TEST SERIES CSIR-NET/JRF Dec. 2017

BOOKLET SERIES B

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

PHYSICAL SCIENCES

Duration: 02:00 Hours

Date: 27-11-2017

Maximum Marks: 120

Read the following instructions carefully:

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

Part - A: This part shall carry **10** questions. Each question shall be of **2 marks.**

Part - B: This part shall contain **50** questions. Each question shall be of **2 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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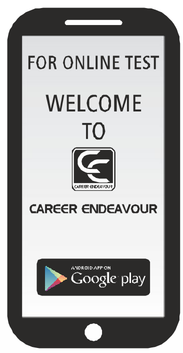

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PART-A : GENERAL APTITUDE

1. The average annual income of certain agricultural workers is S and that of other workers is T. The number of agriculture workers is 11 times that of other workers. Then the average annual income of all the workers is

(a) $\frac{S+T}{2}$ (b) $\frac{S+11T}{2}$ (c) $\frac{1}{11S}+T$ (d) $\frac{11S+T}{12}$

2. Find out the missing number

7	10	11
?	28	3
13	1	14

(a) 9 (b) 8 (c) 15 (d) 6

3. A bag contains 2 red, 3 green and 2 blue balls. Two balls are drawn at random. What is the probability that none of the balls drawn is blue?

(a) $\frac{10}{21}$ (b) $\frac{11}{21}$ (c) $\frac{2}{7}$ (d) $\frac{5}{7}$

4. In a chess tournament each of six players will play with all other players exactly once. How many matches will be played during the tournament?

(a) 12 (b) 15 (c) 30 (d) 36

5. In what ratio must water be mixed with milk to gain $16\frac{2}{3}\%$ on selling the mixture at cost price?

(a) 1 : 6 (b) 6 : 1 (c) 2 : 3 (d) 4 : 3

6. How many times are the hands of a clock at right angle in a day?

(a) 24 (b) 48 (c) 22 (d) 44

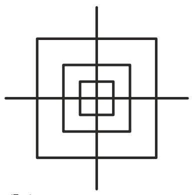
7. How long will a boy take to run round a sequare field of side 35 meters, if he runs at the rate of 9 km/hr?

(a) 50 sec (b) 52 sec (c) 54 sec (d) 56 sec

8. An alloy is to contain copper and zinc in the ratio 9:4. The zinc required to be melted with 24 kg of copper is

(a) $10\frac{2}{3}kg$ (b) $10\frac{1}{3}kg$ (c) $9\frac{2}{3}kg$ (d) $9kg$

9. How many squares are there in the following figure



(a) 13 (b) 14 (c) 15 (d) 16

10. X and Y are two cylinders of the same height. The base of X has diameter that is half the diameter of the base of Y. If the height of X is doubled, the volume of X becomes

(a) equal to the volume of Y (b) double the volume of Y
(c) half the volume of Y (d) greater than the volume of Y.

PART-B : ATOMIC & MOLECULAR PHYSICS, ELECTRONICS & CLASSICAL MECHANICS

11. The wavelength of a spectral line in Positronium atom, which corresponded to Lyman α -line of hydrogen atom, is

(a) 1220Å (b) 2440Å (c) 910Å (d) 3650Å

12. The ground state spectroscopic term for $n\,d^7$ electronic state is :

(a) ${}^4F_{3/2}$ (b) ${}^4F_{9/2}$ (c) ${}^2D_{5/2}$ (d) ${}^2D_{3/2}$

13. The magnetic moment (μ) of an electron in ${}^3P_1$ states is :

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

14. The total number of Zeeman components observed in an electronic transition ${}^2D_{5/2} \to {}^2P_{3/2}$ of an atom in a weak field is

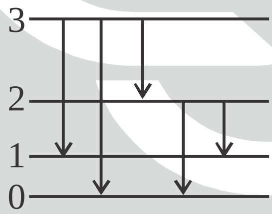
(a) 4 (b) 6 (c) 10 (d) 12

15. The equilibrium vibrational frequency of an IR active molecule is observed at 3000 cm^{-1}. If the ratio of the frequencies of the first overtone and the fundamnetal band is found out to be 1.9, then the anharmonicity constant (x_e) of the oscillator will be

(a) 0.02 (b) 0.045 (c) 0.06 (d) 0.08

16. The figure (shown below) depicts the energy levels of a 4 level atomic system with the Einstein A coefficients as follows:

$$A_{32} = 2\times10^5\ sec^{-1},\ A_{31} = 3.5\times10^5\ sec^{-1},\ A_{30} = 4.5\times10^5\ sec^{-1},$$
$$A_{21} = 1\times10^6\ sec^{-1},\ A_{20} = 4\times10^6\ sec^{-1}$$



The life time of the atomic level 3 is:

(a) 1×10^{-6} sec (b) 1×10^{-7} sec (c) 1.25×10^{-7} sec (d) 1.25×10^{-8} sec

17. Two monochromatic laser sources S_1 and S_2 emits light at 700 nm and 600 nm respectively. If their linewidths are 0.1 nm and 1 pm respectively, then the ratio of frequency bandwidth of S_1 and S_2 will be

(a) 100:1 (b) 75:1 (c) 1:75 (d) 1:100

18. Consider a spectral line arising from $np \to ns$ electronic transition. Under the presence of a strong magnetic field, the spectral line will split into

(a) 3 Components (b) 4 Components (c) 5 Components (d) 6 Components

19. Consider the Zeeman effect of a single electron system for the $3d \to 3p$ electric dipole transition. The fine structure line having the shortest frequency will split into

(a) 6 components (b) 8 components (c) 10 components (d) 14 components

20. The K_α line of an unlnown material has an energy of 66 keV. The atomic number of the unknown material will be

(a) 47 (b) 63 (c) 77 (d) 82

21. The far infrared rotational absorption spectrum of diatomic molecule shows equidistant lines with spacing 10 cm^{-1}. The position of the second anti-stokes line, relative to exciting line, in the rotational Raman spectrum of the molecule is

(a) 20 cm^{-1} (b) 40 cm^{-1} (c) 50 cm^{-1} (d) 60 cm^{-1}

22. If the leading anharmonic correction to the energy of the v-th vibrational level of a diatomic molecule is $-x_e\left(v+\frac{1}{2}\right)^2\hbar\omega$ with $x_e = 0.001$, and the vibrational frequency of the molecule is 4000 cm^{-1}, then dissociation energy of the diatomic molecule will be of the order of

(a) 10^{-12} J (b) 10^{-14} J (c) 10^{-17} J (d) 10^{-19} J

23. A monchromatic source of wavelength of a 0.8 μm is used to pick a particular laser cavity mode in an optical resonator cavity of length 10 cm. The output mode number will be

(a) 250 (b) 2500 (c) 25000 (d) 250000

24. The active medium of He-Ne LASER (operating at 632.8 nm) consists of a mixture of He and Ne gas (in the ratio of 10:1), placed in a discharge tube of length 0.6 m with mirrors attached to the ends. The gain band width of the laser medium is 1.5 GHz. The seperation of the longitudinal modes of the cavity is:

(a) 250 MHz (b) 375 MHz (c) 750 MHz (d) 1200 MHz

25. Atomic number of chlorine (Cl) is 17. The ground state spectroscopic term for chlorine (Cl) is:

(a) ${}^2P_{1/2}$ (b) ${}^2S_{1/2}$ (c) ${}^2P_{3/2}$ (d) ${}^2D_{3/2}$

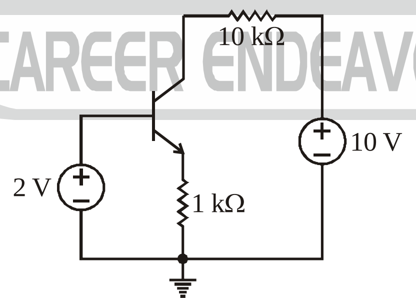
26. A sample of certain element is placed in a magnetic field of 1T and suitably excited. The Zeeman shift for the 600 nm spectral line of this element will be:

(a) 0.085Å (b) 0.17Å (c) 1Å (d) 0.34Å

27. The wavelength of a certain transition from excited state, of life time 1.6 ns, is 3000Å. Then coefficient of stimulated emisiuon (B) is (in m^3/J-s^2)

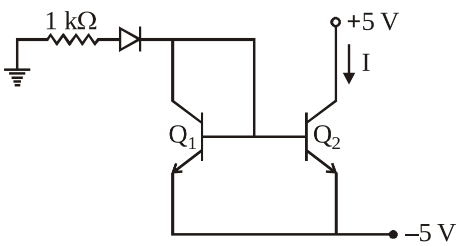
(a) 10^{21} (b) 10^{-21} (c) 10^{12} (d) 10^{-12}

28. For the BJT circuit shown, assume that the β of the transistor is very large and V_{BE} = 0.7 V. The mode of operation of the BJT is



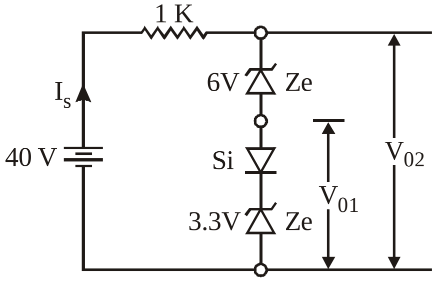
(a) cut-off (b) saturation (c) normal active (d) reserve active

29. Two perfectly matched silicon transistor are connected as shown in the figure. Assuming the β of the transistors to be very high and the forward voltage drop in diodes to be 0.7 V, the value of current I is



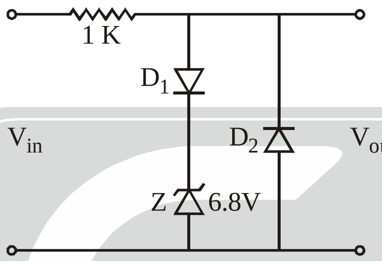
(a) 0 mA (b) 3.6 mA (c) 4.3 mA (d) 5.7 mA

30. A 40 V dc supply is connected across the network comprising of Zener and silicon diodes as shown. The regulated voltages V_{01}, V_{02} and source current I_s are



(a) 2.4 V, 5.1 V and 21.7 mA
(b) 3 V, 6 V and 22.7 mA
(c) 3.3 V, 9.3 V and 20.5 mA
(d) 4 V, 10 V and 20 mA

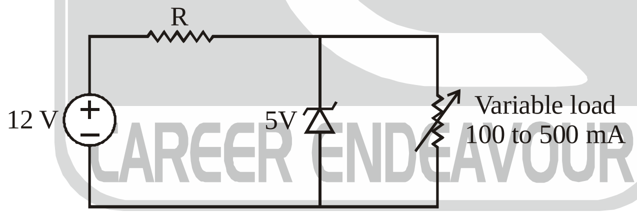
31. In the following limiter circuit, an input voltage $V_i = 100 \sin 100\pi t$ is applied. Assume that the diode drop is 0.7 V when it is forward biased. The Zener breakdown voltage is 6.8 V.



The maximum and minimum values of the output voltage respectively are

(a) 6.1 V, –0.7 V (b) 0.7 V, –7.5 V (c) 7.5 V, –0.7 V (d) 7.5 V, –7.5 V

32. In the voltage regulator shown in the figure, the load current can vary from 100 mA to 500 mA. Assuming that the Zener knee current is negligibly small and Zener resistance is zero in the breakdown region), the value of R is



(a) 7Ω (b) 70Ω (c) $\frac{70}{3}\Omega$ (d) 14Ω

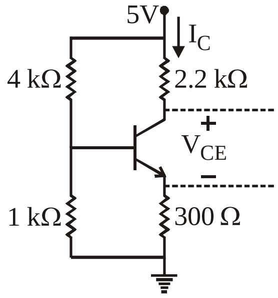
33. A planet of mass m revolves around the sun of mass M (assumed to be at rest) in elliptical orbit of semi-major axis 'a'. Maximum and minimum speed of planet in its orbit are v_1 and v_2 respectively. Angular momentum of planet about centre of force is

(a) $\frac{mv_1v_2a}{v_1+v_2}$ (b) $\frac{2mv_1v_2a}{v_1+v_2}$ (c) $2m(v_1+v_2)a$ (d) $2m\sqrt{v_1v_2}\,a$

34. A particle of mass m moving with speed v collides elastically with another stationary particle of same mass. After collision if angle of scattering in centre of mass frame is 60° then speed of second particle in lab frame is

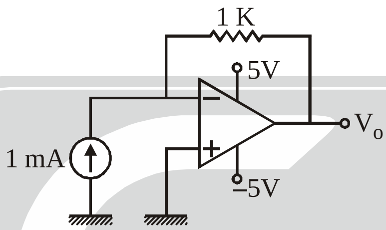
(a) $\frac{v}{\sqrt{2}}$ (b) $\frac{\sqrt{3}}{2}v$ (c) $\frac{v}{2}$ (d) $\frac{v}{\sqrt{3}}$

35. Assuming that the β of the transistor is extremely large and $V_{BE} = 0.7\,V$, I_C and V_{CE} in the circuit shown in the figure are :



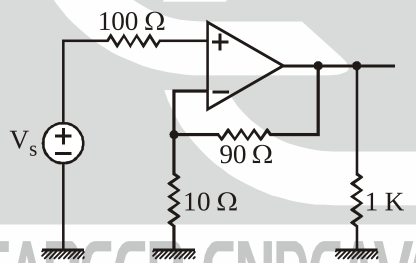
(a) $I_C = 1\,mA,\ V_{CE} = 4.7\,V$
(b) $I_C = 0.5\,mA,\ V_{CE} = 3.75\,V$
(c) $I_C = 1\,mA,\ V_{CE} = 2.5\,V$
(d) $I_C = 0.5\,mA,\ V_{CE} = 3.9\,V$

36. The circuit shown in figure uses an ideal op-amp working with +5 V and –5 V power supplies. The output voltage V_o is equal to



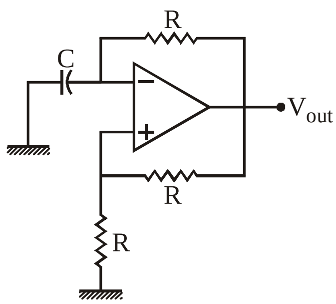
(a) +5 V
(b) –5 V
(c) +1 V
(d) –1 V

37. The feedback factor for the circuit shown in figure is



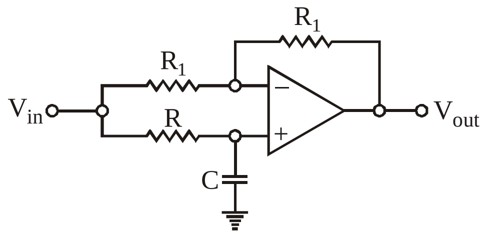
(a) 9/100
(b) 9/10
(c) 1/9
(d) 1/10

38. For the oscillator circuit shown in figure. The expression for the time period of oscillation can be given by (where τ = RC)



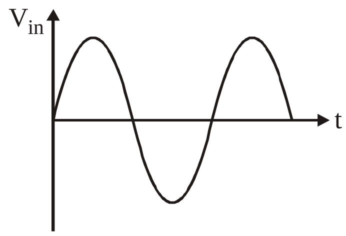
(a) τ ln 3
(b) 2τ ln 3
(c) τ ln 2
(d) 2τ ln 2

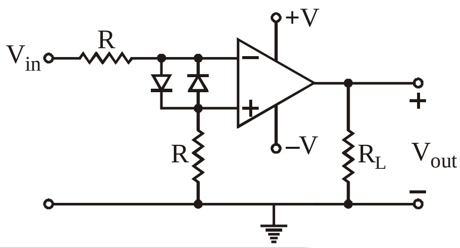
39. For the circuit of figure with an ideal operational amplifier, the maximum phase shift of the output V_{out} with reference to the input V_{in} is

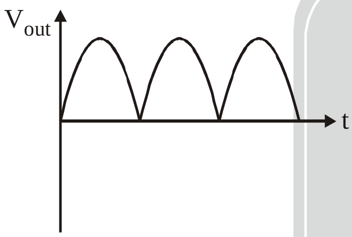


(a) 0º (b) –90º (c) +90º (d) ±180º

40. In figure, if the input is a sinusoidal signal, the output will appear as shown in





(a)


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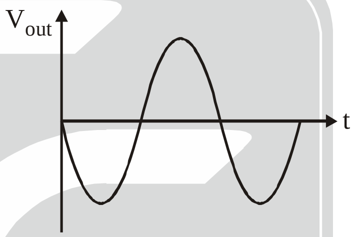
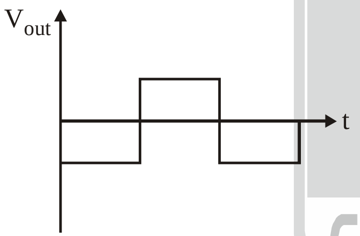
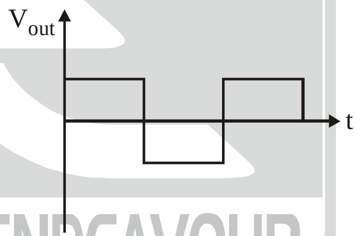


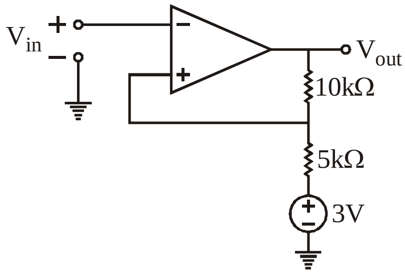
(c)


(d)


41. An op-amp has a slew rate of 5V/µs. The largest sine wave output voltage possible at a frequency of 1 MHz is

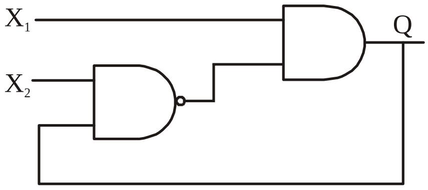
(a) 10πV (b) 5V (c) $\frac{5}{\pi}$V (d) $\frac{5}{2\pi}$V

42. For the operational amplifier circuit shown, the output saturation voltages are ± 15 V. The upper and lower threshold voltages for the circuit are, respecively.



(a) +5 V and –5 V (b) +7 V and –3 V (c) +3 V and –7 V (d) +3 V and –3 V

43. In figure, as long as $X_1 = 1$ and $X_2 = 1$, the output Q remains



(a) At 1 (b) At 0 (c) At its initial value (d) Unstable

44. The truth table for implementing a boolean variable F is given by

C	B	A	F
0	0	0	d
0	0	1	1
0	1	0	1
0	1	1	d
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

where d represents do not care states. The minimized expression for F is

(a) $B.\bar{C} + A.\bar{C} + A.B$ (b) $A.B + \bar{C}$

(c) $\bar{A}.B.\bar{C} + A.\bar{B}.\bar{C} + A.B.C$ (d) None of the above

45. A particle of mass m falls from height h ($\ll$ radius of earth). A viscous drag force bv also acts on particle in addition to gravity where 'b' is constant and v is instantaneous speed. If g is acceleration due to gravity then acceleration of particle after time t is

(a) g (b) $ge^{-\frac{bt}{m}}$

(c) $ge^{\frac{bt}{m}}$ (d) $g\left(1+\frac{bt}{m}\right)$

46. Lagrangian of a system is $L = \frac{1}{2}m(\dot{x}^2 + \dot{y}^2) - a(x\dot{y} + y\dot{x})$. Hamiltonian of system will be

(a) $\frac{p_x^2 + p_y^2}{2m} + \frac{a^2(x^2+y^2)}{2m} + \frac{a}{m}(xp_y + yp_x)$

(b) $\frac{p_x^2 + p_y^2}{2m} - \frac{a^2(x^2+y^2)}{2m} + \frac{a}{m}(xp_y + yp_x)$

(c) $\frac{p_x^2 + p_y^2}{2m} + \frac{a^2(x^2+y^2)}{2m} + \frac{a}{m}(xp_y - yp_x)$

(d) $\frac{p_x^2 + p_y^2}{2m} + \frac{a^2(x^2+y^2)}{2m}$

47. Hamiltonian of a system is $H = \frac{p_x^2}{2m}e^{-\gamma t} + \frac{1}{2}Kx^2e^{\gamma t}$ Lagrangian of a system is

(a) $e^{\gamma t}\left(\frac{1}{2}m\dot{x}^2 - \frac{1}{2}Kx^2\right)$ (b) $e^{-\gamma t}\left(\frac{1}{2}m\dot{x}^2 - \frac{1}{2}Kx^2\right)$

(c) $e^{-\gamma t}\frac{1}{2}m\dot{x}^2 - e^{\gamma t}\frac{1}{2}Kx^2$ (d) $e^{\gamma t}\frac{1}{2}m\dot{x}^2 - \frac{1}{2}Kx^2e^{-\gamma t}$

48. Two particles of masses m and $2m$ are connected by light spring of spring constant K. x_1 and x_2 denote the coordinates of m and $2m$ respectively. If at $t = 0$, $x_1 = 0$, $x_2 = A$, then which of the following is correct

(a) $x_1 = A\sin\left(\sqrt{\frac{3K}{2m}}t\right)$, $x_2 = A\cos\left(\sqrt{\frac{3K}{2m}}t\right)$ (b) $|x_2 - x_1| = A\cos\left(\sqrt{\frac{3K}{2m}}t\right)$

(c) $|x_2 - x_1| = A\cos\left(\sqrt{\frac{K}{m}}t\right)$ (d) $|x_2 - x_1| = A\cos\left(\sqrt{\frac{3K}{m}}t\right)$

49. Lagrangian of a particle is $L = \frac{1}{2}m\dot{x}^2 - \frac{1}{2}m\omega^2x^2 - m\omega^2x\dot{x}t$. If at $t = 0$, $x = 0$ and $\dot{x} = v_0$ then velocity of particle at the moment particle is at $x = A$ is

(a) v_0 (b) ωA (c) zero (d) $\sqrt{v_0^2 - \omega^2A^2}$

50. Lagrangian of a particle is $L = \frac{1}{2}m\dot{x}^2 + bx\dot{x}$. Shape of phase space trajectory of the particle is

(a) circle (b) parabola (c) hyperbola (d) straight line

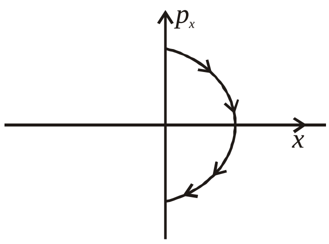
51. A particle moving under central force has mass m, energy E and angular momentum L. If $r = r_0$ be turning point then speed of the particle at this point is

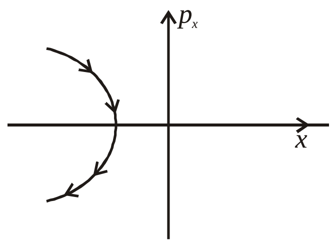
(a) $\sqrt{\frac{2E}{m}}$ (b) $\frac{L}{mr_0}$ (c) $\sqrt{\frac{2}{m}\left(E - \frac{L^2}{mr_0^2}\right)}$ (d) $\sqrt{\frac{2}{m}\left(E + \frac{L^2}{mr_0^2}\right)}$

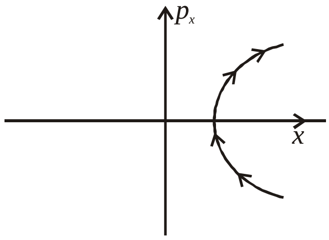
52. A uniform rectangular plate has mass M and sides 'a' and '$2a$'. Moment of inertia of plate about an axis through one corner and perpendicular to plane is

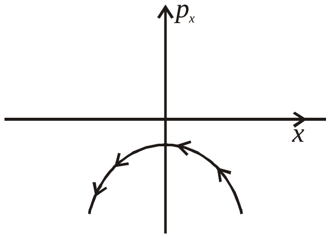
(a) $\frac{5Ma^2}{12}$ (b) $\frac{3Ma^2}{4}$ (c) $\frac{5Ma^2}{3}$ (d) $\frac{7Ma^2}{12}$

53. Phase space trajectory of a particle moving in potential $V(x) = x + 2$ for energy $E = -2$ is

(a) 

(b) 

(c) 

(d) 

54. If $A=\frac{p^2}{2}-\frac{1}{2q^2}, B=\frac{pq}{2}$, Poisson bracket $\{B, A\}$ is equal to

(a) B (b) zero (c) A (d) –A

55. Hamiltonian of a system is $H=\sqrt{p_x^2+1}-1$. Shape of $x-t$ graph for the particle is

(a) straight line (b) parabola (c) hyperbola (d) ellipse

56. In lab frame two events occur simultaneously. An observer moving along the line joining the two events with velocity v_1 with respect to lab finds them to occur at a time difference Δt_1 while another observer moving in same direction with velocity v_2 with respect to lab finds the time difference to be Δt_2. Value of $\frac{\Delta t_1}{\Delta t_2}$ is

(a) $\frac{v_1}{v_2}$ (b) $\frac{v_2}{v_1}$ (c) $\frac{v_1}{v_2}\sqrt{\frac{c^2-v_1^2}{c^2-v_2^2}}$ (d) $\frac{v_1}{v_2}\sqrt{\frac{c^2-v_2^2}{c^2-v_1^2}}$

57. Proper mean life time of an unstable radioactive particle moving lab frame is $4\mu s$ and it is found to travel a distance of 900 meter. Speed of the particle is

(a) $0.5c$ (b) $0.6c$ (c) $0.8c$ (d) $0.4c$

58. Hamiltonian of a particle moving on *x-y* plane is $H=\frac{(p_x-y)^2+(p_y-x)^2}{2m}$ which of the following is conserved.

(a) only H (b) H, p_x, p_y (c) H, L_z (d) H, p_x, p_y, L_z

59. Poisson bracket of canonical coordinate with Hamiltonian is equal to canonical momentum and Poisson bracket of canonical momentum with Hamiltonian is equal to canonical coordinate for a particle moving in one dimension. Shape of phase space trajectory of the particle is

(a) straight line (b) parabola (c) circle (d) hyperbola

60. A canonical transformation $(q, p \to Q, P)$ is made through the generating function $F(q,P)=q^2P$ on the Hamiltonian $H(q,p)=\frac{p^2}{4q^2}+q^4$. Shape of phase space trajectory on the Q – P plane is

(a) straight line (b) circle (c) parabola (d) hyperbola

Space for rough work

PHYSICAL SCIENCES
TEST SERIES-B

Date : 27-11-2017

ANSWER KEY

PART-A

1. (d)	2. (b)	3. (a)	4. (b)	5. (a)	6. (d)	7. (d)
8. (a)	9. (c)	10. (c)				

PART-B

11. (b)	12. (b)	13. (c)	14. (d)	15. (b)	16. (a)	17. (b)
18. (a)	19. (c)	20. (d)	21. (c)	22. (c)	23. (d)	24. (a)
25. (c)	26. (b)	27. (a)	28. (b)	29. (b)	30. (d)	31. (c)
32. (d)	33. (b)	34. (b)	35. (c)	36. (d)	37. (d)	38. (d)
39. (d)	40. (c)	41. (d)	42. (c)	43. (d)	44. (b)	45. (b)
46. (a)	47. (a)	48. (b)	49. (a)	50. (d)	51. (b)	52. (c)
53. (b)	54. (c)	55. (c)	56. (d)	57. (b)	58. (c)	59. (d)
60. (b)						