PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

CSIR NET Physics - June 2015 - Full Paper

Complete question paper with answer key

75 questions . Answer key included

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Q1. [June 2015] . 2.0 marks
General Aptitude > Reasoning

CSIR NET	2015 June	2 M

Each of the following pairs of words hides a number, based on which you can arrange them in ascending order. Pick the correct answer:

I. Cloth reel
J. Silent wonder
K. Good tone
L. Bronze rod

1. L, K, J, I
2. I, J, K, L
3. K, L, J, I
4. K, J, I, L

Q2. [June 2015] . 2.0 marks
General Aptitude > Mathematical Analysis

CSIR NET	2015 June	2 M

Which of the following values is same as $2^{2^{2^2}}$?

1. 2^6
2. 2^8
3. 2^{16}
4. 2^{222}

Q3. [June 2015] . 2.0 marks

General Aptitude > Geometry

CSIR NET	2015 June	2 M

A $12\text{m} \times 4\text{m}$ rectangular roof is resting on four 4m tall thin poles. Sunlight falls on the roof at an angle of $45°$ from the east, creating a shadow on the ground. What will be the area of the shadow?

1. 24m^2
2. 36m^2
3. 48m^2
4. 60m^2

Q4. [June 2015] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2015 June	2 M

If

$$\begin{array}{r} 2a \\ \times \quad b2 \\ \hline c6 \\ 84 \\ \hline 8\,d\,6 \\ \hline \end{array}$$

Here a, b, c, d are digits.

Then a + b =

1. 4
2. 9
3. 11
4. 16

Q5. [June 2015] . 2.0 marks
General Aptitude > Geometry

CSIR NET	2015 June	2 M

The maximum number of points formed by intersection of all pairs of diagonals of convex octagon is

1. 70
2. 400
3. 120
4. 190

Q6. [June 2015] . 2.0 marks
General Aptitude > Geometry

CSIR NET	2015 June	2 M

Find the height of a box of base area 24 cm 48 cm, in which the longest stick that can be kept is 56 cm long.

1. 8 cm
2. 32 cm
3. 37.5 cm
4. 16 cm

Q7. [June 2015] . 2.0 marks
General Aptitude > Geometry

CSIR NET	2015 June	2 M

The product of the perimeter of a triangle, the radius of its in-circle, and a number gives the area of the triangle. The number is

1. $^1/_4$
2. $^1/_3$
3. $^1/_2$
4. 1

Q8. [June 2015] . 2.0 marks
General Aptitude > Geometry

CSIR NET	2015 June	2 M

An infinite row of boxes is arranged. Each box has half the volume of the previous box. If the largest box has a volume of 20 cc, what is the total volume of all boxes'?

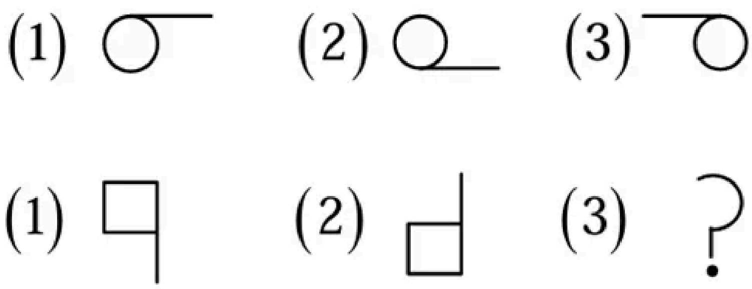
1. Infinite
2. 400 cc
3. 40 cc
4. 80 cc

Q9. [June 2015] . 2.0 marks

General Aptitude > Reasoning

CSIR NET	2015 June	2 M

Find the missing element based on the given pattern

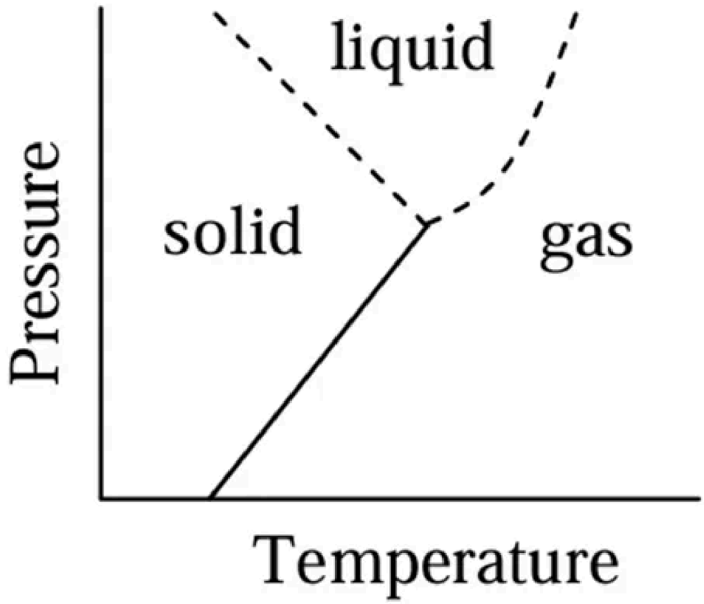


Q10. [June 2015] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2015 June	2 M

By reading the accompanying graph, determine the INCORRECT statement out of the following.



1. Melting point increases with pressure
2. Melting point decreases with pressure
3. Boiling point increases with pressure
4. Solid. liquid and gas can co-exist at the same pressure and temperature

Q11. [June 2015] . 2.0 marks

General Aptitude > Mathematical Analysis

CSIR NET	2015 June	2 M

If you change only one observation from a set of 10 observations, which of the following will definitely change?

1. Mean
2. Median
3. Mode
4. Standard Deviation

Q12. [June 2015] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2015 June	2 M

A man starts his journey at 0100 Hrs local time to reach another country at 0900 Hrs local time on the same date. He starts a return journey on the same night at 2100 Hrs local time to his original place, taking the same time to travel back. If the time zone of his country of visit lags by 10 hours, the duration for which the man was away from his place is

1. 48 hours
2. 20 hours
3. 25 hours
4. 36 hours

Q13. [June 2015] . 2.0 marks
General Aptitude > Mathematical Analysis

CSIR NET	2015 June	2 M

Let r be a positive number satisfying

$$r^{(1/1234)} + r^{(-1/1234)} = 2$$

Then

$$r^{4321} + r^{-4321} = ?$$

1. 2
2. $2^{(4321/1234)}$
3. 2^{3087}
4. 2^{1234}

Q14. [June 2015] . 2.0 marks
General Aptitude > Basic Physics

CSIR NET	2015 June	2 M

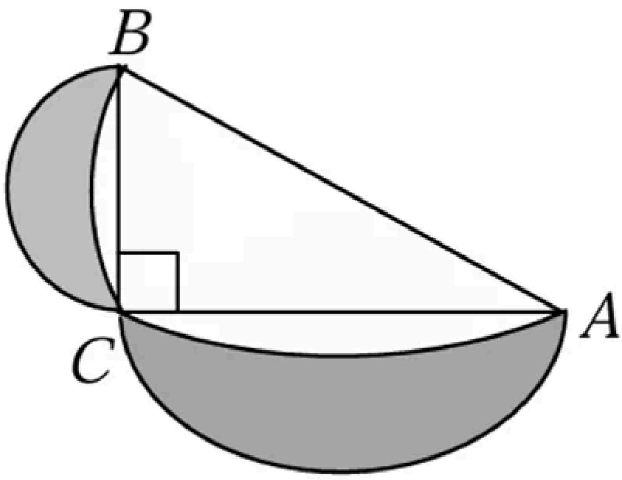
A float is drifting in a river, 10 m downstream of a boat that can be rowed at a speed of 10m/ minute in still water. If the boat is rowed downstream, the time taken to catch up with the float

1. will be 1 minute
2. will be more than 1 min
3. will be less than 1 min
4. can be determined only if the speed of the river is known

Q15. [June 2015] . 2.0 marks
General Aptitude > Geometry

CSIR NET	2015 June	2 M

ABC is a right-angled triangle inscribed in a semicircle. Smaller semicircles are drawn on sides BC and AC . If the area of the triangle is a, what is the total area of the shaded lumes?



1. a
2. π a
3. a /π
4. a /2π

Q16. [June 2015] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2015 June	2 M

An ant can lift another ant of its size whereas an elephant cannot lift another elephant of its size, because

1. ant muscle fibres are stronger than elephant muscle fibres.
2. ant has proportionately thicker legs than elephant
3. strength scales as the square of the size while weight scales as cube of the size
4. ants work cooperatively, whereas elephants work as individuals

Q17. [June 2015] . 2.0 marks
General Aptitude > Reasoning

CSIR NET	2015 June	2 M

Consider a series of letters placed in the following way:

U_G_C_C_S_I_R

Each letter moves one step to its right and the extreme right letter takes the first position, completing one operation. After which of the following numbers of operations do the Cs not sit side by side?

1. 3
2. 10
3. 19
4. 25

Q18. [June 2015] . 2.0 marks
General Aptitude > Geometry

CSIR NET	2015 June	2 M

An inclined plane rests against a horizontal cylinder of radius R. If the plane makes an angle of $30°$ with the ground, the point of contact of the plane with the cylinder is at a height of

1. $1.500\ R$
2. $1.866\ R$
3. $1.414\ R$
4. $1.000\ R$

Q19. [June 2015] . 2.0 marks
General Aptitude > Geometry

CSIR NET	2015 June	2 M

What is the maximum number of parallel, non-overlapping cricket pitches(length 24 m , width 3m) that can be laid in a field of diameter 140 m , if the boundary is required to be at least 60 m from the centre of any pitch?

1. 6
2. 7
3. 12
4. 4

Q20. [June 2015] . 2.0 marks

General Aptitude > Basic Physics

CSIR NET	2015 June	2 M

In a fast-moving car with open windows, the driver feels a continuous incoming breeze. The pressure inside the car, however, does not keep increasing because,

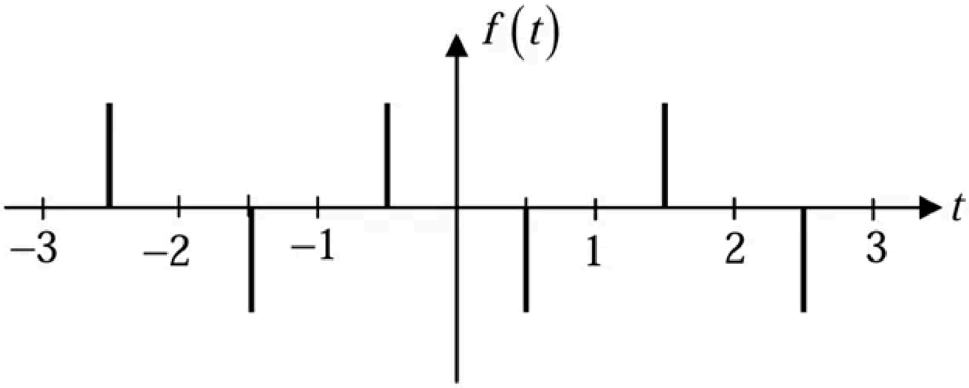
1. air coming in from the front window goes out from the rear.
2. air comes in as well as goes out through every window but the driver only feels the incoming one.
3. no air actually comes in and the feeling of breeze is an illusion.
4. cool air reduces the temperature therefore the pressure does not increase.

Q21. [June 2015] . 3.5 marks

Mathematical Physics > Fourier Series

CSIR NET	2015 June	3.5 M

Consider the periodic function f(t) with time period T as shown in the figure below



The spikes, located at $t = \frac{1}{2}(2n-1)$, where $n = 0, \pm1, \pm2, \cdots$, are Dirac-delta functions of strength ±1. The amplitudes a_n in the Fourier expansion

$$f(t) = \sum_{n=-\infty}^{\infty} a_n e^{2\pi i n t/T}$$

are given by

1. $(-1)^n$
2. $\frac{1}{n\pi}\sin\frac{n\pi}{2}$
3. $i\sin\frac{n\pi}{2}$
4. $n\pi$

Q22. [June 2015] . 3.5 marks
Mathematical Physics > Vector Algebra and Vector Calculus

CSIR NET	2015 June	3.5 M

A particle moves in two dimensions on the ellipse $x^2 + 4y^2 = 8$. At a particular instant it is at the point $(x, y) = (2,1)$ and the x-component of its velocity is 6 (in suitable units). Then the y-component of its velocity is

1. -3
2. -2
3. 1
4. 4

Q23. [June 2015] . 3.5 marks
Mathematical Physics > Ordinary Differential Equations

CSIR NET	2015 June	3.5 M

Consider the differential equation

$\frac{d^2x}{dt^2} - 3\frac{dx}{dt} + 2x = 0$. If $x = 0$ at $t = 0$ and $x = 1$ at $t = 1$, the value of x at $t = 2$ is

1. $e^2 + 1$
2. $e^2 + e$
3. $e + 2$
4. $2e$

Q24. [June 2015] . 3.5 marks
Mathematical Physics > Complex analysis

CSIR NET	2015 June	3.5 M

The value of the integral $\int_{-\infty}^{\infty} \frac{dx}{1+x^4}$ is

1. $\frac{\pi}{\sqrt{2}}$
2. $\frac{\pi}{2}$
3. $\sqrt{2}\pi$
4. 2π

Q25. [June 2015] . 3.5 marks
Mathematical Physics > Laplace transform

CSIR NET	2015 June	3.5 M

The Laplace transform of $6t^3 + 3\sin 4t$ is

1. $\frac{36}{s^4} + \frac{12}{s^2+16}$
2. $\frac{36}{s^4} + \frac{12}{s^2-16}$
3. $\frac{18}{s^4} + \frac{12}{s^2-16}$
4. $\frac{36}{s^3} + \frac{12}{s^2+16}$

Q26. [June 2015] . 3.5 marks

Classical Mechanics > Lagrangian and Hamiltonian

CSIR NET	2015 June	3.5 M

If the Lagrangian of a dynamical system in two dimensions is $L = \frac{1}{2}m\dot{x}^2 + m\dot{x}\dot{y}$, then its Hamiltonian is

1. $H = \frac{1}{m}p_x p_y + \frac{1}{2m}p_y^2$
2. $H = \frac{1}{m}p_x p_y + \frac{1}{2m}p_x^2$
3. $H = \frac{1}{m}p_x p_y - \frac{1}{2m}p_y^2$
4. $H = \frac{1}{m}p_x p_y - \frac{1}{2m}p_x^2$

Q27. [June 2015] . 3.5 marks
Classical Mechanics > Oscillations

CSIR NET	2015 June	3.5 M

A particle of mass m moves in the one-dimensional potential $V(x) = \frac{\alpha}{3}x^3 + \frac{\beta}{4}x^4$ where $\alpha, \beta > 0$. One of the equilibrium points is $x = 0$. The angular frequency of small oscillations about the other equilibrium point is

1. $\frac{2\alpha}{\sqrt{3m\beta}}$
2. $\frac{\alpha}{\sqrt{m\beta}}$
3. $\frac{\alpha}{\sqrt{12m\beta}}$
4. $\frac{\alpha}{\sqrt{24m\beta}}$

Q28. [June 2015] . 3.5 marks
Classical Mechanics > Central forces

CSIR NET	2015 June	3.5 M

A particle of unit mass moves in the xy plane in such a way that $\dot{x}(t) = y(t)$ and $\dot{y}(t) = -x(t)$. We can conclude that it is in a conservative force-field which can be derived from the potential

1. $\frac{1}{2}(x^2 + y^2)$
2. $\frac{1}{2}(x^2 - y^2)$
3. $x + y$
4. $x - y$

Q29. [June 2015] . 3.5 marks

Classical Mechanics > Special theory of relativity

CSIR NET	2015 June	3.5 M

Consider three inertial frames of reference A. B and C. The frame B moves with a velocity $c/2$ with respect to A , and C moves with a velocity $c/10$ with respect to B in the same direction. The velocity of C as measured in A is

1. $\frac{3c}{7}$
2. $\frac{4c}{7}$
3. $\frac{c}{7}$
4. $\frac{\sqrt{3}c}{7}$

Q30. [June 2015] . 3.5 marks

Electromagnetism > EM Waves

CSIR NET	2015 June	3.5 M

A plane electromagnetic wave is travelling along the positive z-direction. The maximum electric field along the x direction is $10 \mathrm{~V/m}$. The approximate maximum values of the power per unit area and the magnetic induction B, respectively, are

1. 3.3×10^{-7} watts $/\mathrm{m}^2$ and 10 tesla
2. 3.3×10^{-7} watts $/\mathrm{m}^2$ and 3.3×10^{-8} tesla
3. 0.265 watts $/\mathrm{m}^2$ and 10 tesla
4. 0.265 watts $/\mathrm{m}^2$ and 3.3×10^{-8} tesla

Q31. [June 2015] . 3.5 marks

Electromagnetism > Electrostatics

CSIR NET	2015 June	3.5 M

Suppose the yz-plane forms a chargeless boundary between two media of permittivities ϵ_{left} and ϵ_{right} where $\epsilon_{\text{left}} : \epsilon_{\text{right}} = 1:2$. If the uniform electric field on the left is $\vec{E}_{\text{left}} = c(\hat{\imath} + \hat{\jmath} + \hat{k})$ (where c is a constant), then the electric field on the right $\vec{E}_{\text{right}}$ is

1. $c(2\hat{\imath} + \hat{\jmath} + \hat{k})$
2. $c(\hat{\imath} + 2\hat{\jmath} + 2\hat{k})$
3. $c\left(\frac{1}{2}\hat{\imath} + \hat{\jmath} + \hat{k}\right)$
4. $c\left(\hat{\imath} + \frac{1}{2}\hat{\jmath} + \frac{1}{2}\hat{k}\right)$

Q32. [June 2015] . 3.5 marks
Electromagnetism > Magetostatics

CSIR NET	2015 June	3.5 M

A proton moves with a speed of $300 \text{ m}/s$ in a circular orbit in the xy-plane in a magnetic field 1 tesla along the positive z direction. When an electric field of 1 V/m is applied along the positive y-direction. the centre of the circular orbit

1. remains stationary
2. moves at $1 \text{ m}/s$ along the negative x direction
3. moves at $1 \text{ m}/s$ along the positive z direction
4. moves at $1 \text{ m}/s$ along the positive x direction

Q33. [June 2015] . 3.5 marks
Electromagnetism > Potential Formulation

CSIR NET	2015 June	3.5 M

Which of the following transformations $(V, \vec{A}) \to (V', \vec{A}')$ of the electrostatic potential V and the vector potential $\vec{A}$ is a gauge transformation?

1. $\left(V' = V + ax, \vec{A}' = \vec{A} + at\hat{k}\right)$
2. $\left(V' = V + ax, \vec{A}' = \vec{A} - at\hat{k}\right)$
3. $\left(V' = V + ax, \vec{A}' = \vec{A} + at\,\hat{i}\right)$
4. $\left(V' = V + ax, \vec{A}' = \vec{A} - at\hat{i}\right)$

Q34. [June 2015] . 3.5 marks
Quantum Mechanics > Potential Well

CSIR NET	2015 June	3.5 M

The ratio of the energy of the first excited state E_1, to that of the ground state E_0, of a particle in a three-dimensional rectangular box of sides L, L and $L/2$, is

I. 3:2

2. $2:1$

3. $4:1$

4. $4:3$

Q35. [June 2015] . 3.5 marks
Quantum Mechanics > Basic Quantum Mechanics

CSIR NET	2015 June	3.5 M

The wavefunction of a particle in onedimension is denoted by $\psi(x)$ in the coordinate representation and by $\phi(p) = \int \psi(x) e^{-ipx/h} dx$ in the momentum representation. If the action of an operator $\hat{T}$ on $\psi(x)$ is given by $\hat{T}\psi(x) = \psi(x + a)$, where a is a constant, then $\hat{T}\phi(p)$ is given by

1. $-\frac{i}{h} ap\phi(p)$
2. $e^{-iap/\hbar}\phi(p)$
3. $e^{+iap/h}\phi(p)$
4. $\left(1 + \frac{i}{h} ap\right)\phi(p)$

Q36. [June 2015] . 3.5 marks
Quantum Mechanics > Orbital angular Momentum and Hydrogen atom

CSIR NET	2015 June	3.5 M

If L_i are the components of the angular momentum operator $\vec{L}$, then the operator $\sum_{i=1,2,3}\left[\left[\vec{L}, L_i\right], L_i\right]$ equals

1. $\vec{L}$
2. $2\vec{L}$
3. $3\vec{L}$
4. $-\vec{L}$

Q37. [June 2015] . 3.5 marks

Quantum Mechanics > Basic Quantum Mechanics

CSIR NET	2015 June	3.5 M

A particle moves in one dimension in the potential $V = \frac{1}{2}k(t)x^2$, where $k(t)$ is a time dependent parameter. Then $\frac{d}{dt}\langle V\rangle$. the rate of change of the expectation value $\langle V\rangle$ of the potential energy, is

1. $\frac{1}{2}\frac{dk}{dt}\langle x^2\rangle + \frac{k}{2m}\langle xp + px\rangle$
2. $\frac{1}{2}\frac{dk}{dt}\langle x^2\rangle + \frac{1}{2m}\langle p^2\rangle$
3. $\frac{k}{2m}\langle xp + px\rangle$
4. $\frac{1}{2}\frac{dk}{dt}\langle x^2\rangle$

Q38. [June 2015] . 3.5 marks

Statistical Mechanics > Microcanonical Ensemble

CSIR NET	2015 June	3.5 M

A system of N distinguishable particles, each of which can be in one of the two energy levels 0 and ϵ, has a total energy $n\epsilon$, where n is an integer. The entropy of the system is proportional to

1. $N \ln n$
2. $n \ln N$
3. $\ln\left(\frac{N!}{n!}\right)$
4. $\ln\left(\frac{N!}{n!(N-n)!}\right)$

Q39. [June 2015] . 3.5 marks

Statistical Mechanics > Canonical Ensemble

CSIR NET	2015 June	3.5 M

A system of N non-interacting classical particles, each of mass m is in a two dimensional harmonic potential of the form $V(r) = \alpha(x^2 + y^2)$ where α is a positive constant. The canonical partition function of the system at temperature T is $\left(\beta = \frac{1}{k_B T}\right)$:

1. $\left[\left(\frac{\alpha}{2m}\right)^2 \frac{\pi}{\beta}\right]^N$
2. $\left(\frac{2m\pi}{\alpha\beta}\right)^{2N}$
3. $\left(\frac{\alpha\pi}{2m\beta}\right)^N$
4. $\left(\frac{2m\pi^2}{\alpha\beta^2}\right)^N$

Q40. [June 2015] . 3.5 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2015 June	3.5 M

In a two-state system, the transition rate of a particle from state 1 to state 2 is t_{12}, and the transition rate from state 2 to state 1 is t_{21}. In the steady state, the probability of finding the particle in state 1 is

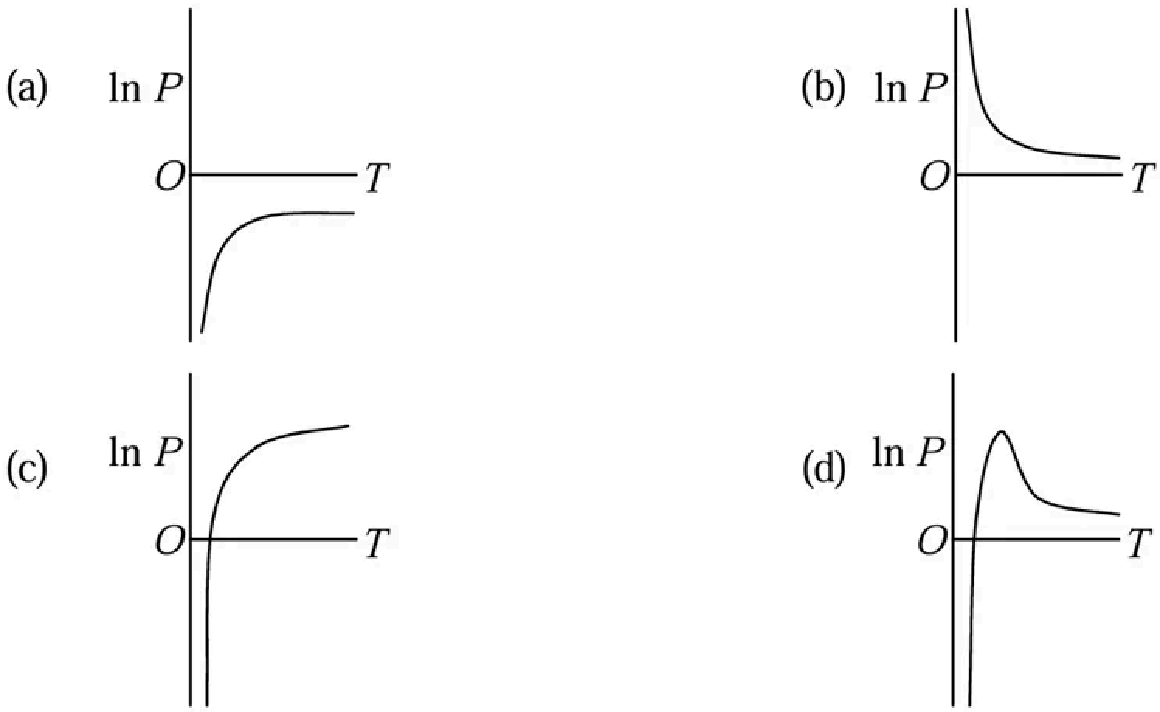
1. $\frac{t_{21}}{t_{12}+t_{21}}$
2. $\frac{t_{12}}{t_{12}+t_{21}}$
3. $\frac{t_{12}t_{21}}{t_{12}+t_{21}}$
4. $\frac{t_{12}-t_{21}}{t_{12}+t_{21}}$

Q41. [June 2015] . 3.5 marks

Thermodynamics > Phase transitions

CSIR NET	2015 June	3.5 M

The condition for the liquid and vapour phases of a fluid to be in equilibrium is given by the approximate equation $\frac{dP}{dT} \approx \frac{Q_l}{Tv_{\text{vap}}}$ (Clausius-Clayperon equation), where v_{vap} is the volume per particle in the vapour phase, and Q_l is the latent heat, which may be taken to be a constant. If the vapour obeys ideal gas law, which of the following plots is correct?

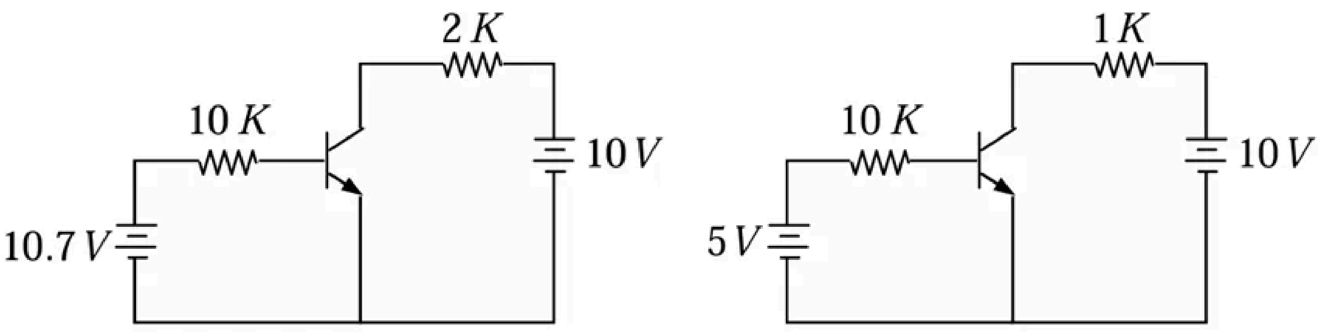


Q42. [June 2015] . 3.5 marks

Electronics > Transistors

CSIR NET	2015 June	3.5 M

Consider the circuits show in Figures (a) and (b) below.



(a) (b)

If the transistors in Figures (a) and (b) have current gain (β_{dc}) of 100 and 10 respectively, then they operate in the.

1. active region and saturation region respectively
2. saturation region and active region respectively
3. saturation region in both cases
4. active region in both cases

Q43. [June 2015] . 3.5 marks

Electronics > "Errors , curve fitting and data analysis"

CSIR NET	2015 June	3.5 M

The viscosity η of a liquid is given by Poiseuille's formula $\eta = \frac{\pi P a^4}{8lV}$. Assume that l and V can be measured very accurately, but the pressure P has an rms error of 1% and the radius a has an independent rms error of 3%. The rms error of the viscosity is closest to

1. 2%
2. 4%
3. 12%
4. 13%

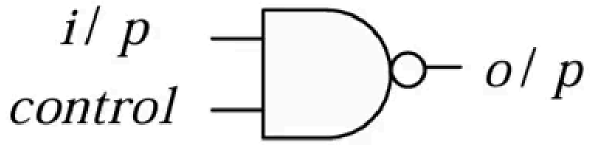
Q44. [June 2015] . 3.5 marks

Electronics > Digital Electronics

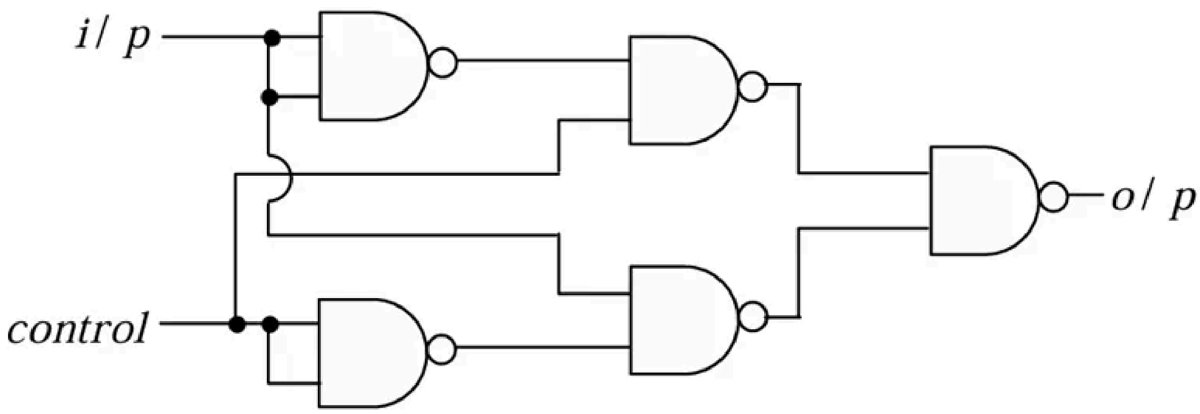
CSIR NET	2015 June	3.5 M

Which of the following circuits behaves a control invertor?

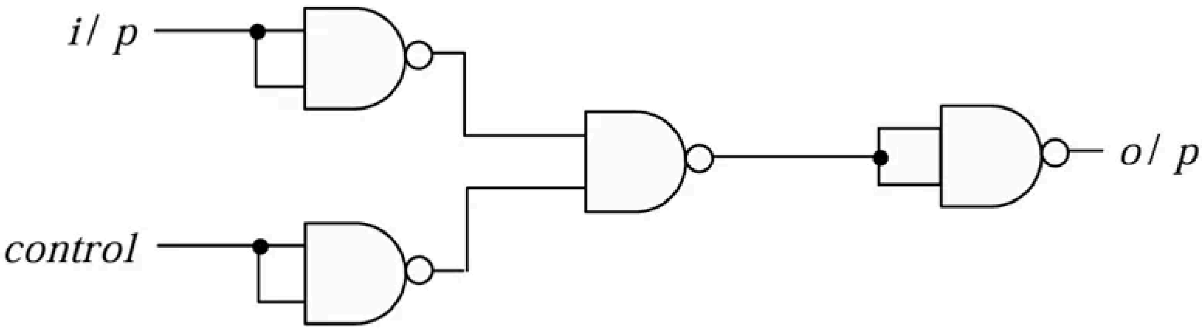
1.



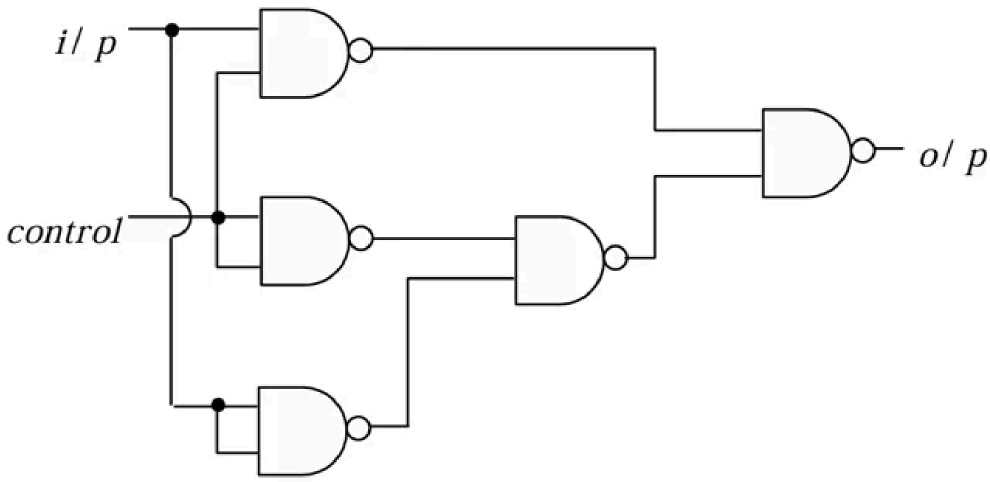
2.



3.



4.



Q45. [June 2015] . 3.5 marks

Solid State Physics > Semiconductor Physics

CSIR NET	2015 June	3.5 M

The concentration of electrons, n, and holes, p, for an intrinsic semiconductor at a temperature T can be expressed as $n = p = AT^{3/2}\exp\left(-\frac{E_g}{2k_BT}\right)$, where E_g is the band gap and A is a constant. If the mobility of both types of carriers is proportional to $T^{-3/2}$, then the log of the conductivity is a linear function of T^{-1}. with slope

1. $E_g/(2k_B)$
2. E_g/k_B
3. $-E_g/(2k_B)$
4. $-E_g/k_B$

Q46. [June 2015] . 5.0 marks
Mathematical Physics > Probability

CSIR NET	2015 June	5 M

Three real variables a, b and c are each randomly chosen from a uniform probability distribution in the interval $[0,1]$. The probability that $a + b > 2c$ is

1. $\frac{3}{4}$
2. $\frac{2}{3}$
3. $\frac{1}{2}$
4. $\frac{1}{4}$

Q47. [June 2015] . 5.0 marks
Mathematical Physics > Tensors

CSIR NET	2015 June	5 M

The rank-2 tensor $x_i x_j$, where x_i are the Cartesian coordinates of the position vector in three dimensions, has 6 independent elements. Under rotation, these 6 elements decompose into irreducible sets (that is, the elements of each set transform only into linear combinations of elements in that set) containing

1. 4 and 2 elements
2. 5 and 1 elements
3. 3, 2 and 1 elements
4. 4, 1 and 1 elements

Q48. [June 2015] . 5.0 marks
Mathematical Physics > Numerical Methods

CSIR NET	2015 June	5 M

Consider the differential equation $\frac{dy}{dx} = x^2 - y$ with the initial condition $y = 2$ at $x = 0$. Let $y_{(1)}$ and $y_{(1/2)}$ be the solutions at $x = 1$ obtained using Euler's forward algorithm with step size 1 and $\frac{1}{2}$ respectively.

The value of $\left(y_{(1)} - y_{(1/2)}\right)/y_{(1/2)}$ is

1. $-1/2$
2. -1
3. ½
4. 1

Q49. [June 2015] . 5.0 marks

Mathematical Physics > Partial Differential Equations

CSIR NET	2015 June	5 M

Let $f(x,t)$ be a solution of the wave equation $\frac{\partial^2 f}{\partial t^2} = v^2 \frac{\partial^2 f}{\partial x^2}$ in 1 -dimension. If at $t = 0, f(x,0) = e^{-x^2}$ and $\frac{\partial f}{\partial t}(x,0) = 0$ for all x, then $f(x,t)$ for all future times $t > 0$ is described by

1. $e^{-(x^2-v^2t^2)}$
2. $e^{-(x-vt)^2}$
3. $\frac{1}{4}e^{-(x-vt)^2} + \frac{3}{4}e^{-(x+vt)^2}$
4. $\frac{1}{2}\left[e^{-(x-vt)^2} + e^{-(x+vt)^2}\right]$

Q50. [June 2015] . 5.0 marks

Classical Mechanics > Canonical transformations

CSIR NET	2015 June	5 M

Let q and p be the canonical coordinate and momentum of a dynamical system. Which of the following transformations is canonical?

A: $Q_1 = \frac{1}{\sqrt{2}} q^2$ and $P_1 = \frac{1}{\sqrt{2}} p^2$

B: $Q_2 = \frac{1}{\sqrt{2}}(p+q)$ and $P_2 = \frac{1}{\sqrt{2}}(p-q)$

1. neither A nor B
2. both A and B
3. only A
4. only B

Q51. [June 2015] . 5.0 marks

Quantum Mechanics > Scattering theory

CSIR NET	2015 June	5 M

The differential cross-section for scattering by a target is given by $\frac{d\sigma}{d\Omega}(\theta,\varphi) = a^2 + b^2\cos^2\theta$.

If N is the flux of the incoming particles, the number of particles scattered per unit time is

1. $\frac{4\pi}{3}N(a^2+b^2)$
2. $4\pi N\left(a^2+\frac{1}{6}b^2\right)$
3. $4\pi N\left(\frac{1}{2}a^2+\frac{1}{3}b^2\right)$
4. $4\pi N\left(a^2+\frac{1}{3}b^2\right)$

Q52. [June 2015] . 5.0 marks

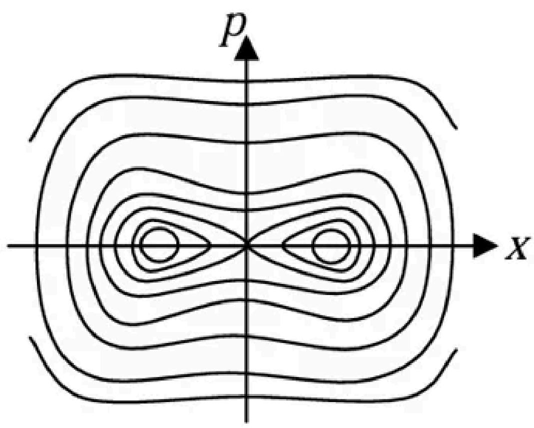
Classical Mechanics > Phase space diagrams

CSIR NET	2015 June	5 M

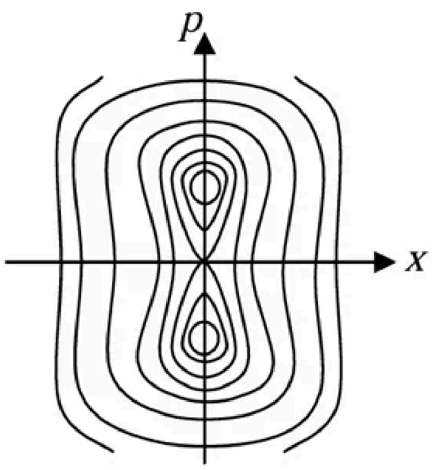
Which of the following figures is a schematic representation of the phase space trajectories (i.e., contours of constant energy) of a particle moving in a one-dimensional potential

$$V(x) = -\frac{1}{2}x^2 + \frac{1}{4}x^4?$$

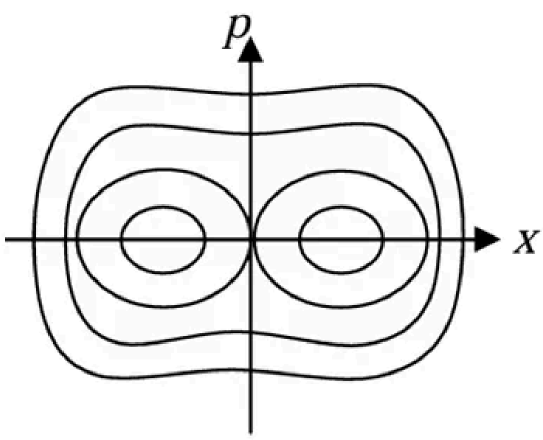
1.



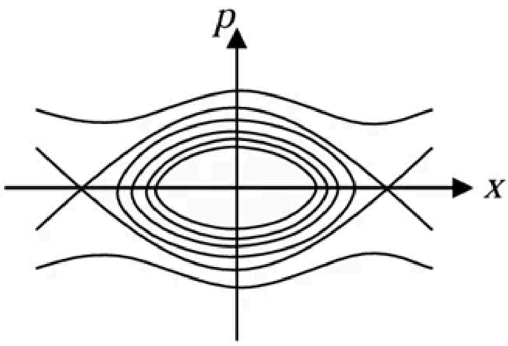
2.



3.



4.



Q53. [June 2015] . 5.0 marks

Electromagnetism > Waveguides

CSIR NET	2015 June	5 M

Consider a rectangular wave guide with transverse dimensions $2\ \mathrm{m} \times 1\ \mathrm{m}$ driven with an angular frequency $\omega = 10^9 \mathrm{rad/s}$. Which transverse electric (TE) modes will propagate in this wave guide?

1. $\mathrm{TEE}_{10}, \mathrm{TEE}_{01}$ and TE_{20}
2. $\mathrm{TE}_{10}, \mathrm{TE}_{11}$ and $\mathrm{TE}_{20}3$
3. $\mathrm{TE}_{01}, \mathrm{TE}_{10}$ and TE_{11}
4. $\mathrm{TE}_{01}, \mathrm{TE}_{10}$ and TE_{22}

Q54. [June 2015] . 5.0 marks

Classical Mechanics > Special theory of relativity

CSIR NET	2015 June	5 M

A rod of length L carries a total charge Q distributed uniformly. If this is observed in a frame moving with a speed v along the rod, the charge per unit length (as measured by the moving observer) is

1. $\frac{Q}{L}\left(1-\frac{v^2}{c^2}\right)$
2. $\frac{Q}{L}\sqrt{1-\frac{v^2}{c^2}}$
3. $\frac{Q}{L\sqrt{1-\frac{v^2}{c^2}}}$
4. $\frac{Q}{L\left(1-\frac{v^2}{c^2}\right)}$

Q55. [June 2015] . 5.0 marks

Electromagnetism > EM Waves

CSIR NET	2015 June	5 M

The electric and magnetic fields in the charge free region $z > 0$ are given by

$$\vec{E}(\vec{r},t) = E_0 e^{-k_1 z} \cos(k_2 x - \omega t)\hat{j}$$

$$\vec{E}(\vec{r},t) = \frac{E_0}{\omega} e^{-k_1 z}\left[k_1 \sin(k_2 x - \omega t)\hat{i} + k_2 \cos(k_2 x - \omega t)\hat{k}\right]$$

where ω, k_1 and k_2 are positive constants. The average energy flow in the x-direction is

1. $\frac{E_0^2 k_2}{2\mu_0 \omega} e^{-2k_1 z}$
2. $\frac{E_0^2 k_2}{\mu_0 \omega} e^{-2k_1 z}$
3. $\frac{E_0^2 k_1}{2\mu_0 \omega} e^{-2k_1 z}$
4. $\frac{1}{2} c\epsilon_0 E_0^2 e^{-2k_1 z}$

Q56. [June 2015] . 5.0 marks

Electromagnetism > Electrodynamics

CSIR NET	2015 June	5 M

A uniform magnetic field in the positive z direction passes through a circular wire loop of radius 1 cm and resistance 1Ω lying in the xy-plane. The field strength is reduced from 10 tesla to 9 tesla in 1 s . The charge transferred across any point in the wire is approximately

1. 3.1×10^{-4} coulomb
2. 3.4×10^{-4} coulomb
3. 4.2×10^{-4} coulomb
4. 5.2×10^{-4} coulomb

Q57. [June 2015] . 5.0 marks
Electromagnetism > Relativistic electromagnetism

CSIR NET	2015 June	5 M

The Dirac Hamiltonian $H = c\vec{\alpha}\cdot\vec{p} + \beta mc^2$ for a free electron corresponds to the classical relation $E^2 = p^2c^2 + m^2c^4$. The classical energy-momentum relation of a particle of charge q in a electromagnetic potential $(\phi, \vec{A})$ is $(E - q\phi)^2 = c^2\left(\vec{p} - \frac{q}{c}\vec{A}\right)^2 + m^2c^4$.

Therefore, the Dirac Hamiltonian for an electron in an electromagnetic field is

1. $c\vec{\alpha}\cdot\vec{p} + \frac{e}{c}\vec{A}\cdot\vec{A} + \beta mc^2 - e\phi$
2. $c\vec{\alpha}\cdot\left(\vec{p} + \frac{e}{c}\vec{A}\right) + \beta mc^2 + e\phi$
3. $c\left(\vec{\alpha}\cdot\vec{p} + e\phi + \frac{e}{c}|\vec{A}|\right) + \beta mc^2$
4. $c\vec{\alpha}\cdot\left(\vec{p} + {}^{e}\vec{A}\right) + \beta mc^2 - e\phi$

Q58. [June 2015] . 5.0 marks

Quantum Mechanics > Basic Quantum Mechanics

CSIR NET	2015 June	5 M

A particle of mass m is in a potential $V = \frac{1}{2}m\omega^2 x^2$, where ω is a constant. Let $\hat{a} = \sqrt{\frac{m\omega}{2h}}\left(\hat{x} + \frac{i\hat{p}}{m\omega}\right)$. In the Heisenberg picture $\frac{d\hat{a}}{dt}$ is given by

1. $\omega\hat{a}$
2. $-i\omega\hat{a}$
3. $\omega\hat{a}^\dagger$
4. $i\omega\hat{a}^\dagger$

Q59. [June 2015] . 5.0 marks
Quantum Mechanics > Scattering theory

CSIR NET	2015 June	5 M

A particle of energy E scatters off a repulsive spherical potential

$$V(r)=\begin{cases} V_0 \text{ for} & r<a \\ 0 \text{ for} & r\geq a \end{cases}$$

where V_0 and a are positive constants. In the low energy limit, the total scattering crosssection is

$\sigma = 4\pi a^2\left(\frac{1}{ka}\tanh ka - 1\right)^2$, where

$k^2 = \frac{2m}{h^2}(V_0 - E) > 0$. In the limit $V_0 \rightarrow \infty$ the ratio of σ to the classical scattering cross-section off a sphere of radius a is

1. 4
2. 3
3. 1
4. 1/2

Q60. [June 2015] . 5.0 marks
Quantum Mechanics > Basic Quantum Mechanics

CSIR NET	2015 June	5 M

Two different sets of orthogonal basis vectors $\left\{\begin{pmatrix}1\\0\end{pmatrix}, \begin{pmatrix}0\\1\end{pmatrix}\right\}$ and $\left\{\frac{1}{\sqrt{2}}\begin{pmatrix}1\\1\end{pmatrix}, \frac{1}{\sqrt{2}}\begin{pmatrix}1\\-1\end{pmatrix}\right\}$ are given for a two-dimensional real vector space. The matrix representation of a linear operator $\hat{A}$ in these bases are related by a unitary transformation. The unitary matrix may be chosen to be

1. $\begin{pmatrix}0 & -1\\1 & 0\end{pmatrix}$
2. $\begin{pmatrix}0 & 1\\1 & 0\end{pmatrix}$
3. $\frac{1}{\sqrt{2}}\begin{pmatrix}1 & 1\\1 & -1\end{pmatrix}$
4. $\frac{1}{\sqrt{2}}\begin{pmatrix}1 & 0\\1 & 1\end{pmatrix}$

Q61. [June 2015] . 5.0 marks
Statistical Mechanics > Random Walk/Brownian motion/Diffusion

CSIR NET	2015 June	5 M

A large number N of Brownian particles in one dimension start their diffusive motion from the origin at time $t = 0$. The diffusion coefficient is D. The number of particles crossing a point at a distance L from the origin, per unit time, depends on L and time t as

1. $\frac{N}{\sqrt{4\pi Dt}} e^{-L^2/(4Dt)}$

2. $\frac{NL}{\sqrt{4\pi Dt}} e^{-4Dt/L^2}$

3. $\frac{N}{\sqrt{16\pi Dt^3}} e^{-L^2/(4Dt)}$

4. Ne^{-4Dt/L^2}

Q62. [June 2015] . 5.0 marks

Statistical Mechanics > Ising model

CSIR NET	2015 June	5 M

Consider three Ising spins at the vertices of a triangle which interact with each other with a ferromagnetic Ising interaction of strength J. The partition function of the system at temperature T is given by

$$\left(\beta = \frac{1}{k_B T}\right):$$

1. $2e^{3\beta j} + 6e^{-\beta j}$
2. $2e^{-3\beta I} + 6e^{\beta J}$
3. $2e^{3\beta J} + 6e^{-3\beta J} + 3e^{\beta J} + 3e^{-\beta J}$
4. $(2\cosh \beta J)^3$

Q63. [June 2015] . 5.0 marks

Statistical Mechanics > Quantum Statistical Mechanics

CSIR NET	2015 June	5 M

An ideal Bose gas in d-dimensions obeys the dispersion relation $\epsilon(\vec{k}) = Ak^s$, where A and s are constants. For Bose-Einstein condensation to occur, the occupancy of excited states

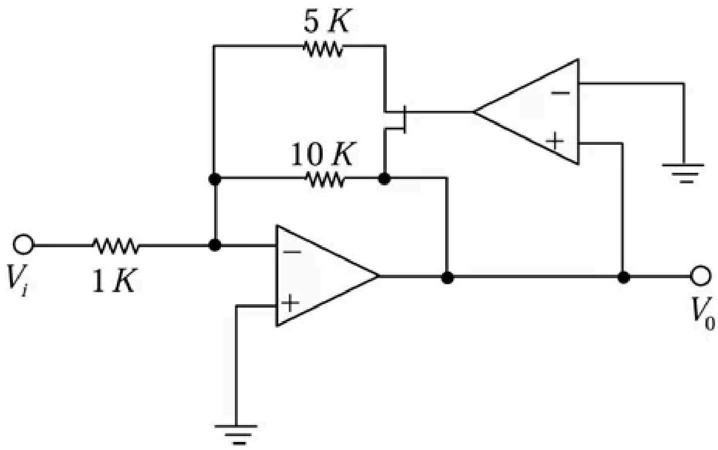
1. $\frac{d}{s} < \frac{1}{4}$
2. $\frac{1}{4} < \frac{d}{s} < \frac{1}{2}$
3. $\frac{d}{s} > 1$
4. $\frac{1}{2} < \frac{d}{s} < 1$

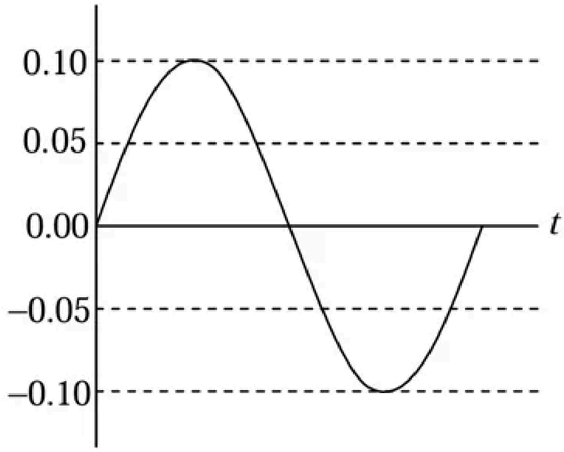
Q64. [June 2015] . 5.0 marks

Electronics > FET

CSIR NET	2015 June	5 M

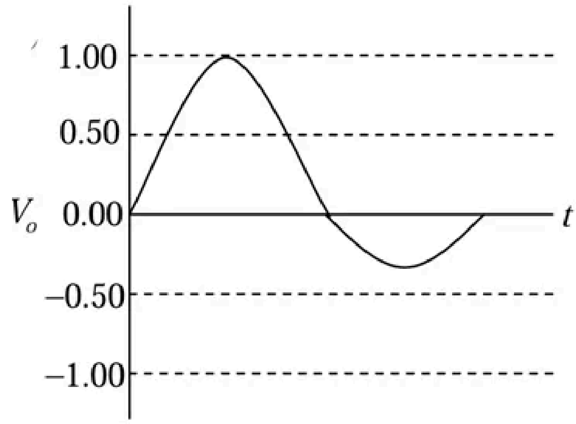
For the circuit and the input sinusoidal waveform shown in the figures below, which is the correct waveform at the output?



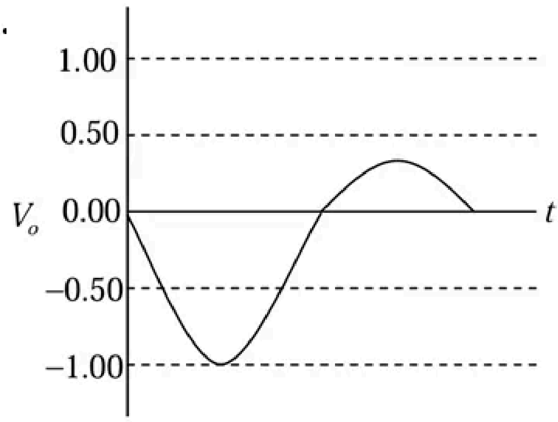


(The time scales in all plots are the same.)

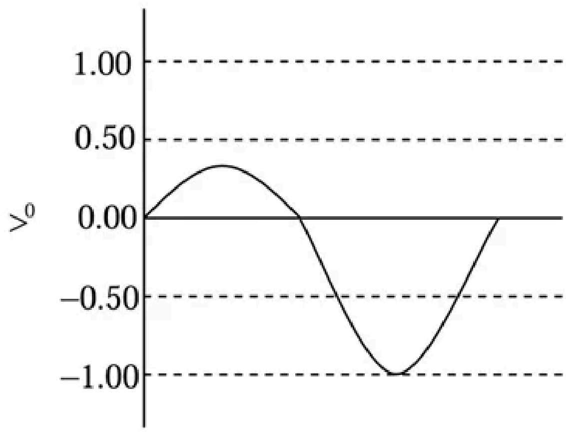
1



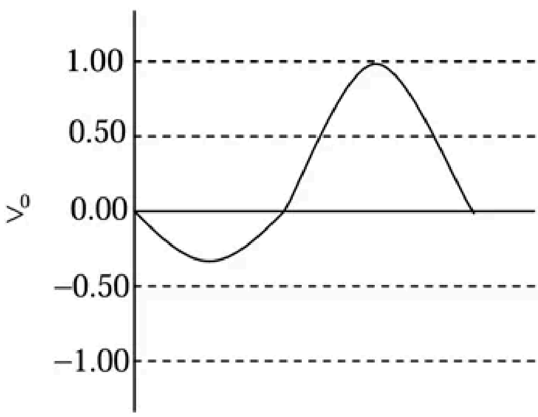
2.



3



4.

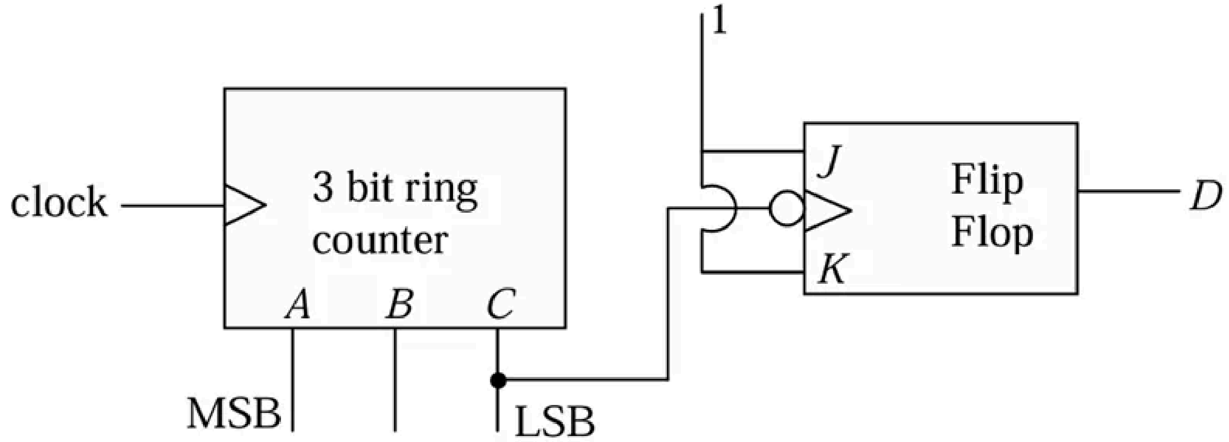


Q65. [June 2015] . 5.0 marks

Electronics > Flip flops/Counters/Registers/microcontroller etc.

CSIR NET	2015 June	5 M

For the logic circuit given below, the decimal count sequence and the modulus of the circuit corresponding to A B C D are

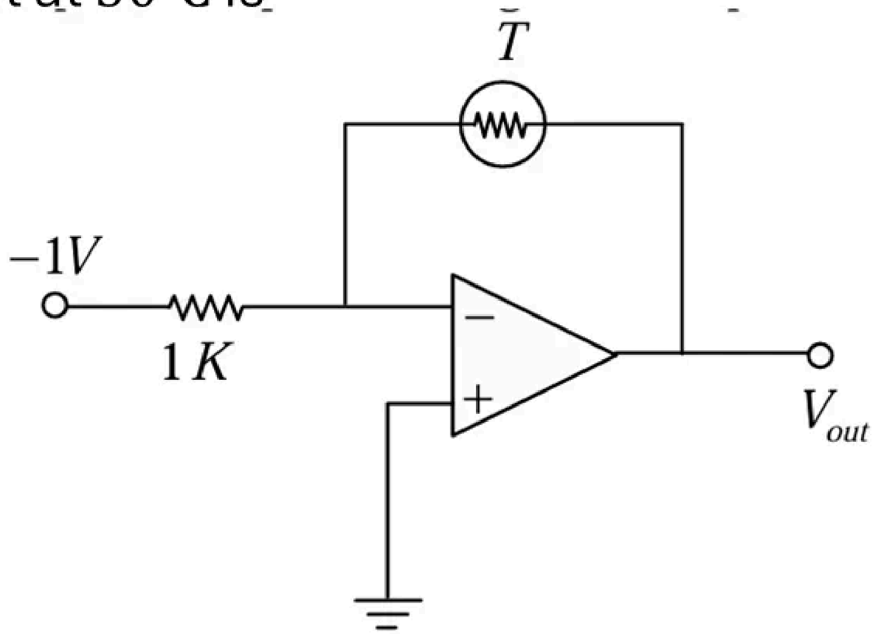


1. $8 \rightarrow 4 \rightarrow 2 \rightarrow 1 \rightarrow 9 \rightarrow 5 (mod 6)$
2. $8 \rightarrow 4 \rightarrow 2 \rightarrow 9 \rightarrow 5 \rightarrow 3 (mod 6)$
3. $2 \rightarrow 5 \rightarrow 9 \rightarrow 1 \rightarrow 3 (mod 5)$
4. $8 \rightarrow 5 \rightarrow 1 \rightarrow 3 \rightarrow 7 (\text{mod} 5)$

Q66. [June 2015] . 5.0 marks
Electronics > OPAMP

CSIR NET	2015 June	5 M

In the circuit given below, the thermistor has a resistance $3k\Omega$ at $25^\circ C$. Its resistance decreases by 150Ω per $^\circ C$ upon heating. The output voltage of the circuit at $30^\circ C$ is



1. -3.75 V
2. -2.25 V
3. 2.25 V
4. 3.75 V

Q67. [June 2015] . 5.0 marks
Statistical Mechanics > Quantum Statistical Mechanics

CSIR NET	2015 June	5 M

The low-energy electronic excitations in a two-dimensional sheet of graphene is given by $E(\vec{k}) = \hbar v k$, where v is the velocity of the excitations. The density of states is proportional to

1. E
2. $E^{3/2}$
3. $E^{1/2}$
4. E^2

Q68. [June 2015] . 5.0 marks
Solid State Physics > Xray diffraction

CSIR NET	2015 June	5 M

X-ray of wavelength $\lambda = a$ is reflected from the (111) plane of a simple cubic lattice. If the lattice constant is a, the corresponding Bragg angle (in radian) is

1. $\pi/6$
2. $\pi/4$
3. $\pi/3$
4. $\pi/8$

Q69. [June 2015] . 5.0 marks

Solid State Physics > Superconductivity

CSIR NET	2015 June	5 M

The critical magnetic fields of a superconductor at temperatures 4 K and 8 K are $11\ \mathrm{mA/m}$ and $5.5\ \mathrm{mA/m}$ respectively. The transition temperature is approximately

1. 8.4 K
2. 10.6 K
3. 12.9 K
4. 15.0 K

Q70. [June 2015] . 5.0 marks
Atomic and Molecular Physics > Molecular physics

CSIR NET	2015 June	5 M

A diatomic molecule has vibrational states with energies $E_v = \hbar\omega\left(v + \frac{1}{2}\right)$ and rotational states with energies $E_j = Bj(j+1)$, where v and j are non-negative integers. Consider the transitions in which both the initial and final states are restricted to $v \leq 1$ and $j \leq 2$ and subject to the selection rules $\Delta v = \pm 1$ and $\Delta j = \pm 1$. Then the largest allowed energy of transition is

1. $\hbar\omega - 3B$
2. $\hbar\omega - B$
3. $\hbar\omega + 4B$
4. $2\hbar\omega + B$

Q71. [June 2015] . 5.0 marks

Atomic and Molecular Physics > "LS, JJ and other interactions"

CSIR NET	2015 June	5 M

Of the following term symbols of the np^2 atomic configurations, $^1S_0$, $^3P_0$, $^3P_1$, $^3P_2$ and $^1D_2$, which is the ground state?

1. $^3P_0$
2. $^IS_0$
3. $^3P_2$
4. $^3P_1$

Q72. [June 2015] . 5.0 marks

Atomic and Molecular Physics > Lasers

CSIR NET	2015 June	5 M

A $He-Ne$ laser operates by using two energy levels of Ne separated by 2.26 eV . Under steady state conditions of optical pumping, the equivalent temperature of the system at which the ratio of the number of atoms in the upper state to that in the lower state will be $1/20$, is approximately (the Boltzmann constant $k_B = 8.6 \times 10^{-5} \mathrm{eV/K}$)

1. 10^{10} K
2. 10^8 K
3. 10^6 K
4. 10^4 K

Q73. [June 2015] . 5.0 marks

Nuclear and Particle Physics > Shell model

CSIR NET	2015 June	5 M

Let us approximate the nuclear potential in the shell model by a three dimensional isotropic harmonic oscillator. Since the lowest two energy levels have angular momenta $l = 0$ and $l = 1$ respectively. which of the following two nuclei have magic numbers of protons and neutrons?

1. ${}^{4}_{2}\mathrm{He}$ and ${}^{16}_{8}\mathrm{O}$
2. ${}^{2}_{1}\mathrm{D}$ and ${}^{8}_{4}\mathrm{Be}$
3. ${}^{4}_{2}\mathrm{He}$ and ${}^{8}_{4}\mathrm{Be}$
4. ${}^{4}_{2}\mathrm{He}$ and ${}^{12}_{6}\mathrm{C}$

Q74. [June 2015] . 5.0 marks
Nuclear and Particle Physics > Particle physics

CSIR NET	2015 June	5 M

The charm quark is assigned a charm quantum number $C = 1$. How should the Gellmann-Nishijima formula for electric charge be modified for four flavours of quarks?

1. $I_3 + \frac{1}{2}(B - S - C)$
2. $I_3 + \frac{1}{2}(B - S + C)$
3. $I_3 + \frac{1}{2}(B + S - C)$
4. $I_3 + \frac{1}{2}(B + S + C)$

Q75. [June 2015] . 5.0 marks
Nuclear and Particle Physics > Particle physics

CSIR NET	2015 June	5 M

The reaction ${}_1^2\mathrm{D} + {}_1^2\mathrm{D} \rightarrow {}_2^4\mathrm{He} + \pi^0$ cannot proceed via strong interactions because it violates the conservation of

1. angular momentum
2. electric charge
3. baryon number
4. isospin

Answer Key

75 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	General Aptitude	Reasoning	**1**
Q2	General Aptitude	Mathematical Analysis	**3**
Q3	General Aptitude	Geometry	**3**
Q4	General Aptitude	Mathematical Analysis	**3**
Q5	General Aptitude	Geometry	**1**
Q6	General Aptitude	Geometry	**4**
Q7	General Aptitude	Geometry	**3**
Q8	General Aptitude	Geometry	**3**
Q9	General Aptitude	Reasoning	**2**
Q10	General Aptitude	Basic Physics	**1**
Q11	General Aptitude	Mathematical Analysis	**1**
Q12	General Aptitude	Basic Physics	**1**
Q13	General Aptitude	Mathematical Analysis	**1**
Q14	General Aptitude	Basic Physics	**1**
Q15	General Aptitude	Geometry	**1**
Q16	General Aptitude	Basic Physics	**3**
Q17	General Aptitude	Reasoning	**4**
Q18	General Aptitude	Geometry	**2**
Q19	General Aptitude	Geometry	**2**
Q20	General Aptitude	Basic Physics	**2**
Q21	Mathematical Physics	Fourier Series	**3**
Q22	Mathematical Physics	Vector Algebra and Vector Calculus	**1**
Q23	Mathematical Physics	Ordinary Differential Equations	**2**
Q24	Mathematical Physics	Complex analysis	**1**
Q25	Mathematical Physics	Laplace transform	**1**
Q26	Classical Mechanics	Lagrangian and Hamiltonian	**3**
Q27	Classical Mechanics	Oscillations	**2**
Q28	Classical Mechanics	Central forces	**1**
Q29	Classical Mechanics	Special theory of relativity	**2**
Q30	Electromagnetism	EM Waves	**4**
Q31	Electromagnetism	Electrostatics	**3**
Q32	Electromagnetism	Magetostatics	**4**
Q33	Electromagnetism	Potential Formulation	**4**
Q34	Quantum Mechanics	Potential Well	**1**
Q35	Quantum Mechanics	Basic Quantum Mechanics	**3**
Q36	Quantum Mechanics	Orbital angular Momentum and Hydrogen atom	**2**
Q37	Quantum Mechanics	Basic Quantum Mechanics	**1**
Q38	Statistical Mechanics	Microcanonical Ensemble	**4**
Q39	Statistical Mechanics	Canonical Ensemble	**4**
Q40	Atomic and Molecular Physics	Lasers	**1**

Answer Key (cont.)

Q. No	Subject	Topic	Answer
Q41	Thermodynamics	Phase transitions	**1&3**
Q42	Electronics	Transistors	**2**
Q43	Electronics	"Errors , curve fitting and data analysis"	**3**
Q44	Electronics	Digital Electronics	**2&4**
Q45	Solid State Physics	Semiconductor Physics	**3**
Q46	Mathematical Physics	Probability	**3**
Q47	Mathematical Physics	Tensors	**2**
Q48	Mathematical Physics	Numerical Methods	**2**
Q49	Mathematical Physics	Partial Differential Equations	**4**
Q50	Classical Mechanics	Canonical transformations	**4**
Q51	Quantum Mechanics	Scattering theory	**4**
Q52	Classical Mechanics	Phase space diagrams	**1**
Q53	Electromagnetism	Waveguides	**1**
Q54	Classical Mechanics	Special theory of relativity	**3**
Q55	Electromagnetism	EM Waves	**1**
Q56	Electromagnetism	Electrodynamics	**1**
Q57	Electromagnetism	Relativistic electromagnetism	**4**
Q58	Quantum Mechanics	Basic Quantum Mechanics	**2**
Q59	Quantum Mechanics	Scattering theory	**1**
Q60	Quantum Mechanics	Basic Quantum Mechanics	**3**
Q61	Statistical Mechanics	Random Walk/Brownian motion/Diffusion	**None**
Q62	Statistical Mechanics	Ising model	**1**
Q63	Statistical Mechanics	Quantum Statistical Mechanics	**3**
Q64	Electronics	FET	**2**
Q65	Electronics	Flip flops/Counters/Registers/microcontroller etc.	**2**
Q66	Electronics	OPAMP	**3**
Q67	Statistical Mechanics	Quantum Statistical Mechanics	**1**
Q68	Solid State Physics	Xray diffraction	**3**
Q69	Solid State Physics	Superconductivity	**2**
Q70	Atomic and Molecular Physics	Molecular physics	**3**
Q71	Atomic and Molecular Physics	"LS, JJ and other interactions"	**1**
Q72	Atomic and Molecular Physics	Lasers	**4**
Q73	Nuclear and Particle Physics	Shell model	**1**
Q74	Nuclear and Particle Physics	Particle physics	**4**
Q75	Nuclear and Particle Physics	Particle physics	**4**

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