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FOR PG TRB (PHYSICS) THIS KERALA STATE QUESTION PAPER IS VERY USEFUL

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A

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16124 **120 MINUTES**

1. Let **F** = ∇f be the gradient of a scalar function f. The value of the closed line integral ∫**F**.d**l** where d**l** is an element of length along a curve C is
   A) Zero B) π
   C) 2π D) 1

2. Consider an imaginary rectangular box inside a vessel in which water is flowing. There will be a net positive outward flux of water across the closed surface of the box per unit area. What is this quantity referred to in vector language?
   A) Divergence of a vector field. B) Gradient of a scalar field.
   C) Gradient of a vector field. D) Curl of a vector field.

3. A scalar function is defined by ϕ (**r**) = $3x^2 + 4yz$. What is its gradient at the point (1,-1,2) and what is its orientation with respect to the surface ϕ = a constant?
   A) 6 **i** + 8 **j** – 4 **k**; Tangential to the surface ϕ = a constant.
   B) 6 **i** + 8 **j** – 4 **k**; Normal to the surface ϕ = a constant.
   C) 10; Arbitrary direction.
   D) 6 **i** + 8 **j** – 4 **k**; at 45^0 to the normal to the surface ϕ = a constant.

4. A function f(t) is represented by the following equation :
   f(t) = t^2 $0 \le t \le 2$
   = $-t + 6$ for $2 \le t \le 6$
   The Fourier expansion of the function has a constant term given by
   A) 8 / (9π) B) 16 / 9
   C) 24 / (9π) D) 32 / 9

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5. A_i and B_{jk} are two arbitrary tensors of rank one and two respectively. ε_{ijk} is the Levi-Civita symbol in 3 dimensions. Then what is the nature of the quantity $A_iB_{jk}\varepsilon_{ijk}$?
   A) A scalar B) A tensor of 3^{rd} rank
   C) A tensor of 6^{th} rank D) A vector

6. The edges of a parallelepiped are represented by the vectors $\vec{A} = (2\hat{i} - 3\hat{j} + \hat{k})$ m, $\vec{B} = (\hat{i} - \hat{j} + 2\hat{k})$m and $\vec{C} = (2\hat{i} + \hat{j} - \hat{k})$ m. Then its volume is
   A) 14 m^3 B) 10 m^3 C) 20 m^3 D) 24 m^3

7. The adjacent sides of a parallelogram can be represented by the vectors $\vec{A} = 2\hat{i} - 3\hat{j} + \hat{k}$ and $\vec{B} = \hat{i} - \hat{j} + 2\hat{k}$. Then its diagonals are given by the vectors
   A) $2\hat{i} + 3\hat{j} + 2\hat{k}$ and $-2\hat{i} - 3\hat{j} - 2\hat{k}$
   B) $3\hat{i} - 4\hat{j} + 3\hat{k}$ and $\hat{i} - 2\hat{j} - \hat{k}$
   C) $-2\hat{i} + 3\hat{j} - 2\hat{k}$ and $-\hat{i} + 2\hat{j} + \hat{k}$
   D) $3\hat{i} - 4\hat{j} + 3\hat{k}$ and $-2\hat{i} - 3\hat{j} - 2\hat{k}$

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8. The density of the material of a wire is determined by measuring its length, radius and mass. The respective measured values are: (5 $\pm$ 0.01) cm, (0.5 $\pm$ 0.005) cm, (0.4 $\pm$ 0.004) gm. What is the maximum percentage error in the calculated value of the density?

A) 4 % B) 2.2 % C) 0.022 % D) 3.2 %

9. Given the following matrices:

$$A = \begin{bmatrix} 1 & -2 & 3 \\ 2 & 4 & -1 \end{bmatrix} \qquad B = \begin{bmatrix} 5 \\ 2 \\ -3 \end{bmatrix}$$

Indicate whether the product AB is defined or not; if defined what is the order of the matrix product?

A) Defined; 2 X 1 B) Defined; 1 X 2
C) Not defined D) Defined, 3 X 3

10. Given the function $f(z) = (z^2 - 2)/ \{(z+1)^3 (z^2 - 4)\}$. Where are the poles located?

A) z = 0, 1, -1 B) z = -1, 2, -2 C) z = 1, 1, -1 D) z = 2, 1, -1

11. For a particular system, one of the generalized co-ordinates is an angle. What are the dimensions of the corresponding generalized force component?

A) Force B) Angular momentum
C) Energy D) Torque

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12. In the Kepler problem of a planet moving in a planar elliptical orbit around the sun, which of the following quantities is conserved and why?

A) Linear momentum because there are no external forces on the system.
B) Kinetic energy because there are no external forces on the system.
C) Angular momentum because there are no external torques acting on the system.
D) Potential energy because the motion is in one plane.

13. Which of the following is the unit of scattering cross-section?

A) m^{-2} B) barn C) steradian D) fermi

14. Law of conservation of linear momentum results from

A) Homogeneity of space.
B) Isotropy of space.
C) Unidirectional property of time.
D) Homogeneity of time.

15. A particle has its de Broglie wavelength equal to its Compton wavelength. What will be its speed?

A) c B) c/2 C) $\sqrt{2}c$ D) $c/\sqrt{2}$

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16. The following examples illustrate constraints in mechanical systems. Which among them is a non-holonomic constraint?
   A) A simple pendulum composed of a weight and an inextensible string attached at the top end to a pivot.
   B) A rigid body in uniform motion under the action of a conservative force field.
   C) Foucault pendulum
   D) A particle moving in a smooth horizontal plane.

17. Given below are examples of forces. Choose the one type of force that cannot be referred to as a "central force". Here, **i** is the unit vector along the X axis, **r** is the radius vector and **v** is the velocity.
   A) $\mathbf{F} = -kx\mathbf{i}$, B) $\mathbf{F} = GM_1M_2\mathbf{r}/r^3$
   C) $\mathbf{F} = \mathbf{K}Q_1Q_2\mathbf{r}/r^3$ D) $\mathbf{F} = K\mathbf{v}$

18. A canonical transformation is effected from (q,p) to (Q,P) via a generating function of the form F(q, Q, t). What will be the relation between q, p, Q and P?

   A) $p = \partial F / \partial q$; $P = -\ \partial F / \partial Q$
   B) $p = \partial F / \partial q$; $P = \partial F / \partial Q$
   C) $q = \partial F / \partial p$; $P = -\ \partial F / \partial Q$
   D) $q = \partial F / \partial p$; $P = \partial F / \partial Q$

19. A relativistic particle is moving with a momentum 6 MeV/c. Its total relativistic energy is 10 MeV. What is the speed of the particle?
   A) 0.8 c B) 0.2 c C) 0.6 c D) $c / \sqrt{3}$

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20. A particle confined to move in the X-Y plane has its Lagrangian given by $L = \frac{1}{2}(p_x^2 + p_y^2)/m + m\omega^2 (x^2+y^2)$. Here m and ω are constants of the motion, x and y are the generalized co-ordinates and p_x and p_y are the corresponding generalized momenta. Identify the conserved quantity.

   A) $p_x + p_y$ B) $(x\,p_y - y\,p_x)^n$ where n = 1, 2, 3 .....
   C) $(p_x^2 + p_y^2)$ D) p_z

21. If v_p denotes phase velocity and v_g denotes group velocity of a wavepacket, which of the following is true for a medium with anomalous dispersion?
   A) $v_p < v_g$ B) $v_p > v_g$
   C) $v_p = v_g$ D) $v_p = \frac{d\omega}{dk}$

22. Although there are indications of a non-zero rest mass for the neutrinos, often they are assumed to be massless. What will be the relative velocity of a neutrino approaching a photon head on?
   A) c B) 2c C) Zero D) $\sqrt{2}c$

23. The Poisson bracket for $\{L_x, L_z\}$ is
   A) Zero B) L_y C) $-L_y$ D) iL_y

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24. A periodic and repeating disturbance exists on the surface of a lake which generates waves travelling outward from the point of disturbance in the form of circular waves. The frequency of the disturbance is 10 Hz. The velocity of the waves on the surface is 5 m/s. What is the minimum distance between particles of the medium which remain stationery?
A) 5 m B) 0.25 m C) 2.5 m D) 0.5 m

25. Find the magnitude and direction of force acting on a charge particle of charge 20 m C, moving with a velocity $(6\ \mathbf{i} + 8\ \mathbf{j})\ ms^{-1}$ in a magnetic field of $(8\ \mathbf{i} - 6\ \mathbf{j}) \times 10^{-3}$ Tesla.

A) 2×10^{-3} N along the positive Z axis.
B) 1.92×10^{-3} N along the positive Z axis.
C) 1.92×10^{-3} N along the negative Z axis.
D) 2×10^{-3} N along the negative Z axis.

26. A is a point very close to and outside the surface of a metal sheet which carries a uniform charge distribution. B is another point directly beneath A, but just inside the metal. An electric field of 2 V/m exists at A. What are the values of the surface charge density (in terms of the electronic charge) and the discontinuity in the tangential component of the electric field across the surface?
A) 2.2×10^{8}e and 2V/m. B) 1.1×10^{8}e and 2V/m.
C) 2.2×10^{8}e and zero. D) 1.1×10^{8}e and zero.

27. A static electric field exists in a certain region of space which contains a non-uniform distribution of charges. Equipotential surfaces in this region
A) Are always parallel to one another.
B) Can intersect along a straight line.
C) Can intersect along curved lines.
D) Never cross each other.

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28. The ratio of the electric permitivity to the magnetic susceptibility of vacuum has units as
A) Ohm^{2} B) Ohm^{-2}
C) ms^{-1} D) Volt. Ampere

29. Let **B** represent a static magnetic field density and **J** the associated current density. Then which of the following conditions is satisfied?
A) $\nabla \mathbf{X}\ \mathbf{B} = \mathbf{0}$. B) $\nabla \mathbf{X}\ \mathbf{B} = \mathbf{J}$. C) $\nabla .\ \mathbf{B} = \mathbf{0}$. D) $\nabla .\ \mathbf{B} = \mathbf{J}$.

30. An electromagnetic wave has an electric field component given by $E = E_o \sin(10^7\ t - 5x)$. What are the magnitudes of the velocity and wavelength of the waves?
A) 2.0×10^{6} m/s and $2\pi/5$ m. B) 2.0×10^{6} m/s and $\pi/5$ m.
C) 2.0×10^{6} m/s and 2 m. D) 1.0×10^{6} m/s and $\pi/5$ m.

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31. A waveguide section in a microwave circuit will act as a
A) low pass filter B) band pass filter
C) high pass filter D) band stop filter

32. The differential form of Faraday's law of electromagnetic induction is
A) $\nabla.\mathbf{E} = \partial\mathbf{B}/\partial t$ B) $\nabla.\mathbf{E} = -\partial\mathbf{B}/\partial t$
C) $\nabla \times \mathbf{E} = -\partial\mathbf{B}/\partial t$ D) $\nabla \times \mathbf{E} = -\partial\mathbf{H}/\partial t$

33. The dimensions of a rectangular waveguide are 6 cm X 4cm. What is the cut-off wavelength for the TE_{10} mode?
A) 120 mm B) 12 mm C) 120 m D) 60 mm

34. At a certain point in space and time, the magnetic field in a plane electromagnetic wave travelling in free space along the positive *x*-direction is given by $\vec{B} = 6.0 \times 10^{-8}\ \hat{k}$ tesla. The electric field at the same point at the same instant is given by $\vec{E} =$
A) $-18\ \hat{j}\ Vm^{-1}$ B) $18\ \hat{j}\ Vm^{-1}$
C) $18\ \hat{i}\ Vm^{-1}$ D) $2\times10^{-16}\ \hat{j}\ Vm^{-1}$

35. An electric circuit consists of six 1.5 V cells in series with a bulb. A charge of 0.1 C is driven through the circuit in 10 seconds. What is the work done in the process?
A) 0.9 J B) 0.09 J C) 0.15 J D) 9 J

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36. A plane electromagnetic wave of a particular frequency is incident normally on the surface of a good conductor. If the wavelength of the wave decreases by a factor of nine, the skin depth will
A) increase by a factor of 3. B) decrease by a factor of 9.
C) remain the same. D) decrease by a factor of 3.

37. Given below are the names of certain laws or equations and the corresponding mathematical expressions in electromagnetism. Which pair of the two entries is not correct?
A) Faraday's law of electromagnetic induction. $\nabla \times \mathbf{E} = -\partial\mathbf{B} / \partial t$.
B) Continuity equation, $\nabla.\mathbf{j} = -\partial\rho / \partial t$.
C) Poisson's equation, $\nabla^2\phi = 0$.
D) Ampere's circuital law, $\nabla \times \mathbf{H} = \mathbf{j} + \partial\mathbf{D} / \partial t$.

38. A plane electromagnetic wave is passing through a dielectric medium (K = 9) along the X direction. Its electric field amplitude is 20mV/m. What is the maximum value and direction of the Poynting's vector?

A) 3 $mJ.m^{-2}.\ s^{-1}$, along the X-axis
B) 3 $\mu J.m^{-2}.\ s^{-1}$, along the X-axis
C) 47 $mJ.m^{-2}.\ s^{-1}$, along the Z -axis
D) 47 $\mu J.m^{-2}.\ s^{-1}$, along the Y-axis

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39. A charged particle of velocity **v** enters a region of space where a magnetic field exists. The initial direction of motion of the particle is at 45^0 to the direction of the field. Which statement is correct?

A) The particle is accelerated by the component of the field parallel to **v** and deflected by the component of the field normal to **v**.
B) The particle is accelerated by the component of the field normal to **v** and deflected by the component of the field parallel to **v**.
C) The particle is not at all accelerated, but only deflected by the component of the field parallel to **v**.
D) The particle is not at all affected by the component of the field parallel to **v** and is only deflected by the component of the field normal to **v**.

40. The dominant mode of electromagnetic wave propagation in a rectangular waveguide is
A) TE_{10}. B) TE_{11}. C) TM_{11}. D) TM_{10}

41. Two charged particles move along exactly equal helical paths in opposite directions. What can be said about the two particles?
A) They have equal z components of momentum
B) The specific charges are equal
C) They have equal charges
D) They represent a particle-antiparticle pair

42. The peak in the intensity distribution of a certain emitting surface occurs at λ= 4000 Å at a temperature of 4000^o K. What is the corresponding wavelength in the radiation emitted from the surface of the human body at a temperature of 37^o C?
A) 5000 Å B) 6160 Å C) 5.16 microns D) 5162 Å

43. In a micro canonical ensemble, a system A of fixed volume is in contact with a large reservoir B. Then
A) A can exchange only energy with B
B) A can exchange only particles with B
C) A can exchange neither energy nor particles with B
D) A can exchange both energy and particles with B

44. Two containers A and B having the same volume contain helium gas and argon gas respectively at the same temperature and pressure. What can be said about the partition function of the two gases, assuming them to be ideal?
A) The partition functions have the same value for both A and B**.**
B) Partition function of the gas in A is greater than that in B because A contains a lighter gas.
C) Partition function of the gas in B is greater than that in A because B contains a heavier gas.
D) The answer will depend on the actual values of the temperature and pressure.

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45. Which of the following physical constants has the same dimensions as pressure x velocity per $(^0K)^4$?
A) Boltzmann's constant. B) Stefan's constant.
C) Rydberg constant. D) Planck's constant.

46. Which of the following thermodynamic relations is not correctly related to the law of conservation of energy?
A) dU = dQ - dW B) dU = TdS - PdV
C) dH = TdS + VdP D) dF = SdT - PdV

47. A block of ice is taken out from a freezer, kept on a table and allowed to melt. What happens to the entropy and why?
A) The entropy increases because the density of water is more than that of ice.
B) The entropy decreases because water is less dense than ice.
C) The entropy decreases because the specific heat of water is more than that of ice.
D) The entropy increases because the molecular arrangement of molecules in the water is less ordered than in the solid ice.

48. Given below are four statements about Eigen functions of quantum mechanical operators. One among them is not correct. Which one is it?
A) No two Eigen functions can have the same Eigen value.
B) Eigen functions with different Eigen values are orthogonal to one another.
C) Normally Eigen functions are normalized.
D) All the Eigen functions must be single valued, finite and continuous.

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49. Which of the following relations is WRONG with regard to Dirac delta function?
A) $\int_{-\infty}^{+\infty} f(x)\delta(x)dx = f(0)$
B) $\delta(ax) = \frac{1}{a}\delta(x), \quad a > 0$
C) $\delta(x) = \lim_{\alpha \to 0} \frac{1}{\alpha\sqrt{\pi}} \exp\left(-\frac{x^2}{\alpha^2}\right)$
D) $x\delta(x) = 1$

50. Define an operator $p_r = -i (h / 2\pi r) (\partial / \partial r) r$. Which is the corresponding Eigen function?
A) e^{-ikr} B) sin (kr) C) e^{ikr} / r D) $r e^{ikr}$

51. A particle in confined to move inside a cubical box wherein the potential is a constant equal to zero. It is well known that the energy of the particle depends on three integer quantum numbers n_x, n_y and n_z. What is the dependence of energy on these numbers?
A) Sum of the three integers
B) Sum of the squares of the three integers
C) Product of the squares of the three integers
D) Product of the three integers

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52. A particle is confined to move inside a spherical volume of radius 10^{-15} m. What is the most likely magnitude of its momentum?
A) 20 keV/c B) 200 keV/c C) 100 MeV/c D) 2 GeV/c

53. It is found that a particle in a one-dimensional box of length L can be excited from the n = 1 state to the n = 2 state by light of frequency ν. If the length of the box is doubled, the frequency needed to produce the n =1 to n = 2 transition becomes
A) $\frac{\nu}{4}$ B) $\frac{\nu}{2}$ C) 2 ν D) 4 ν

54. Spin orbit interaction is a common feature of the shell models in the atom and the nucleus. While comparing the two cases, which of the following statements is wrong?
A) The ordering of the two levels j = l + 1/2 are different in the two cases.
B) The order of magnitudes of the spin orbit splittings are widely different for the two cases.
C) Both shell models consider a predominant centre of force which causes the coupling
D) The spins involved in the two cases have different values.

55. If two operators commute,
A) they have the same set of eigen values
B) their eigen values can be accurately measured simultaneously
C) their eigen values cannot be measured
D) one of them has always the eigen value zero

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56. The distinct levels of a harmonic oscillator labelled with different integer values of the quantum number l are
A) All degenerate with a degeneracy of 2l + 1.
B) All non-degenerate.
C) All degenerate with a degeneracy of l.
D) All degenerate with a degeneracy of l^2.

57. All real physically observable variables have corresponding quantum mechanical operators. This necessitates that the matrices representing such operators
A) Have all zeros as diagonal elements
B) Have all diagonal elements imaginary
C) Have all diagonal elements real
D) Are diagonal matrices.

58. At what energy will the de Broglie wavelength of an electron be equal to the radius of the first Bohr orbit in a hydrogen atom?
A) 13.6 eV
B) 3.4 eV
C) 533 eV
D) Equal to the rest mass energy of the electron

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59. A certain species of atoms get excited and remains in that state for an average time period of 1 ns. It then decays to the ground state emitting radiation of the appropriate wavelength. What is the uncertainty in the frequency of the light emitted?
A) 160 kHz B) 1 GHz C) 6.28 GHz D) 160 MHz

60. A quantum mechanical system is oscillating at a frequency of 2765 rad per sec and has an energy of 1.963 MeV. Identify the value of the corresponding quantum number n.
A) 1.08×10^{18} B) 6.77×10^{18}
C) 1.77×10^{17} D) 1.08×10^{16}

61. The quantum numbers s = ½ and s = -½ are the allowed values for the spin components of an electron. What do these represent?
A) Clockwise and anti-clockwise rotation of an electron about its axis respectively.
B) Anti-clockwise and clockwise rotation of an electron about its axis respectively.
C) Magnetic moments of the electron pointing up and down respectively.
D) Two quantum mechanical spin states which do not have classical analog.

62. 10 eV photons belong to
A) X-rays B) Ultra violet rays
C) Infra red rays D) Microwaves

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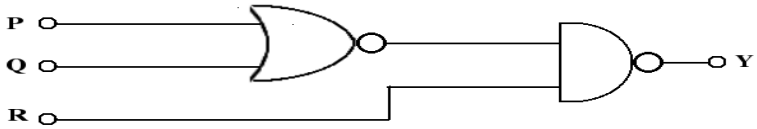
63. To get an output $Y = 0$ from the circuit shown below, the input must be one of the following. Which one is it?



A) 1 0 0 B) 0 1 0
C) 0 0 1 D) 1 0 1

64. Which of the following configuration is frequently used for impedance matching in transistor circuits?
A) Fixed-bias B) Emitter-follower
C) Voltage-divider bias D) Collector feedback

65. In which of the following applications of an OP Amp does the output get more and more amplified as the input frequency increases, keeping same input amplitude?
A) Integrating circuit. B) Averaging amplifier
C) Logarithmic amplifier D) Differentiating circuit

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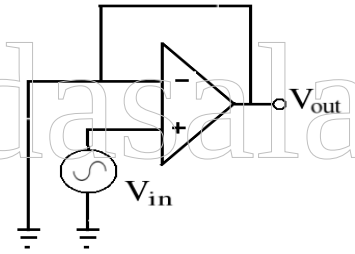
66. A student constructs a voltage regulator using a 3.1 V Zener diode. However he connects the diode with a reversed polarity as compared to the normal operation. What will be the output?
A) 3.1 V
B) Slightly less than 3.1V
C) Around 0.7 V.
D) Zero since the connection is wrong.

67. Any type of sophisticated logic gates can be constructed using
A) AND and OR gates only. B) AND and NOT gates only.
C) NAND or NOR gates only. D) OR and NOT gates only.

68. An integrating circuit is constructed using an μA741 OP AMP. What are the important components in the circuit apart from the OP AMP?
A) A resistor in series with the input and an inductor as the feedback element.
B) A resistor in series with the input and a capacitor as the feedback element.
C) A capacitor in series with the input and a resistor as the feedback element.
D) A capacitor in series with the input and an inductor as the feedback element.

69. Figure shows a typical OP AMP circuit. Which statement below does not pertain to this circuit?



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A) Gain is unity.
B) Input and output are in phase.
C) It is used to isolate the input and output so that the input is not loaded too much.
D) There is no feedback in the circuit.

70. A MOD-16 counter is holding the count 1001_2. What will the count be after 31 clock pulses?
A) 1000_2. B) 1010_2. C) 1011_2. D) 1101_2.

71. A mod-2 counter is followed by a mod-5 counter. The combination is equivalent to which one of the following counters?
A) mod-7 counter B) mod-3 counter
C) decade counter D) binary coded decimal counter

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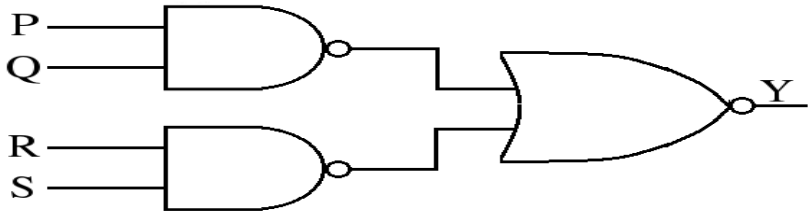
72. Which expression describes the output of the following logic gate correctly?



A) $P.Q + R.S$ B) $(P+Q).(R+S)$

C) $P.Q.R.S$ D) $\overline{P}.\overline{Q} + \overline{R}.\overline{S}$

73. A low pass filter has upper cut off frequency of 450 kHz. Another filter has a lower cutoff frequency of 455 kHz, passing all frequencies above this frequency 455 kHz. If these are connected in parallel, what will be the nature of the resulting circuit?

A) Low pass filter with upper cutoff frequency of 455 kHz.
B) High pass filter with lower cutoff frequency of 450 kHz.
C) Band pass filter with a band width of 5 kHz.
D) Band stop filter with a stop band width of 5 kHz.

74. Which of the following is not a common type of optical fibre?

A) Single-mode graded-index B) Single-mode step-index
C) Multimode graded-index D) Multimode step-index

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75. With a 200 kHz frequency clock pulses, eight bits are serially entered into a shift register. What time will the entire operation last?

A) 4 micro sec B) 40 micro sec C) 400 micro sec D) 4 milli sec

76. What does the envelope of an amplitude modulated wave contain?

A) The information in the signal being communicated.
B) Carrier frequency.
C) Harmonic frequencies of the signal.
D) The two side band frequencies.

77. It is desired to make a solar panel to provide 9 V output at a maximum load current of 2 amperes. Individual solar cells with output voltage of 0.6 V and rated maximum output currents of 100 mA are available. Which combination of the solar cells will give the desired output?

A) One series combination of 20 solar cells to provide the 2 amp current output, connected to one parallel combination of 15 solar cells providing output voltage of 9 V .
B) One series combination of 15 solar cells to provide the output voltage of 9 V, connected to one parallel combination of 20 solar cells providing 2 amp current.
C) Parallel connection of 15 sets, each of 20 serially connected solar cells to provide both output voltage and current.
D) Parallel connection of 20 sets, each of 15 serially connected solar cells to provide both output voltage and current.

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78. The ideal value for the CMRR of an OP AMP is
A) Infinity B) Zero C) 10. D) 1000

79. A π^0 meson at rest decays into two photons of equal energy. If the mass of the meson is 135 MeV/c^2, what will be the wavelength of each photon in fm?
A) 2.925 B) 18.37
C) 1.837×10^{-5} D) 2.925×10^{-6}

80. Consider the Lyman and Balmer series of the hydrogen atom. What is the ratio of the wavelengths of the first lines of the two series in the above order?
A) 5/27 B) 27/4 C) 27/5 D) 27/8

81. An NMR experiment consists of measuring the energy associated with what physical phenomenon?
A) Flipping the magnetic spin vector of a nucleus (having a non-zero magnetic moment) in a strong magnetic field.
B) Excitation of a core electron from an atom
C) Activating a molecular vibration.
D) Orienting the spin vector of the nucleus by the magnetic field of the electrons.

82. The Raman spectra of the HCl molecule is observed. If the vibrational constants w_e and $w_e x_e$ are respectively 2937.5 and 51.6, both in units of cm^{-1}. What will be the location of the first Stokes line in the spectrum in the same unit?
A) 2989.1 B) 2885.9 C) 2834.3 D) 3040.7

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83. How many distinct peaks do you expect in the proton NMR spectrum of $^{12}CH_4$ molecule?
A) 4. B) 2. C) 1. D) 3.

84. What is the correct ratio, in decreasing order of magnitude, of the intensities of the main components in the scattered spectrum of a given sample?
A) Rayleigh : Stokes : Anti-Stokes
B) Rayleigh : Anti-Stokes : Stokes
C) Anti-Stokes : Stokes : Rayleigh
D) Stokes : Anti-Stokes : Rayleigh

85. Choose the correct statement regarding a mesonic hydrogen atom
A) It has one electron of the hydrogen atom replaced by a mu meson and mesonic transitions result in X-ray emission rather than visible light.
B) It has an electron revolving round a mu meson and electronic transitions result in gamma rays instead of visible light.
C) It has one electron of the hydrogen atom replaced by a mu meson and mesonic transitions result in ultra violet emission rather than visible light.
D) It has an electron revolving round a mu meson and electronic transitions result in X- rays instead of visible light.

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86. Pick the correct statement regarding the main processes involved in the operation of lasers:

A) Spontaneous emission depends both on the number of atoms present in the excited state and on the intensity of incident light, whereas stimulated emission depends only on the intensity of incident light.

B) Spontaneous emission depends only on the intensity of incident light whereas stimulated emission depends also on the number of atoms present in the excited state.

C) Spontaneous emission depends only on the number of atoms present in the excited state whereas stimulated emission depends also on the intensity of the incident light.

D) Both spontaneous emission and stimulated emission depend on the number of atoms present in the excited state and on the intensity of incident light.

87. The ground state and excited state spins of ^{57}Fe nucleus are respectively 1/2 and 3/2. The Mössbauer spectrum of a foil of iron enriched with ^{57}Fe exhibits a single signal at zero velocity. The spectrum is now recorded in an applied magnetic field. How does the spectrum change?

A) Two lines B) Three lines C) Four lines D) Six lines

88. Which combination of the four quantum numbers n, l, m_l, m_s of an electron in an atom is not allowed?

A) 3, 2, 1, -1/2. B) 3, 3, -2, 1/2.

C) 2, 1, 0, 1/2. D) 2, 1, -1, -1/2.

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89. Hyperfine splitting of atomic spectral lines results from

A) Spin-orbit coupling

B) Coupling of the spins of individual electrons

C) Coupling of nuclear spin with the magnetic field generated by the electron.

D) Spin-lattice interaction

90. The J = 0 → 1 rotational transition for $H^{79}Br$ occurs at 500.72 GHz. Assuming the molecule to be a rigid rotor, the J = 4 → 5 transition occurs at:

A) 50.1 cm^{-1} B) 66.8 cm^{-1}

C) 16.7 cm^{-1} D) 83.5 cm^{-1}

91. The ratio of the electrical conductivity to the thermal conductivity of metals at ordinary temperatures is

A) Directly proportional to the temperature.

B) Inversely proportional to the temperature.

C) Constant over a range of temperatures.

D) A universal constant.

92. Phonons are quanta of lattice vibrations in the same way as photons are quanta of electromagnetic waves. What is the spin of these particles?

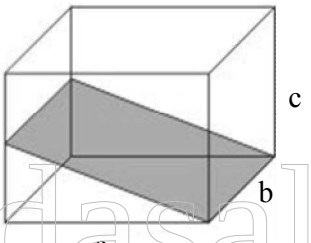
A) Zero. B) 1/2.

C) 1. D) Their spin is undefined.

93. In the photoelectric effect, light is incident on the surface of a metal and causes photoelectrons to be emitted. For a given metal, which of the following is true about the energy of the emitted photoelectrons?
A) The energy of the photoelectrons increases when the frequency of the incident light increases.
B) The energy of the photoelectrons increases when the intensity of the incident light increases.
C) The energy of the photoelectrons increases when the wavelength of the incident light increases.
D) The energy of the photoelectrons is characteristic of the metal and independent of the incident light.

94. The lattice constant of a face centred cubic lattice is 3.14 Å. What will be the volume of the unit cell in the reciprocal lattice?
A) 3.23×10^{28} m^3 B) 30.96×10^{-30} m^3
C) 8.0×10^{30} m^{-3} D) 7.67×10^{-27} m^3

95. What are the miller indices of the set of crystal planes shown shaded in the figure?



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A) (102) B) (101) C) (110) D) (201)

96. An electron gas has a Fermi energy ϵ_F at the temperature T. The energy ϵ of the state for which the probability of being occupied is $(\frac{1}{3})$ is given by
A) ϵ_F B) $\epsilon_F + 0.5\, k_B T$
C) $\epsilon_F + 0.693\, k_B T$ D) $\epsilon_F - 0.693\, k_B T$

97. Which of the following aspects is NOT COMMON to ferromagnets and ferroelectrics?
A) They possess permanent magnetic or electric dipoles
B) They contain iron
C) They show hysteresis behaviour
D) Their characteristic property disappears when heated to high temperature

98. The dielectric constant of a material at optical frequencies is mainly due to
A) ionic polarizability
B) dipolar polarizability
C) electronic polarizability
D) ionic and dipolar polarizability

99. Curie-Weiss law is obeyed by a magnetic material
A) At the Curie temperature only.
B) Above the Curie temperature.
C) Below the Curie temperature.
D) At all temperatures.

100. A material was subjected to electrical conductivity studies at various temperatures. A part of the data obtained is reproduced below:

Temperature (K)	300	400	500	600
Conductivity ($S.m^{-1}$)	0.004	0.047	0.202	0.535

What type of material is it?
A) Semiconductor.
B) Good conductor.
C) Perfect insulator.
D) It is difficult to decide using the limited data provided.

101. The powder method is usually employed for obtaining the X-ray diffraction pattern of samples. Which type of samples is it best suited for?
A) Any type of samples. B) Single crystals.
C) Amorphous materials. D) Polycrystalline samples.

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102. Which magnetic property is exhibited by all materials in varying degrees?
A) Paramagnetism. B) Ferromagnetism
C) Ferrimagnetism. D) Diamagnetism.

103. The Debye temperature in tantalum is given as 240 K. What is the corresponding high frequency cut off in the derivation of the energy of all vibrations in Debye theory?
A) 5000 GHz B) 5000 MHz
C) 796 GHz D) 796 MHz

104. Select the correct statement regarding Cooper pairs
A) The binding energy of Cooper pairs is of the order of 10^{-6} eV, they are broken at temperature below the critical temperature and are fermions.
B) The binding energy of Cooper pairs is of the order of 10^{-3} eV, they are broken at temperature above the critical temperature and are fermions.
C) The binding energy of Cooper pairs is of the order of 10^{-3} eV, they are broken at temperature above the critical temperature and are bosons.
D) The binding energy of Cooper pairs is of the order of 10^{-6} eV, they are broken at temperature above the critical temperature and are bosons.

105. Which type of material can be used in a microphone as transducer?
A) Piezo electric materials B) Pyroelectric materials
C) Ferroelectric materials D) All dielectric materials

106. Shell model incorporating spin orbit coupling is useful for predicting the spin and parity of the ground states of nuclei. What is the prediction in the case of $_8O^{17}$ nucleus?
A) 0^- B) $(3/2)^-$ C) $(5/2)^+$ D) 1^+

107. The radius of a $^{27}_{12}Mg$ nucleus is measured to be 3.6×10^{-15}m. The radius of a $^{64}_{29}Cu$ nucleus can be estimated to be
A) 8.6×10^{-15}m B) 4.8×10^{-15}m
C) 7.2×10^{-15}m D) 2.7×10^{-15}m

108. The radioactive isotope $_{95}Am^{241}$ decays by alpha emission. Two prominent groups of alpha particles have energies of 5.486 MeV and 5. 443 MeV. Which is the daughter nucleus and what is the energy difference of the energy levels of the daughter nucleus involved?
A) $_{93}Np^{239}$, 10.929 MeV. B) $_{94}Pu^{237}$, 43 MeV.
C) $_{95}Am^{237}$, 43 keV. D) $_{93}Np^{237}$, 43 keV.

109. Co^{60} nucleus has two excited states of energies 2.5 MeV and 1.33 MeV. The higher excited state decays by gamma emission to the ground state via the intermediate state and emits two gamma rays. Give the energies of the two radiations in the order in which they are emitted.

A) 2.5 MeV and 1.33 MeV. B) 1.17 MeV and 1.33 MeV.
C) 1.33 MeV and 1.17 MeV. D) 2.5 MeV and 3.83 MeV.

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110. Which of the following pairs of nuclei are mirror nuclei?
A) $_{13}Al^{27}$ and $_{14}Si^{28}$ B) $_{13}Al^{27}$ and $_{13}Al^{26}$
C) $_{13}Al^{27}$ and $_{14}Si^{27}$ D) $_{14}Si^{27}$ and $_{14}Si^{28}$

111. One group of elementary particles in the list below interact via the strong interaction. Which is it?
A) Leptons B) Hadrons
C) Photons D) Muons

112. The total binding energy of $_{53}I^{127}$ nucleus is 1072.58 MeV. It is required to expel two neutrons from this nucleus. How much energy is required on the average to be supplied to the nucleus to do this?
A) 8.446 MeV B) 16.892 MeV
C) 931 MeV D) 14.49 MeV

113. Fission chain reaction in a nuclear reactor can be controlled by introducing
A) Iron rods B) Graphite rods
C) Platinum rods D) Cadmium rods

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114. Consider the processes of fusion of two light nuclei with A < 12 and the fission of a heavy nucleus beyond Uranium. Which statement below will be most appropriate regarding the two cases?

A) The heavy nucleus will always undergo spontaneous fission, whereas the two light nuclei can fuse only if they have sufficient kinetic energies.
B) The heavy nucleus will always undergo spontaneous fission and the light nuclei can fuse irrespective of their energies.
C) The heavy nucleus can sometimes undergo spontaneous fission, whereas the two light nuclei can fuse only if they have sufficient kinetic energies.
D) The heavy nucleus can undergo fission only if it absorbs slow neutrons, but the light nuclei can fuse irrespective of their energies.

115. Geiger counter is suitable for
A) Extremely fast counting
B) Slow counting
C) Differentiating between radiation types
D) All the above situations

116. How fast should a charged particle travel to emit Cerenkov radiation?
A) With a speed greater than the speed of light in vacuum
B) With a speed equal to the speed of light in vacuum
C) With a speed greater than the speed of light in the medium
D) With a speed greater than the speed of sound in the medium

117. In the nuclear fusion process two nuclei collide with each other and fuse into a heavier nucleus. Which of the following statements is true about this process?
A) The process can occur at all energies of the incident particle and the total mass is conserved.
B) The process can occur only above a minimum energy of the incident particle and the total mass is conserved.
C) The process can occur only above a minimum energy of the incident particle and the total mass of the lighter nuclei is greater than that of the fused nucleus.
D) The process can occur only above a minimum energy of the incident particle and the total mass of the lighter nuclei is smaller than that of the fused nucleus

118. In deep inelastic scattering experiments to investigate whether the proton has any internal structure, electrons are scattered off by protons. For this, the energy of the electron must be of the order of
A) KeV B) MeV C) GeV D) TeV

119. Which of the following radiations move with the maximum velocity?
A) 200 MeV electron B) 2 MeV proton
C) 0.2 eV gamma ray D) 200 MeV pion

120. Pick the only elementary particle interaction process from the following:
A) $\pi^- + p \rightarrow \Lambda^0 + K^0$ B) $\Lambda^0 \rightarrow \pi^- + p$
C) $p \rightarrow n + e^- + \nu$ D) $e \rightarrow \gamma + \gamma$

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PHYSICS[16124-A]

Qn.No	Key	Qn.No	Key	Qn.No	Key	Qn.No	Key	Qn.No	Key	Qn.No	Key
1	A	21	A	41	B	61	D	81	A	101	D
2	A	22	A	42	C	62	B	82	C	102	D
3	B	23	C	43	C	63	C	83	C	103	A
4	B	24	B	44	C	64	B	84	A	104	C
5	A	25	D	45	B	65	D	85	A	105	A
6	A	26	D	46	D	66	C	86	C	106	C
7	B	27	D	47	D	67	C	87	D	107	B
8	D	28	B	48	A	68	B	88	B	108	D
9	A	29	C	49	D	69	D	89	C	109	B
10	B	30	A	50	C	70	A	90	D	110	C
11	D	31	C	51	B	71	C	91	B	111	B
12	C	32	C	52	C	72	C	92	A	112	B
13	B	33	A	53	A	73	D	93	A	113	D
14	A	34	B	54	C	74	A	94	C	114	C
15	D	35	A	55	B	75	B	95	A	115	B
16	C	36	D	56	B	76	A	96	C	116	C
17	D	37	C	57	C	77	D	97	B	117	C
18	A	38	B	58	C	78	A	98	C	118	D
19	C	39	D	59	D	79	B	99	B	119	C
20	B	40	A	60	A	80	A	100	A	120	A

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