1:3 (b) 1:2

(c) 2:3 (d) 2:1

33. Length of a simple pendulum is l and its maximum angular displacement is θ, then its maximum KE is

(a) $mgl\sin\theta$ (b) $mgl(1+\sin\theta)$

(c) $mgl(1+\cos\theta)$ (d) $mgl(1-\cos\theta)$

34. What is the velocity of the bob of a simple pendulum at its mean position, if it is able to rise to vertical height of 10 cm?

(a) $2.2\,m/s$ (b) $1.8\,m/s$

(c) $1.4\,m/s$ (d) $0.6\,m/s$

35. Mark the wrong statement

(a) All SHM have fixed time period

(b) All motion having same time period are SHM

(c) In SHM total energy is proportional to square of amplitude

(d) Phase constant of SHM depends upon initial conditions

36. The total energy of a particle executing SHM is

(a) Directly proportional to x (b) Directly proportional to x^2

(c) Independent of x (d) Directly proportional to $x^{1/2}$

37. The phase (at a time t) of a particle in SHM tells

(a) Only the position of the particle at time t

(b) Only the direction of motion of the particle at time t

(c) Both the position and direction of motion of the particle at time t

(d) Neither the position of the particle nor its direction of motion at time t

38. If a body of mass 0.98 kg is made to oscillate on a spring of force constant 4.84 N/m, the angular frequency of the body is

(a) 2.22 rad/s (b) 1.22 rad/s

(c) 4.22 rad/s (d) 3.22 rad/s

39. Two springs of constant k_1 and k_2 are joined in series. The effective spring constant of the combination is given by

(a) $\sqrt{k_1 k_2}$ (b) $\frac{(k_1 + k_2)}{2}$

(c) $k_1 + k_2$ (d) $\frac{k_1 k_2}{k_1 + k_2}$

40. The acceleration of a particle performing SHM is 12cm/sec^2 at a distance of 3cm from the mean position. Its time period is

(a) 0.5 sec (b) 1.0 sec

(c) 2.2 sec (d) 3.14 sec

41. A pendulum suspended from the ceiling of a train has a period T, when the train is at rest. When the train is accelerating with a uniform acceleration α, the period of oscillation will

(a) Increase (b) Decrease

(c) Remain unchanged (d) Become infinite

42. To make the frequency double in a spring oscillator, we have to

(a) Reduce the mass to one fourth (b) Quadruple the mass

(c) Double the mass (d) Half the mass

43. A particle is executing simple harmonic motion with an amplitude of 0.02 m and frequency 50 Hz The maximum acceleration of the particle is

(a) $100\, m/s^2$ (b) $100\, \pi m/s^2$

(c) $100\, \pi^2 m/s^2$ (d) $200\, \pi^2 m/s^2$

44. Lissajous figure is due to

(a) Superposition of two perpendicular SHMs with equal frequencies

(b) Superposition of two perpendicular SHMs with unequal frequencies

(c) Superposition of two perpendicular SHMs with equal amplitudes

(d) Superposition of two perpendicular SHMs with unequal amplitudes

45. Sharpness of resonance is measured in terms of Q factor, which is defined as

(a) Resonant frequency upon bandwidth

(b) Natural frequency upon bandwidth

(c) Resonant frequency upon peak frequency

(d) Ratio of natural frequency and the full width at half maxima

46. In SHM maximum acceleration is at

(a) Amplitude (b) Equilibrium

(c) Acceleration is constant (d) None of these

47. When the potential energy of a particle executing simple harmonic motion is one-fourth of its maximum value during the oscillation, the displacement of the particle from the equilibrium position in terms of its amplitude α is

(a) $\alpha/4$ (b) $\alpha/3$

(c) $\alpha/2$ (d) α

48. Van der Waals derived an expression for the pressure in defect for real gas, if the observed pressure is P, and V is the volume, the gas pressure in the bulk of the gas is equal to (α is a constant for the particular gas)

(a) $P+\frac{a}{V}$ (b) $P+\frac{a}{V^2}$

(c) $P+aV$ (d) $P+aV^2$

49. In thermodynamic process, 200 *Joules* of heat is given to a gas and 100 *Joules* of work is also done on it. The change in internal energy of the gas is

(a) 100 J (b) 200 J

(c) 300 J (d) 400 J

50. For free expansion of the gas which of the following is true (Q = heat supplied, W = workdone, ΔE_{int} = change in internal energy)

(a) $Q=W=0$ and $\Delta E_{int}=0$ (b) $Q=0, W>0$ and $\Delta E_{int}=-W$

(c) $W=0, Q>0$ and $\Delta E_{int}=-Q$ (d) $W>0, Q<0$ and $\Delta E_{int}=0$

51. Which of the following cannot determine the state of a thermodynamic system

(a) Pressure and volume

(b) Volume and temperature

(c) Temperature and pressure

(d) Any one of pressure, volume or temperature

52. In a given process for an ideal gas, $dW=0$ and $dQ<0$. Then for the gas

(a) The temperature will decrease (b) The volume will increase

(c) The pressure will remain constant (d) The temperature will increase

53. A monoatomic gas of n-moles is heated from temperature T_1 and T_2 under two different conditions (i) at constant volume and (ii) at constant pressure. The change in internal energy of the gas is

(a) More for (i) (b) More for (ii)

(c) Same in both cases (d) Independent of number of moles

54. The gas law $\frac{PV}{T} = constant$ is true for

(a) Isothermal changes only
(b) Adiabatic changes only
(c) Both isothermal and adiabatic changes
(d) Neither isothermal nor adiabatic changes

55. The specific heat of a gas in an isothermal process is

(a) Infinite
(b) Zero
(c) Negative
(d) Remains constant

56. A monoatomic gas ($\gamma = 5/3$) is suddenly compressed to 1/8 of its original volume adiabatically, then the pressure of the gas will change to

(a) 64 times its initial pressure
(b) 24 times its initial pressure
(c) 5 times its initial pressure
(d) 32 times its initial pressure

57. Two identical samples of a gas are allowed to expand isothermally and adiabatically. Work done is

(a) More in the isothermal process
(b) More in the adiabatic process
(c) Neither of them
(d) Equal in both processes

58. In a cyclic process, the internal energy of the gas

(a) Increases
(b) Decreases
(c) Remains constant
(d) Becomes zero

59. The temperature of sink of Carnot engine is 27° C. Efficiency of engine is 25%. Then temperature of source is

(a) 127° C
(b) 27° C
(c) 427° C
(d) 327° C

60. Even Carnot engine cannot give 100% efficiency because we cannot

(a) Prevent radiation
(b) Find ideal sources
(c) Reach absolute zero temperature
(d) Eliminate friction

61. "Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement or consequence of

(a) Second law of thermodynamics
(b) Conservation of momentum
(c) First law of thermodynamics
(d) Third law of thermodynamics

62. Which of the following processes is reversible?

(a) Transfer of heat by radiation
(b) Electrical heating of a nichrome wire
(c) Transfer of heat by conduction
(d) Isothermal compression

63. In a refrigerator, the low temperature coils are at a temperature of – 23° C and the compressed gas in the condenser has a temperature of 27° C. The theoretical coefficient of performance is

(a) 5
(b) 6
(c) 7
(d) 8

64. A measure of the degree of disorder of a system is known as

(a) Isobaric
(b) Isotropy
(c) Enthalpy
(d) Entropy

65. For a reversible process, necessary condition is

(a) In the whole cycle of the system, the loss of any type of heat energy should be zero

(b) That the process should be too fast

(c) That the process should be slow so that the working substance should remain in thermal and mechanical equilibrium with the surroundings

(d) The loss of energy should be zero and it should be quasistatic

66. In a cyclic process, work done by the system is

(a) Zero (b) Equal to heat given to the system

(c) More than the heat given to system (d) Independent of heat given to the system

67. If the door of a refrigerator is kept open, then which of the following is true

(a) Room is cooled (b) Room is heated

(c) Room is neither cooled nor heated (d) None of these

68. The ratio of specific heats $\frac{C_P}{C_V}$ of CO is

(a) 1.33 (b) 1.40

(c) 1.65 (d) 1.21

69. One mole of an ideal monoatomic gas requires 210 J heat to raise the temperature by 10 K, when heated at constant pressure. If the same gas is heated at constant volume to raise the temperature by 10 K then heat required is

(a) 126 J (b) 210 J

(c) 146 J (d) 326 J

70. The energy of a gas/litre is 300 joules, then its pressure will be

(a) $3\times10^5\ N/m^2$ (b) $1\times10^5\ N/m^2$

(c) $2\times10^5\ N/m^2$ (d) $4\times10^5\ N/m^2$

71. One mole of a monoatomic ideal gas is mixed with one mole of a diatomic ideal gas. The molar specific heat of the mixture at constant volume is

(a) R (b) $2R$

(c) $\frac{3}{2}R$ (d) $\frac{5}{2}R$

72. At what temperature, the mean kinetic energy of O_2 will be the same as H_2 molecules at -73° C

(a) -23° C (b) -135° C

(c) 25° C (d) -73° C

73. The degree of freedom of a triatomic gas is

(a) 2 (b) 4

(c) 6 (d) 8

74. A particle has an initial velocity of $3\hat{i}+4\hat{j}$ and an acceleration of 0.4+ 0.3. Its speed after 10 s is

(a) 10 units (b) 7 units

(c) $7\sqrt{2}$ units (d) 8.5 units

75. A bird flies for 4s with a velocity of $|t-2|$ m/s in a straight line, where t = time in seconds. It covers a distance of

(a) 2m (b) 4m

(c) 6m (d) 8m

76. A particle moves in a straight line with a retardation proportional to its displacement. Its loss of kinetic energy for an displacement x is proportional to

(a) x (b) x^2

(c) ln x (d) e^x

77. A balloon starts rising from the ground with an acceleration of 1.25 m/s^2. After 8s, a stone is released from the balloon. The stone will

(a) cover a distance of 40 m (b) have a displacement of 50m

(c) reach the ground in 4s (d) begin to move down after being released

78. A ball falls from rest from a height h onto a floor and rebounds to a height h/4. The coefficient of restitution between the ball and the floor is

(a) $\frac{1}{\sqrt{2}}$ (b) ½

(c) ¼ (d) ¾

79. In a tug-of-war-contest. Two men pull on a horizontal rope from opposite sides. The winner will be the man who

(a) Exerts greater force on the rope

(b) Exerts greater force on the ground

(c) Exerts a force on the rope which is greater than the tension in the rope

(d) Makes a small angle with the vertical

80. A spring, which is initially in its unstretched condition, is first stretched by a length x and then again by a further length x. The work done in the first case is W_1 and in the second case is W_2.

(a) $W_2 = W_1$ (b) $W_2 = 2W_1$

(c) $W_2 = 3W_1$ (d) $W_2 = 4W_1$

81. A projectile is moving at 60 m/s at its highest point, where it breaks into two equal parts due to an internal explosion. One part moves vertically up at 50 m/s with respect to the ground. The other part will move at

(a) 110 m/s (b) 120 m/s

(c) 130 m/s (d) 10Ö61 m/s

82. An airplane flying at a constant velocity releases a bomb. As the bomb drops down from the airplane,

(a) it will always be vertically below the airplane

(b) it will always be vertically below the airplane only if the airplane is flying horizontally

(c) it will always be vertically below the airplane only if the airplane is flying at an angle of 45° to the horizontal

(d) it will gradually fall behind the airplane if the airplane is flying horizontally

83. Two particles are projected simultaneously in the same vertical plane, from the same point, but with different speeds and at different angles to the horizontal. The path followed by one, as seen by the other is,

(a) a vertical straight line

(b) a straight line making a constant angle ($\neq 90°$) with the horizontal

(c) a parabola

(d) a hyperbola

84. If a metal wire is stretched a little beyond its elastic limit (or yield point) and released, it will

(a) lose its elastic property completely

(b) not contract

(c) contract, but its final length will be greater than its initial length

(d) contract only up to its length at the elastic limit

85. A uniform rod of mass m, length L, area of cross-section A and Young's modulus Y hangs from the ceiling. Its elongation under its own weight will be

(a) zero

(b) $\frac{mgL}{2AY}$

(c) $\frac{mgL}{AY}$

(d) $\frac{2mgL}{AY}$

86. A liquid drop at temperature t, isolated from its surroundings, breaks into a number of droplets. The temperature of the droplets will be

(a) equal to t

(b) greater than t

(c) less than t

(d) either (a), (b) or (c) depending on the surface tension of the liquid

87. When cooking oil is heated in a frying pan, the oil moves around in the pan more easily when it is hot. The main reason for this is that with rise in temperature, there is a decrease in

(a) surface tension

(b) viscocity

(c) angle of contact

(d) density

88. If F represents force, A represents area and t represents time, then which of the following quantities has the same dimensions as the coefficient of viscosity η?

(a) $\frac{FA}{t}$

(b) $\frac{Ft}{A}$

(c) FtA

(d) $\frac{F}{At}$

89. Which of the following processes will be least affected by the viscosity of water?

(a) Water flowing through a pipe

(b) Air bubble rising up through water

(c) A wide, shallow sheet of water flowing on a flat surface

(d) Water flowing out through a hole in the side of a tank

90. A raindrop reaching the ground with terminal velocity has momentum p. Another drop of twice the radius, also reaching the ground with terminal velocity, will have momentum

(a) $4\,p$ (b) $8\,p$

(c) $16\,p$ (d) $32\,p$

91. The equation $y = a\cos^2\left(2\pi nt - 2\pi x/\lambda\right)$ represents a wave with

(a) amplitude a, frequency n and wavelength λ

(b) amplitude a, frequency $2n$ and wavelength 2λ

(c) amplitude $a/2$, frequency $2n$ and wavelength λ

(d) amplitude $a/2$, frequency $2n$ and wavelength $\lambda/2$

92. A wave represented by the equation $y = a\cos\left(kx - \omega t\right)$ is superposed with another wave to form a stationary wave such that the point $x = 0$ is a node. The equation for the other wave is

(a) $a\sin\left(kx + \omega t\right)$ (b) $-a\cos\left(kx - \omega t\right)$

(c) $-a\cos\left(kx + \omega t\right)$ (d) $-a\sin\left(kx - \omega t\right)$

93. A wave travelling in a medium is described by the equation $\mathrm{y} = \mathrm{A}\sin\left(kx - \omega t\right)$. The maximum particle velocity is

(a) $\mathrm{A}\omega$ (b) ω / k

(c) $d\omega / dk$ (d) x / t

94. A cylindrical resonance tube, open at both ends, has a fundamental frequency F in air. Half of the length of the tube is dipped vertically in water. The fundamental frequency of the air column now is

(a) $4F$ (b) $2F$

(c) F (d) F/2

95. An open pipe is suddenly closed at one end, as a result of which the frequency of the third harmonic of the closed pipe is found to be higher by 100Hz than the fundamental frequency of the open pipe. The fundamental frequency of the open pipe is

(a) 200 Hz (b) 300 Hz

(c) 240 Hz (d) 480 Hz

96. The third overtone of an open organ pipe of length l_0 has the same frequency as the third overtone of a closed pipe of length l_c. The ratio l_0 / l_c is equal to

(a) 2 (b) 3/2

(c) 5/3 (d) 8/7

97. A body cools from 50°C to 40°C in 5 minutes. The surrounding temperature is 20°C. In what further time (in minutes) will it cool to 30°C?

(a) 5 (b) $\frac{15}{2}$

(c) $\frac{25}{3}$ (d) 10

98. A spherical black body with a radius of 12 cm radiates 450 W power at 500K. If the radius were halved and the temperature doubled, the power radiated in watts would be

(a) 225 (b) 450

(c) 900 (d) 1800

99. A gas at absolute temperature 300K has pressure= $4\times10^{-10}N/m^2$.

Boltzmann constant, $k = 1.38\times10^{-23}$ J/K. The number of molecules per cm^3 is of the order

(a) 100 (b) 10^5

(c) 10^8 (d) 10^{11}

100. A closed vessel is maintained at a constant temperature. It is first evacuated and then vapour is injected into it continuously. The pressure of the vapour in the vessel

(a) increases continuously (b) first increases and then remains constant

(c) first increases and then decreases (d) none of these

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