PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

Canonical transformations - CSIR NET Physics PYQs

Classical Mechanics . All PYQs (2015-2025) with answer key

10 questions . Answer key included

www.physicsbyaaryan.com . www.csirnetphysics.com
Contact: 9501976811

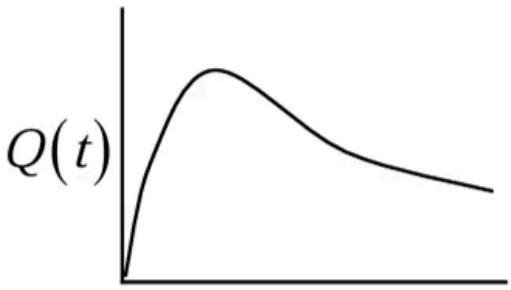
Q1. [Dec 2015] . 5.0 marks

Classical Mechanics > Canonical transformations

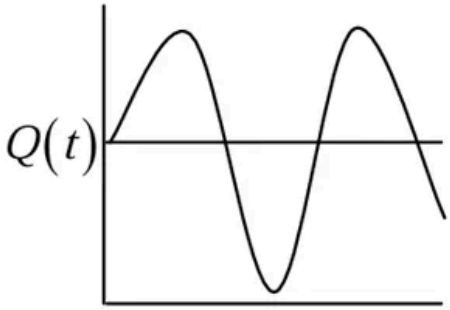
CSIR NET	2015 Dec	5 M

A canonical transformation $(p, q) \rightarrow (P, Q)$ is performed on the Hamiltonian $H = \frac{1}{2mp^2} + \frac{1}{2}m\omega^2 q^2$ via the generating function $F = \frac{1}{2}m\omega q^2 \cot Q$. If $Q(0) = 0$, which of the following graphs shows schematically the dependence of $Q(t)$ on t ?

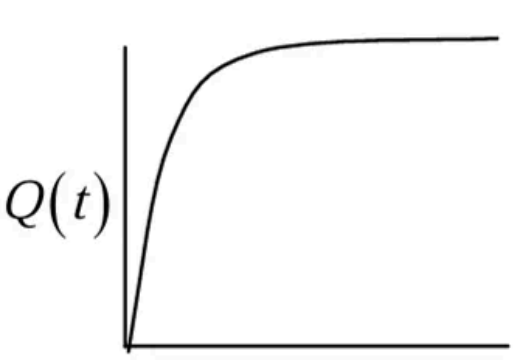
1.



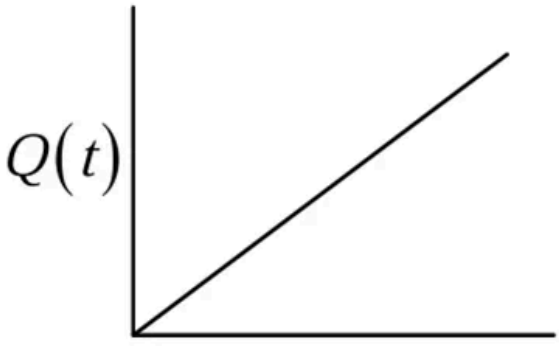
2.



3.



4.



Q2. [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

Q3. [June 2016] . 5.0 marks

Classical Mechanics > Canonical transformations

CSIR NET	2016 June	5M

A canonical transformation $(q, p) \rightarrow (Q, P)$ is made through the generating function $F(q, P) = q^2 P$ on the Hamiltonian

$$H(q, p) = \frac{p^2}{2\alpha q^2} + \frac{\beta}{4} q^4$$

where α and β are constants. The equations of motion for (Q, P) are

1. $\dot{Q} = P/\alpha$ and $\dot{P} = -\beta Q$
2. $\dot{Q} = 4P/\alpha$ and $\dot{P} = -\beta Q/2$
3. $\dot{Q} = P/\alpha$ and $\dot{P} = -\frac{2P^2}{Q} - \beta Q$
4. $\dot{Q} = 2P/\alpha$ and $\dot{P} = -\beta Q$

Q4. [Dec 2017] . 5.0 marks

Classical Mechanics > Canonical transformations

CSIR NET	2017 Dec	5M

Let (x, p) be the generalized coordinate and momentum of a Hamiltonian system. If new variables (X, P) are defined by $X = x^{\alpha}\sinh(\beta p)$ and $P = x^{\gamma}\cosh(\beta p)$, where α, β and γ are constants, then the conditions for it to be a canonical transformation, are

1. $\alpha = \frac{1}{2\beta}(\beta + 1)$ and $\gamma = \frac{1}{2\beta}(\beta - 1)$
2. $\beta = \frac{1}{2\gamma}(\alpha + 1)$ and $\gamma = \frac{1}{2\alpha}(\alpha - 1)$
3. $\alpha = \frac{1}{2\beta}(\beta - 1)$ and $\gamma = \frac{1}{2\beta}(\beta + 1)$
4. $\beta = \frac{1}{2\gamma}(\alpha - 1)$ and $\gamma = \frac{1}{2\alpha}(\alpha + 1)$

Q5. [June 2017] . 5.0 marks

Classical Mechanics > Canonical transformations

CSIR NET	2017 June	5M

A Hamiltonian system is described by the canonical coordinate q and canonical momentum p. A new coordinate Q is defined as $Q(t) = q(t + \tau) + p(t + \tau)$, where t is the time and τ is a constant, that is, the new coordinate is a combination of the old coordinate and momentum at a shifted time. The new canonical momentum $P(t)$ can be expressed as

1. $p(t + \tau) - q(t + \tau)$
2. $p(t + \tau) - q(t - \tau)$
3. $\frac{1}{2}[p(t - \tau) - q(t + \tau)]$
4. $\frac{1}{2}[p(t + \tau) - q(t + \tau)]$

Q6. [Dec 2019] . 5.0 marks

Classical Mechanics > Canonical transformations

CSIR NET	2019 Dec	5M

The generator of the infinitesimal canonical transformation $q \rightarrow q^{'} = (1 + \epsilon)q$ and $p \rightarrow p^{'} = (1 - \epsilon)p$ is

1. $q + p$
2. qp
3. $\frac{1}{2}(q^2 - p^2)$
4. $\frac{1}{2}(q^2 + p^2)$

Q7. [Dec 2023] . 5.0 marks

Classical Mechanics > Canonical transformations

CSIR NET	2023 Dec	5 M

A canonical transformation from the phase space coordinates (q, p) to (Q, P) is generated by the function

$$\psi(p, Q) = \frac{p^2}{2\omega} \tan 2\pi Q,$$

where ω is a positive constant. The function $\psi(p, Q)$ is related to $F(q, Q)$ by the Legendre transform $\psi = pq - F$, where F is defined by $dF = pdq - PdQ$. If the solution for (P, Q) is

$$P(t) = \frac{\omega}{4\pi} t^2, Q(t) = Q_0 = \text{constant}$$

where t is time, then the solution for (p, q) variables can be written as

1. $p = \frac{\omega t}{2\pi} \cos 2\pi Q_0, q = \frac{t}{2\pi} \sin 2\pi Q_0$
2. $p = -\frac{\omega t}{2\pi} \cos 2\pi Q_0, q = \frac{t}{2\pi} \sin 2\pi Q_0$
3. $p = \frac{\omega t}{2\pi} \sin 2\pi Q_0, q = \frac{t}{2\pi} \cos 2\pi Q_0$
4. $p = -\frac{\omega t}{2\pi} \sin 2\pi Q_0, q = \frac{t}{2\pi} \cos 2\pi Q_0$

Q8. [June 2023] . 5.0 marks

Classical Mechanics > Canonical transformations

CSIR NET	2023 June	5M

For the transformation $x \to X = \frac{\alpha p}{x}, p \to P = \beta x^2$ between conjugate pairs of a coordinate and its momentum, to be canonical, the constants α and β must satisfy

1. $1 + \frac{1}{2}\alpha\beta = 0$
2. $1 - \frac{1}{2}\alpha\beta = 0$
3. $1 + 2\alpha\beta = 0$
4. $1 - 2\alpha\beta = 0$

Q9. [Dec 2024] . 5.0 marks

Classical Mechanics > Canonical transformations

CSIR NET	2024 Dec	5M

For the transformation

$$Q = \ln\left(1 + q^{1/2}\cos p\right), P = 2q^{1/2}\left(1 + q^{1/2}\cos p\right)\sin p$$

the generating function is

1. $-\left(e^{Q} - 1\right)^{2}\cot p$
2. $\left(e^{Q} - 1\right)^{2}\cot p$
3. $\left(e^{Q} - 1\right)^{2}\tan p$
4. $-\left(e^{Q} - 1\right)^{2}\tan p$

Q10. [Dec 2025] . 5.0 marks

Classical Mechanics > Canonical transformations

CSIR NET	2025 Dec	5M	MMP

The Lagrangian $L = L(x, y, \dot{x}, \dot{y})$ is invariant under the transformation $x \to x + \epsilon y$ and $y \to y + \epsilon x$, for any infinitesimal real parameter ϵ.

If P_x, P_y denote canonically conjugate momenta corresponding to x, y respectively, then the corresponding conserved quantity is

1. $yP_x - xP_y$
2. $yP_x + xP_y$
3. $xP_x + yP_y$
4. $xP_x - yP_y$

Answer Key

10 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	Classical Mechanics	Canonical transformations	**4**
Q2	Classical Mechanics	Canonical transformations	**4**
Q3	Classical Mechanics	Canonical transformations	**2**
Q4	Classical Mechanics	Canonical transformations	**None**
Q5	Classical Mechanics	Canonical transformations	**4**
Q6	Classical Mechanics	Canonical transformations	**2**
Q7	Classical Mechanics	Canonical transformations	**1**
Q8	Classical Mechanics	Canonical transformations	**3**
Q9	Classical Mechanics	Canonical transformations	**4**
Q10	Classical Mechanics	Canonical transformations	**2**

Study with PhysicsByAaryan

Full CSIR NET / GATE / JEST / BARC Physics live batch by Aaryan Mehra Sir.
Concept-first teaching, complete PYQ coverage, daily doubt support.

Use coupon CONSISTENCY for Rs. 500 off

Visit
www.physicsbyaaryan.com
www.csirnetphysics.com

Contact
9501976811