TEST SERIES CSIR-NET/JRF Dec. 2017

BOOKLET SERIES D

FULL LENGTH TEST - I

Paper Code 05 **Test Type: TEST SERIES**

PHYSICAL SCIENCES

Duration: 3:00 Hours **Date: 07-12-2017**

Maximum Marks: 200

Read the following instructions carefully:

* Single Paper Test is divided into **three** Parts.

Part - A: This part shall carry 20 questions. The candidate shall be required to answer any 15 questions. Each question shall be of **2 marks.**

Part - B: This part shall contain 25 questions covering the topics given in the Part 'B' of syllabus. The candidates are required to answer any 20 questions. Each question shall be of **3.5 Marks.**.

Part - C: This part shall contain **30** questions from Part - C of the syllabus. The candidates are required to answer any 20 questions. Each question shall be of **5 Marks**.

* Darken the appropriate bubbles with HB pencil/Ball Pen to write your answer.

* There will be negative marking @25% for each wrong answer.

* The candidates shall be allowed to carry the Question Paper Booklet after completion of the exam.

* For rough work, blank sheet is attached at the end of test booklet.

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PART-A

1. Which one of the following numbers will completely divide $(4^{61} + 4^{62} + 4^{63} + 4^{64})$?
   (a) 3 (b) 10 (c) 11 (d) 13

2. A, B and C start at the same time in the same direction to rurn around a circular stadium. A completes a round in 252 seconds, B in 308 seconds and C in 198 seconds, all starting at the same point. After what time will they meet again at the starting point?
   (a) 26 minutes 18 seconds (b) 42 minutes 36 seconds
   (c) 45 minutes (d) 46 minutes 12 seconds

3. A fires 5 shots to B's 3 but A kills only once in 3 shots while B kills once in 2 shots. When B has missed 27 times, A has killed
   (a) 30 birds (b) 60 birds (c) 72 birds (d) 90 birds

4. A number is increased by 20% and then again by 20%. By what percent should the increased number be reduced so as to get back the original number?
   (a) $19\frac{11}{31}\%$ (b) $30\frac{5}{9}\%$ (c) 40% (d) 44%

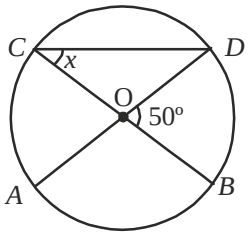
5. The ratio of the number of boys and girls in a school is 3 : 2. If 20% of the boys and 25% of the girls are scholarship holders, what percentage of the students does not get the scholarship
   (a) 56 (b) 70 (c) 78 (d) 80

6. Ronald and Elan are working on an assignment. Ronald takes 6 hours to type 32 pages on a computers. While Elan takes 5 hours to type 40 pages. How much time will they take, working together on two different computers to type an assignment of 110 pages?
   (a) 7 horus 30 minutes (b) 8 hours
   (c) 8 hours 15 minutes (d) 8 hours 25 minutes

7. A vendor bought toffees at 6 for a rupee. How many for a rupee must he sell to gain 20%
   (a) 3 (b) 4 (c) 5 (d) 6

8. A train M leaves Meerut at 5 A.M. and reaches Delhi to 9 A.M. Another train leaves Delhi at 7 A.M. and reaches Meerut at 10:30 A.M. At what time do the two trains cross each other
   (a) 7 : 36 A.M. (b) 7:56 A.M. (c) 8 A.M. (d) 8:26 A.M.

9. In the following figure, O is the centre of the circle. Find $\angle x$ if $\angle BOD = 50^o$



   (a) 35º (b) 25º (c) 15º (d) 5º

10. An equilateral triangle is described on the diagonal of a square. What is the ratio of the area of the triangle to that of the square?
   (a) $2:\sqrt{3}$ (b) $4:\sqrt{3}$ (c) $\sqrt{3}:2$ (d) $\sqrt{3}:4$

11. The height of a closed cylinder of given volume and the minimum surface area is
   (a) equal to its diameter (b) half of its diameter
   (c) double of its diameter (d) equal to its radius

12. If east is replaced to south-east, then west will be replaced to which of the following directions?
(a) north-east (b) north (c) east (d) south-west

13. Find the missing number

4	5	6
2	3	7
1	8	3
21	98	?

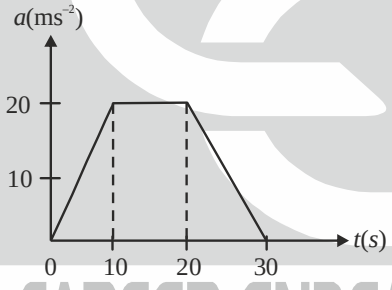
(a) 16 (b) 73 (c) 76 (d) 94

14. In a family, a couple has a son and a daughter. The age of the father is three times that of his daughter and the age of the son is half of his mother. The wife is 9 years younger to her husband and the brother is 7 years older than his sister. What is the age of the mother?
(a) 40 years (b) 50 years (c) 45 years (d) 60 years

15. **Statement :** (I) all books are clocks
(II) all clocks are pens
Conclusions: (I) All books are pens
(II) Some pens are books
(a) only conclusion (I) follows (b) only conclusion (II) follows
(c) both (I) and (II) follows (d) Neither (I) nor (II) follows

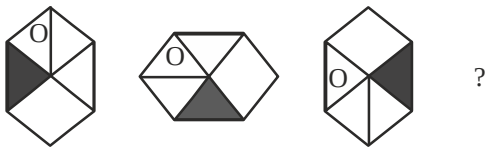
16. Find the number of zeros in 250!
(a) 60 (b) 61 (c) 62 (d) 64

17. The time-acceleration graph for a particle have shown in figure. The average acceleration in first twenty seconds is



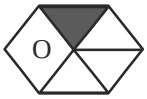
(a) 15 ms^{-2} (b) 20 ms^{-2} (c) 10 ms^{-2} (d) 25 ms^{-2}

18. Find the missing figure is



(a) 

(b) 

(c) 

(d) 

19. P, Q and R are three consecutive odd natural numbers in the ascending order. Three times P is three less than two times R. The value of R is
(a) 19 (b) 13 (c) 9 (d) 5

20. A and B can do a work in 72 days; B and C can do it in 120 days; A and C can do it in 90 days. In what time can A alone do it?
(a) 90 days (b) 100 days (c) 120 days (d) 150 days

PART-B

21. Two events occur simultaneously in *S*-frame. In S'-frame which moves along the line joining the two events with velocity 0.6c with respect to *S*, the two events are separated by a distance 4×10^8 meter. Time interval between the two events in S' frame is

(a) 1 sec (b) 1.5 sec (c) 2 sec (d) 2.5 sec

22. A particle of mass *m* moving in circular orbit under a central force $f = -Kr^3$, has angular momentum L. If radius of circular orbit is doubled then its angular momentum will become

(a) 2L (b) 4L (c) 8L (d) $2^{3/2}$ L

23. A particle of unit mass is released at $x = 1$ in one dimensional potential $V(x) = x^3 - x$. Which one of the following statements is not correct

(a) Particle will come to rest at $x = 0$ (b) Particle's speed is maximum at $x = \frac{1}{\sqrt{3}}$

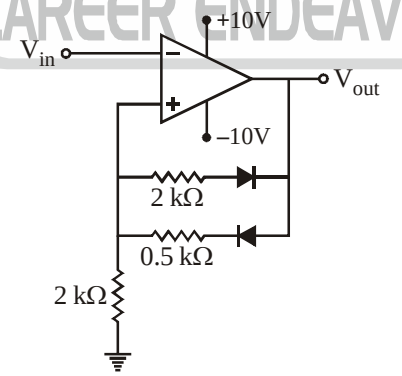
(c) Speed of the particle at $x = \frac{1}{2}$ is $\frac{\sqrt{3}}{2}$ (d) Particle will not return to $x = 1$

24. Lagrangian of a charged particle moving in electromagnetic potential $(\vec{A}, \phi)$ is

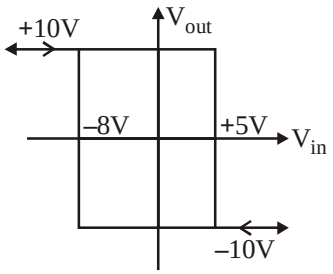
$L = \frac{1}{2}mv^2 - q\phi + q\vec{A}\cdot\vec{v}$. If $(\vec{A}, \phi)$ are transformed by using gauge transformation of electromagnetic potential $(\vec{A}, \phi) \to (\vec{A}', \phi')$, $\vec{A}' = \vec{A} + \vec{\nabla} f(\vec{r}, t)$, $\phi' = \phi - \frac{\partial f(r,t)}{\partial t}$. The transformed Lagrangian has canonical momentum.

(a) $m\vec{v} + q\vec{A}$ (b) $m\vec{v}$ (c) $m\vec{v} + q\vec{A} + q\vec{\nabla} f$ (d) $m\vec{v} + q\vec{A} - q\vec{\nabla} f$

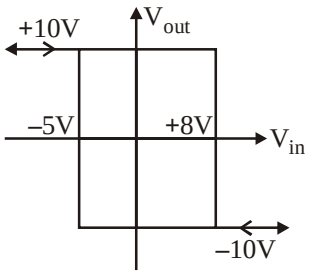
25. Given the ideal operational amplifier circuit shown in the figure indicate the correct transfer characteristics assuming ideal diodes with zero cut-in voltage



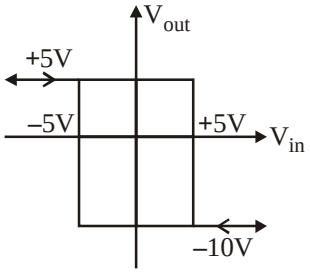
(a)



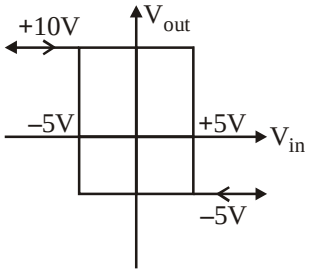
(b)



(c)



(d)



26. In a n-channel JFET, V_{GS} is held constant. V_{DS} is less than the breakdown voltage. As V_{DS} is increased

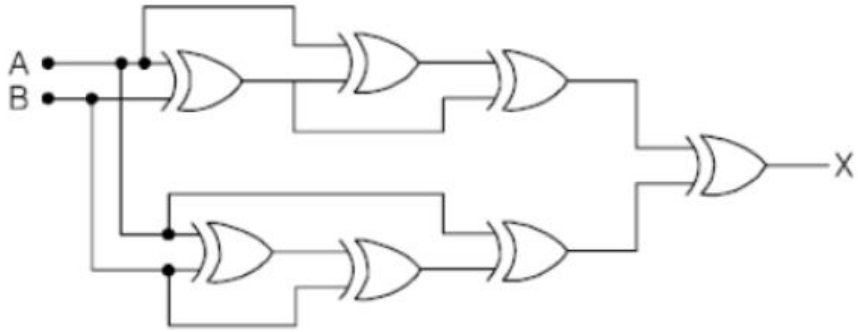
(a) Conducting cross-section area of the channel 'S' and the channel current density 'J' both increase

(b) 'S' decrease and 'J' decerase

(c) 'S' decrease and 'J' increase

(d) 'S' increase and 'J' decrease

27. The output X for the given circuit is



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

28. If a square matrix $A(3\times 3)$ satisfies the equation $A^3 - 8A^2 + 17A - 10I = 0$ and its eigenvalues are given by λ_1, λ_2 and λ_3. Then the value of $\lambda_1\lambda_2 + \lambda_2\lambda_3 + \lambda_3\lambda_1$, is

(a) 17 (b) –17 (c) –34 (d) 34

29. Consider the following differential equation, $\frac{dy}{dx} + y = g(x), 0 \le x < \infty, y(0) = 2$ where,

$$g(x) = \begin{cases} 3 & 0 \le x < \frac{\pi}{2} \\ \cos x & x \ge \frac{\pi}{2} \end{cases}$$

Then,

(a) Solution $y(x) = 3 + e^{-x}$, for $0 \le x < \frac{\pi}{2}$

(b) Continuous solution of differential equation is $y(x) = \frac{1}{2}(\sin x + \cos x) + \left(\frac{5}{2}e^{\frac{\pi}{2}} - 1\right)e^{-x}$, for $x \ge \frac{\pi}{2}$

(c) Contiuous solution of differential equation is $y(x) = \frac{1}{2}(\sin x - \cos x) + \frac{5}{2}(e^{\pi/2} + 1)e^{-x}$, for $x \ge \frac{\pi}{2}$

(d) none of these

30. If the laurent expansion of a complex function $f(z)$ is given as $\sum_{n=1}^{\infty} z^{-n} + \sum_{n=0}^{\infty} \frac{z^n}{2^{n+1}}$ which contains infinitely many negative power terms of z.

Then the point z = 0 is
(a) an essential singularity of the function
(b) a non-essential singularity of the function
(c) we cannot make any claim about whether z = 0 an essential singularity of $f(z)$ simply through the examination of the above series
(d) z = 0 is not a singular point.

31. The equation $3y = z^3 + 3xz$ defines z implicity as a function of x and y. Then z is a solution of the partial differential equation.

(a) $\frac{\partial^2 z}{\partial y^2} + \frac{1}{y}\frac{\partial^2 z}{\partial x^2} = 0$ (b) $x\frac{\partial^2 z}{\partial y^2} + \frac{\partial^2 z}{\partial x^2} = 0$ (c) $\frac{\partial^2 z}{\partial y^2} + x\frac{\partial^2 z}{\partial x^2} = 0$ (d) $x\frac{\partial^2 z}{\partial y^2} + y\frac{\partial^2 z}{\partial x^2} = 0$

32. Consider a physical system with a three dimensional Hilbert space. The Hamiltonian of the system in orthonormal basis of the space is represented by the matrix

$$H = \begin{bmatrix} 2 & 1 & 0 \\ 1 & 2 & 3 \\ 0 & 0 & 3 \end{bmatrix}$$

The system is in the state $|\psi\rangle = \frac{1}{\sqrt{3}}\begin{pmatrix} i \\ -i \\ i \end{pmatrix}$. If energy is measured in this state then probability corresponding to ground state is

(a) $\frac{2}{3}$ (b) $\frac{1}{3}$ (c) $\frac{1}{2}$ (d) $\frac{1}{4}$

33. Consider the rotation operator $\hat{R}_{\hat{n}}(\theta) = \exp\left(\frac{\hat{i}\theta}{2}\hat{n}\cdot\vec{\sigma}\right)$, where $\vec{\sigma}$ is Pauli's spin operator corresponding to spin- ½ and θ is any arbitrary angle and let $|+\rangle$ and $|-\rangle$ be eigenstates of z-component of spin. The correct option is

(a) $\hat{R}_{\hat{z}}\left(\frac{\pi}{2}\right)|+\rangle = \frac{1}{\sqrt{2}}\left(|+\rangle + |-\rangle\right)$ (b) $\hat{R}_{\hat{y}}\left(\frac{\pi}{2}\right)|+\rangle = \frac{1}{\sqrt{2}}\left(|+\rangle - |-\rangle\right)$

(c) $\hat{R}_{\hat{x}}\left(\frac{\pi}{2}\right)|+\rangle = \frac{1}{\sqrt{2}}\left(|+\rangle + |-\rangle\right)$ (d) $\hat{R}_{\hat{x}}\left(-\frac{\pi}{2}\right)|+\rangle = \frac{1}{\sqrt{2}}\left(-i|+\rangle + |-\rangle\right)$

34. Let $\hat{a}$ and $\hat{a}^\dagger$ be lowering and raising operators respectively corresponding to linear harmonic oscillator. The equivalent form of the opertor $e^{+\alpha\hat{a}^\dagger - \alpha^*\hat{a}}$ (where α is complex scalar), is given by

(a) $e^{\alpha\hat{a}^\dagger}\, e^{-\alpha^*\hat{a}}$ (b) $\alpha\hat{a}^\dagger - a^*\hat{a}$ (c) $e^{\frac{|\alpha|^2}{2}}\, e^{\alpha\hat{a}^\dagger}\, e^{-\alpha^*\hat{a}}$ (d) $e^{-\frac{|\alpha|^2}{2}}\, e^{\alpha\hat{a}^\dagger}\, e^{-\alpha^*\hat{a}}$

35. Three moles of an ideal gas (with molar specific heat at constant pressure $=\frac{7}{2}R$) at pressure P_0 and temperature T_0, is isothermally expanded to twice its initial volume. It is then compressed at a constant pressure to its original volume. The net heat supplied to the gas during the complete process is

(a) $3RT_0 \ln 2 - 3RT_0$ (b) $3RT_0 \ln 2 - \frac{3RT_0}{2}$ (c) $3RT_0 \ln 2 - \frac{15}{4}RT_0$ (d) $3RT_0 \ln 2 - \frac{21}{4}RT_0$

36. For isothermal process on an ideal gas, which option is correct?

(a) $\left(\frac{\partial U}{\partial V}\right)_T = \left(\frac{\partial U}{\partial P}\right)_T = 0$ (b) $\left(\frac{\partial H}{\partial P}\right)_T = \left(\frac{\partial H}{\partial V}\right)_T = 0$

(c) $\left(\frac{\partial U}{\partial V}\right)_T = 0$ (d) all are correct.

37. A system is characterized by *N* distinguishable and non interacting atoms in thermal equilibrium with a reservoir at temperature *T*. Each atom can occupy the energy levels $E_n = (n+1)\varepsilon$, $(\varepsilon > 0,\ n = 0,1,2,.....+\infty)$, and the degeneracy of nth level is equal to $g_n = \lambda^n$ with λ>1 . The average energy of the system is

(a) $\frac{\varepsilon}{e^{\varepsilon/kT} - \lambda}$ (b) $\frac{N\varepsilon}{e^{\varepsilon/kT} - \lambda}$ (c) $\frac{N\varepsilon e^{\varepsilon/kT}}{1 - \lambda e^{-\varepsilon/kT}}$ (d) $\frac{N\varepsilon}{1 - \lambda e^{-\varepsilon/kT}}$

38. $\hat{x}$ and $\hat{p}_x$ are quantum mechanical operators corresponding to position and momentum respectively. For any positive constant '*a*' the value of $\left[\hat{x}, \cosh\left(\frac{i\hat{p}_x a}{\hbar}\right)\right]$, is

(a) $ia\cosh\left(\frac{i\hat{p}_x a}{\hbar}\right)$ (b) $-a\sinh\left(\frac{i\hat{p}_x a}{\hbar}\right)$ (c) $a\sinh\left(\frac{i\hat{p}_x a}{\hbar}\right)$ (d) $-ia\cosh\left(\frac{i\hat{p}_x a}{\hbar}\right)$

39. The molar specific heat at constant temperature of a particular material is given by $C_V = aT + bT^3$ in a particular range of temperature. For $a = 1.35\times10^{-3}\ J/K^2$ and $b = 2.48\times10^{-5}\ J/K^2$. The value of absolute entropy at temperature –263ºC is

(a) $1.36\times10^{-3}\ J/K$ (b) $2.18\times10^{-2}\ J/K$ (c) $1.36\times10^{-5}\ J/K$ (d) $2.18\times10^{-8}\ J/K$

40. Consider a particle of mass '*m*' in two dimensional square box of length *L* and the system is perturbed by the following weak potential:

$$V(x,y) = V_0 L^2 \delta\left(x - \frac{L}{2}\right)\delta\left(y - \frac{L}{4}\right)$$

The first order correction to the energy of the ground state is

(a) $2V_0$ (b) V_0 (c) $\frac{V_0}{2}$ (d) $\frac{V_0}{4}$

41. The charge density inside a sphere of radius R is $\rho = k(R - r)$. If electric field on the suface of sphere is E_0, the value of *k* is

(a) $\frac{4\varepsilon_0 E_0}{R^2}$ (b) $\frac{12\varepsilon_0 E_0}{R^2}$ (c) $\frac{3\varepsilon_0 E_0}{R^2}$ (d) $\frac{6\varepsilon_0 E_0}{R^2}$

42. A large sheet having surface charge density σ is lying in *x-y* plane. It is moved with speed v in *y*-direction. The Poynting vector above the sheet is

(a) $\frac{\sigma^2 v}{4\varepsilon_0}\hat{x}$ (b) $\frac{\sigma^2 v}{4\varepsilon_0}\hat{y}$ (c) $\frac{\sigma^2 v}{4\varepsilon_0}\hat{z}$ (d) $\frac{\sigma^2 v}{4\sqrt{2}\varepsilon_0}(\hat{x}+\hat{y})$

43. A dielectric sphere of radius R has polarization $\vec{P} = \beta\hat{r}$. The electric potential at the centre of sphere is

(a) $-\frac{\beta R}{\in_0}$ (b) $\frac{\beta R}{\in_0}$ (c) $\frac{-\beta R^2}{2\in_0}$ (d) $\frac{\beta R^2}{2\in_0}$

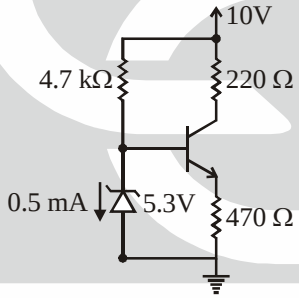
44. A charged particle moves in a uniform magnetic field B in a circular path of radius R. If the strength of the magnetic field is doubled without changing the speed of the particle, the new path will have a radius
(a) 4R (b) 2R (c) R/4 (d) R/2

45. An electric dipole of dipole moment p is placed at d distance from a grounded infinite conducting sheet, with $\vec{p}$ being perpendicular to the sheet. The force on the dipole is

(a) $\frac{3p^2}{16\pi\in_0 d^4}$ (b) $\frac{3p^2}{32\pi\in_0 d^4}$ (c) $\frac{3p^2}{64\pi\in_0 d^4}$ (d) $\frac{p^2}{64\pi\in_0 d^4}$

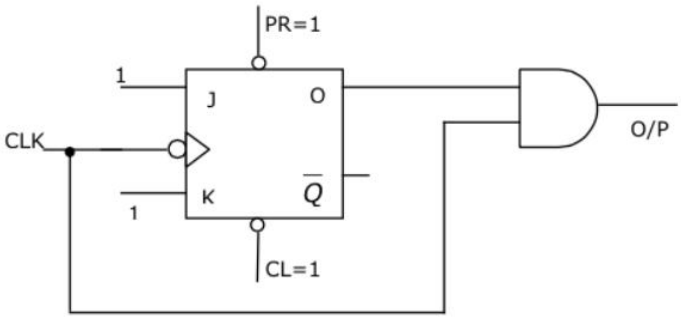
PART-C

46. A transistor circuit is given below. The Zener diode breakdown voltage is 5.3 V as shown. Take base to emitter voltage drop to be 0.6 V. The value of the current gain b is



(a) 16 (b) 18 (c) 19 (d) 20

47. The digital circuit shown in figure generates a modified clock pulse at the output. Choose the correct output waveform form the options given below. (Flip-flop initially reset)



(a)  (b) 

(c)  (d) 

48. Hamiltonian of a system is $H=\frac{p_x^2}{2m}+\frac{1}{2}Kx^2+\alpha x$. If phase space trajectory of the particle is circle then numerical value of angular frequency of small oscillation about stable equilibrium point is

(a) $\frac{1}{m}$ (b) $\frac{1}{2m}$ (c) $\frac{K}{m}$ (d) $2K$

49. For a dynamical system, time evolution of dynamical variable (x) is given as

$$\frac{dx}{dt}=x\sqrt{x^2-1}$$

Which one of the following statements is correct

(a) $x=0$ is unstable fixed point and $x=\pm1$ are stable fixed points

(b) $x=0$ is stable fixed point and $x=\pm1$ are unstable fixed points

(c) $x=0,1$ are stable fixed point and $x=-1$ is unstable fixed points

(d) $x=0,-1$ are stable fixed point and $x=1$ is unstable fixed points

50. Lagrangian of a particle is $L=\frac{1}{2}m(\dot{x}^2+\dot{y}^2)-\alpha(x\dot{y}-y\dot{x})$. If at $t=0, x=0, y=0, \dot{x}=v_0, \dot{y}=0$ then speed of the particle at $t=t$ will be

(a) v_0 (b) $v_0\cos\frac{\alpha t}{m}$

(c) $v_0 e^{\left(\frac{\alpha t}{m}\right)}$ (d) $v_0\cos^2\frac{\alpha t}{m}$

51. Value of Poisson bracket $\{\{L_i,x_j\},\{p_i,L_j\}\}$ is (All the symbols have usual meaning)

(a) 0 (b) 6 (c) –6 (d) 2

52. The fourier transform $f(x)$ is

$$f(k)=\int_{-\infty}^{\infty}dx\,e^{ikx}f(x)$$

If $f(x)=\alpha\,\delta(x^2-a^2)+\beta\,\delta''(bx)$ where $\delta(x)$ is the dirac delta function (and prime denotes derivative), then $f(k)$ is

(a) $\frac{\alpha}{a}\cos ka-\frac{\beta k^2}{b}$ (b) $\frac{\alpha}{a}\sin ka-\frac{\beta k^2}{b}$ (c) $\frac{\alpha}{a}\cos ka+\frac{\beta k^2}{b}$ (d) None of these

53. Consider the complex analytic function $f(z)=u(x,y)+iv(x,y)$, where $u(x,y)=x^2-y^2$ and $z=x+iy$, then which of the following is true

(a) 'u' is harmonic function and $f(z)=\overline{z}^2+\text{constant}$

(b) 'u' is not harmonic and $f(z)=z^2+\text{constant}$

(c) 'u' is harmonic and $f(z)=x^2-y^2+i2xy+\text{constant}$

(d) 'u' is not harmonic and $f(z)=x^2-y^2-i2xy+\text{constant}$

54. An irregular six faced die is thrown and the expectation that in 10 throws it will give 5 even number is twice the expectation that it will give four even numbers. Nearly how many times in 10000 gets of 10 throws would you expect it to give no even numbers?

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

55. In finding the roots of the polynomial $f(x)=x^3-3x-5$. Using iterative Newton-Raphson method, the initial guess is taken to be $x=3$. In the next iteration its value is nearest to

(a) 2.2791 (b) 3.2791 (c) 1.2791 (d) 1.729

56. What would be the ground state energy of a linear harmonic oscillator of mass m and angular frequency ω if variational perinciple is used to estimate it with trial wavefunction

$$\psi(x)=\begin{cases}\cos\left(\dfrac{\pi x}{2a}\right) & -a<x<+a\\ 0 & |x|>a\end{cases}$$

with a as the variational parameter?

(a) $+\dfrac{2}{\pi}\hbar\omega$ (b) $\dfrac{1}{3}\hbar\omega\left(\dfrac{\pi^2-6}{3}\right)^{1/2}$ (c) $\dfrac{1}{3}\hbar\omega\left(\dfrac{\pi^2+6}{3}\right)^{1/2}$ (d) $\dfrac{1}{2}\hbar\omega\left(\dfrac{\pi^2-6}{3}\right)^{1/2}$

57. Consider a system whose unperturbed Hamiltonian H_0 is given by the matrix

$$H_0=\begin{pmatrix}E_0 & 0\\ 0 & E_0\end{pmatrix}$$

and a small perturbation $H'=\begin{pmatrix}0 & -A\\ -A & 0\end{pmatrix}$ is applied to the system.

The correct pair of energy eigenvalue and corresponding eigenfunction by using first order perturbation theory

(a) $E_0-A,\ \dfrac{1}{\sqrt{2}}\begin{bmatrix}1\\-1\end{bmatrix}$ (b) $E_0+A,\ \dfrac{1}{\sqrt{2}}\begin{bmatrix}1\\1\end{bmatrix}$ (c) $E_0-A,\ \dfrac{1}{\sqrt{2}}\begin{bmatrix}1\\1\end{bmatrix}$ (d) $E_0+A,\ \begin{bmatrix}1\\0\end{bmatrix}$

58. The scattering amplitude in the first Born approximation in the scattering amplitude of a particle of mass m and energy $E=\dfrac{\hbar^2k^2}{2m}$ and $b=2k\sin(\theta/2)$ from square well potential $V(x)=\begin{cases}-V_0 & \text{for } r\le a\\ 0 & \text{for } r>a\end{cases}$, if the geometrical radius of the scatterer is much less than the wavelength associated the incident particle, is

(a) $\dfrac{2mV_0a^3}{3\hbar^2}$ (b) $\dfrac{mV_0a^3}{3\hbar^2}$ (c) $\dfrac{2mV_0a^3}{\hbar^2}$ (d) $\dfrac{mV_0a^3}{2\hbar^2}$

59. An atom of tritium in ground state suddenly decays into a He^+ along with the emission of a fast electron and an anti-neutrino without perturbing the extra-nuclear electron. The probability that the He^+ will be in ground state is

(a) 1 (b) $\frac{1}{4}$ (c) $\frac{(2)^9}{(27)^2}$ (d) $\frac{(2)^7}{(27)^2}$

60. The equation for the sublimation and vapourization curves of a particular material are given by

$$\ln p = 0.04 - \frac{6}{T}(\text{sublimation})$$

$$\ln p = 0.03 - \frac{4}{T}(\text{vapourization})$$

where the pressure p is in atmospheric pressure, the temperature T is in kelvin and R is universal gas constant. Assume that the specific volume in vapour phase is much larger than that of liquid and solid phases. The specific latent heat of vapourization is

(a) R (b) $2R$ (c) $6R$ (d) $4R$

61. Consider a system of N and distinguishable particles (in which particles can move in one dimensional segment $q = 0$ and $q = L$) in thermal equilibrium at temperature T. The single particle Hamiltonian is given by

$$H = \frac{p^2}{2m} - \alpha \ell n\left(\frac{q}{L_0}\right),$$

where α is positive constant and L_0 is characteristic length. The equation of state of the system is

(a) $\frac{NKT}{L}$ (b) $\frac{\alpha NKT}{L}\left(1-\frac{\alpha}{kT}\right)$ (c) $\frac{NKT}{L}\left(1+\frac{\alpha}{kT}\right)$ (d) $\frac{NKT}{\alpha L}$

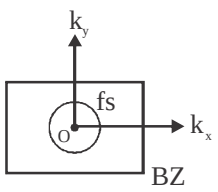
62. The entropy S of a system of N particles at temperature T is given by $S = a(NVU)^{1/3}$, where U and V are internal energy and volume of the system respectively and a is cosntant. If temperature changes to $4T$ then internal energy of the system at constant volume becomes

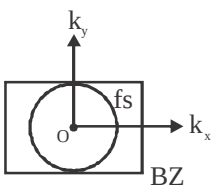
(a) four times (b) two times (c) eight times (d) half

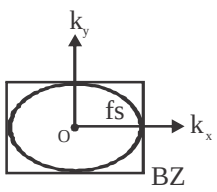
63. X-rays are diffracted from a set of planes with miller indices (110) in NaCl crystal at Bragg angle of 30°. If the lattice parameter (a) of the crystal is 4.2Å, the wavelength λ of the X-rays is:

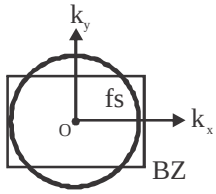
(a) 2.96Å (b) 5.94Å (c) 1.48Å (d) 4.2Å

64. A two-dimensional system consists of a monovalent atom in a rectangular primitive cell with a = 2Å and b = 4Å. Choose the correct sketch of free-electron fermi surface over the first Brillouin zone of the rectangular lattice (where fs denotes the fermi surface and BZ denotes Brillouin zone)

(a) 

(b) 

(c) 

(d) 

65. The α phase of iron above the Curie temperature has a paramagnetic susceptibility satisfying $\chi = \frac{C}{(T - T_C)}$, where C = 2.18 K, and T_C = 1093 K. The spontaneous magnetisation at 0K is 2×10^4 G. The Weiss molecular field in iron at 0K is

(a) 10^5 G (b) 10^6 G (c) 10^7 G (d) 10^8 G

66. The rotational Raman spectra of certian molecule shoes a series of stokes lines at 19230.769 cm^{-1}, 19227.238 cm^{-1}, 19223.707 cm^{-1}. The rotational constant of the molecule in the units of GHz, is

(a) 26.48 (b) 52.97 (c) 105.94 (d) 3.53

67. Light of wavelength 1.5 $\mu m.$ is incident on a material with a characteristic Raman frequency $20\times10^{12}\,Hz$. This results in a stoke-shifted line of wavelength

(a) 1.47 $\mu m.$ (b) 1.57 $\mu m.$ (c) 1.67 $\mu m.$ (d) 1.77 $\mu m.$

68. A sodium atom in the excited 4S state, has a lifetime of 12 ns for decaying to the less excited 3P state. The wavelength of the emitted photon is 589 nm. The corresponding linewidth of the transition will be of the order of

(a) $10^4\,Hz$ (b) $10^7\,Hz$ (c) $10^9\,Hz$ (d) $10^{12}\,Hz$

69. The electric field of an electromagnetic wave is given by $\vec{E} = E_0\left(3\hat{i} + 4\hat{j}\right)\cos k\left(4x - 3y - ct\right)$. The directions of the magnetic field and the poynting vector are

(a) $-\hat{k}, \frac{4\hat{i} + 3\hat{j}}{5}$ (b) $\hat{k}, \frac{4\hat{i} - 3\hat{j}}{5}$ (c) $\frac{4\hat{i} - 3\hat{j}}{5}, \hat{k}$ (d) $\frac{4\hat{i} - 3\hat{j}}{5}, \frac{4\hat{i} + 3\hat{j}}{5}$

70. In a rectangular waveguide for which $a = 1$ cm, $b = 3$ cm,

$$H_x = 2\cos\left(\frac{3\pi y}{b}\right)\sin\left(\pi\times10^{11}t - \beta z\right) A/m$$

Which of the following option is CORRECT.
(a) Mode is TE_{03} and cutoff frequency is 15 GHz
(b) Mode is TM_{03} and cutoff frequency is 15 GHz
(c) Mode is TE_{13} and cutoff frequency is 21.3 GHz
(d) Mode is TM_{13} and cutoff frequency is 21.3 GHz

71. In an inertial reference frame S there are two mutually perpendicular and uniform fields : an electric field of strength 40 kV/m and a magnetic field of strength 0.2 mT. In another inertia frame S', no electric field is observed. The value of magnetic field in S' frame is

(a) 0.15mT (b) 0.25mT (c) 0.3mT (d) 0.4mT

72. A point charge particle having charge '*q*' moves along a circle of radius '*r*' with constant velocity *v*. The average power radiated by the charge particle in one cycle is

(a) $\frac{2qv^4}{3\pi\in_0 r^2}$ (b) $\frac{2q^2v^4}{3\pi\in_0 r^2}$ (c) $\frac{q^2v^4}{6\pi\in_0 r^2}$ (d) $\frac{q^2v^2}{6\pi\in_0 r^2}$

73. A 100 MeV k^+ particle decays as $k^+ \rightarrow \pi^+ + \pi^+ + \pi^-$. The measured value of kinetic energy of one π^+ particle is 68.6 MeVs that of the other π^+ is 80.8 MeV while the kinetic energy of π^- is 75.5 MeV. If the rest mass of π^+ i.e. $m_\pi = 140\ MeV/c^2$, then the rest mass of k^+ is

(a) 124.9 MeV/c^2 (b) 73.6 MeV/c^2 (c) 364.2 MeV/c^2 (d) 544.9 MeV/c^2

74. Read the following statements

(P) In reaction, $\pi^0 + n \rightarrow \bar{k}^0 + \Sigma^0$, strangeness and third component of Isospin are not conserved

(Q) The reaction, $\pi^+ + n \rightarrow k^+ + \Sigma^0$ is allowed by strong interaction

(R) The reaction, $\pi^- + p \rightarrow \Lambda^0 + k^0$ is governed by strong interaction and value of Isospin and its third component are $\frac{3}{2}$ and $-\frac{1}{2}$ respectively for the products.

(S) In reaction, $\pi^+ + n \rightarrow k^0 + k^+$, Baryon number and strangeness are not conserved but charge and third component of isospin are conserved

Which of the following options are correct?

(a) Only P and Q are correct (b) Only P, Q and R are correct

(c) Only P and R are correct (d) Only Q and S are correct

75. According to shell model, the magnetic dipole moment for the nucleus ${}_{83}Bi^{209}$ in terms of nuclear Magneton μ_N is

(a) 3.8 μ_N (b) 1.2 μ_N (c) 2.62 μ_N (d) 0.76 μ_N

Space for rough work

PHYSICAL SCIENCES
TEST SERIES-D

Date : 07-12-2017

FULL LENGTH TEST-1

PART-A

1. (b)	2. (d)	3. (a)	4. (b)	5. (c)	6. (c)	7. (c)
8. (b)	9. (b)	10. (c)	11. (a)	12. (d)	13. (d)	14. (d)
15. (c)	16. (c)	17. (a)	18. (c)	19. (c)	20. (c)	

PART-B

21. (a)	22. (c)	23. (d)	24. (c)	25. (b)	26. (c)	27. (c)
28. (a)	29. (b)	30. (c)	31. (b)	32. (a)	33. (d)	34. (d)
35. (d)	36. (d)	37. (d)	38. (b)	39. (b)	40. (a)	41. (b)
42. (c)	43. (a)	44. (d)	45. (b)			

PART-C

46. (c)	47. (b)	48. (a)	49. (b)	50. (a)	51. (b)	52. (a)
53. (c)	54. (b)	55. (a)	56. (d)	57. (c)	58. (a)	59. (c)
60. (d)	61. (c)	62. (c)	63. (c)	64. (c)	65. (c)	66. (a)
67. (c)	68. (b)	69. (b)	70. (a)	71. (a)	72. (c)	73. (d)
74. (a)	75. (c)					