

Test Booklet No. _____

This booklet consists of 150 questions and pages.

RGUPET/2025/1004/110

RGUPET 2025
Common Entrance Test, 2025
DOCTOR OF PHILOSOPHY IN PHYSICS

Full Marks: 150

Time: 3 Hours

Roll No.

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Day and Date of Examination: _____

Signature of Invigilator(s) _____

Signature of Candidate _____

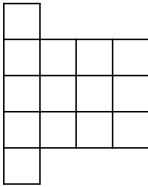
General Instructions:

PLEASE READ ALL THE INSTRUCTIONS CAREFULLY BEFORE MAKING ANY ENTRY.

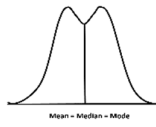
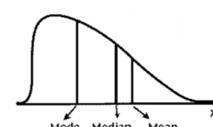
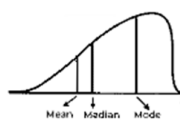
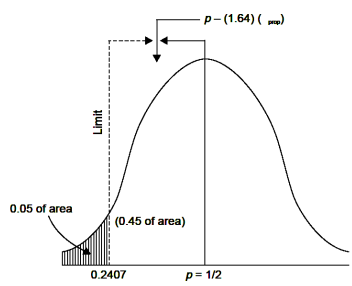
1. DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE TOLD TO DO SO.
2. Candidate must write his/her Roll Number on the space provided.
3. This Test Booklet contains 150 Multiple Choice Questions (MCQs) from the concerned subject. Each question carries 1 mark.
4. Please check the Test Booklet to verify that the total pages and total number of questions contained in the test booklet are the same as those printed on the top of the first page. Also check whether the questions are in sequential order or not.
5. Candidates are not permitted to enter into the examination hall after the commencement of the entrance test or leave the examination hall before completion of Examination.
6. Making any identification mark in the OMR Answer Sheet or writing Roll Number anywhere other than the specified places will lead to disqualification of the candidate.
7. Candidates shall maintain silence inside and outside the examination hall. If candidates are found violating the instructions mentioned herein or announced in the examination hall, they will be summarily disqualified from the entrance test.
8. In case of any dispute, the decision of the Entrance Test Committee shall be final and binding.
9. The OMR Answer Sheet consists of two copies, the Original copy and the Student's copy.

1	The “Mission Sudarshan Chakra”, recently launched by the Prime Minister of India, primarily relates to				development of a multilayered air and missile defence system
	a) a national renewable energy mission	b) a national digital currency mission	c) development of a multilayered air and missile defence system	d) a national mission to modernise Indian Railways	(c)
2	“Pushpak”- a national mission being implemented by the Indian Institute of Technology, Bombay is related to the development of				Drone technology
	a) Helicopters	b) Dairy technology	c) Drone technology	d) Artificial intelligence	(c)
3	North East India’s first underwater tunnel project, announced in 2024, is proposed to connect				Numaligarh and Gohpur
	a) Dibrugarh and Dhemaji	b) Jorhat and Majuli	c) Numaligarh and Gohpur	d) Guwahati and North Guwahati	(c)
4	Which of the following statements are correct? A. Canada hosted the 51 st G7 summit in 2025. B. Four players were honoured with the Khel Ratna Award 2025. C. Sweden was ranked first in Global Innovation Index 2024. D. Operation Sindoor was Launched by India to attack terrorist bases in Pakistan on 7 th May 2025.				(a)
	a) A, B and D	b) A,B and C	c) Only A	d) All of the above	A, B and D
5	Which of the followings are correct? A. Lip Butan has been appointed as the new CEO of Intel in March 2025 B. Shri C P Radhakrishnan has been appointed as the Vice President of India C. India’s rank in the Human Development Index 2025 released by UNDP is 99 D. India has become the 2 nd largest road network in the World.				(d)
	a) A and B only	b) A, B and C only	c) A, C and D only	d) A, B, D only	A, B, D only
6	Which of the following sentences is false? A. Palk Strait joins India and Sri Lanka B. The Radcliffe Line is between India and Bangladesh C. The MacMohan Line separates India and China D. The Durand Line is between Iran and Afghanistan.				
	a) A, B	b) B, C	c) C, D	d) B, D	(d)
7	Assertion (A): Eclipses do not occur on all full moon and new moon days. Reason (R): The moon revolves round the earth in an elliptical orbit.				A and R are true but R doesnot explain A
	a) A and R are true and R correctly explains A.	b) A and R are true but R does not explain A.	c) A is true R is false	d) R is true but A is false	(b)

8	Right to equality is a-				Fundamental right
	a) fundamental right	b) social right	c) cultural right	d) legal right	(a)
9	The author of the book "Midnight's Children" is-				Salman Rushdie
	a) Shakespeare	b) Leo Tolostoy	c) Salman Rushdie	d) R K Narayan	(c)
10	Match the organizations with their headquarters:				
	A. UNESCO		1. New York		
	B. WHO		2. Paris		
	C. UNICEF		3. Geneva		
	D. IMF		4. Washington D.C.		
	a) A-3, B-2, C-4, D-1	b) A-2, B-3, C-1, D-4	c) A-2, B-4, C-3, D-1	d) A-1, B-3, C-2, D-4	(b)
11	He said, "Happy new year!" The correct indirect speech of the above is-				He wished me a happy new year.
	a) He said the new year was happy.	b) He wished me a happy new year.	c) He said to me that happy new year.	d) I was wished a happy new year.	(b)
12	Identify the correct sentence(s) from the following. A. One of my friends is a doctor. B. I don't know nothing about her. C. It is a two-hour journey. D. We will be definitely there at the yesterday's programme.				
	a) A, B	b) B, C	c) A, C	d) C, D	(c)
13	"She drank the _____ milk that was there in the flask." The appropriate quantifier to fill in the blank is-				little
	a) all	b) little	c) sour	d) few	(b)
14	"a/ great /and/ reality/their/ theory/in/there/ disparity/is" The correct reordered meaningful sentence with the above jumbled words/phrases is- P. There is a great theory and their reality in disparity. Q. There is a great disparity in their theory and reality. R. Their great disparity is in a theory and reality there. S. Their great theory is a reality and in disparity there.				There is a great disparity in their theory and reality.
	a) P	b) Q	c) R	d) S	(b)
15	The correct match of synonyms and antonyms is:				A-ii, B-iii, C-i, D-iv
	A. Futile		i. Help		
	B. Generic		ii. Effective		
	C. Hinder		iii. Individual		
	D. Inception		iv. Termination		
	a) A-i, B-ii, C-iii, D-iv	b) A-iii, B-ii, C-iv, D-iii	c) A-iv, B-iii, C-i, D-ii	d) A-ii, B-iii, C-i, D-iv	(d)
16	The total number of squares in the following figure is:				22

					
	a) 24	b) 20	c) 22	d) 18	(c)
1 7	Fill in the blank in the following pattern. ELFY GLHX ILJW ----- MLNU				KLLV
	a) KLLV	b) KLMX	c) JLLV	d) JLMX	a)
1 8	Raghav introduces Vineet as the only son of the only brother of his father's wife. How Raghav and Vineet are related?				cousin
	a) brother	b) cousin	c) uncle	d) son-in-law	(b)
1 9	Which two numbers should be interchanged to make the given equation mathematically correct? $3 \times 6 + 72 \div 8 - 24 = 12$				6, 8
	a) 6, 8	b) 6, 24	c) 3, 8	d) None	(a)
2 0	If BANKER is coded as CAOKFR, then how would LAWYER be coded?				MAXYFR
	a) LBWZES	b) LBWYFR	c) MAXYFR	d) MAXZES	c)
2 1	Same error occurs at the same size in every measurement, and such errors can only be eliminated either by thinking through the sources of problems and removing them. This type of error is termed as:				
	a) Random errors	b) Systematic errors	c) Cascading errors	d) Perpetual errors	b
2 2	Hypothesis-driven research begins with a hypothesis. A hypothesis is a statement about the world that can be true or false, and whose truth is being tested.				
	a) A valid hypothesis is based on 'that exists'	b) A hypothesis is a positive conclusion	c) A hypothesis can never be tested	d) A valid hypothesis must be falsifiable	d
2 3	Which of the following statements that could be considered as valid scientific hypotheses? A. Eating two ounces of olive oil a day decreases the odds of contracting heart disease. B. What is the best fertilizer to use to get large and tasty tomatoes? C. Macs are better than PCs. D. Briar's Aspirin cures headaches faster than RCS Aspirin.				Answer
	a) A, B	b) A, B, C	c) A, D	d) B, C	c
2 4	Relate the 'function or relationship' (A) and 'comment' (B) and select the appropriate answer A: Find how the speed of sound in air at fixed pressure depends upon air temperature.				Answer

	B: The control variable is temperature, and the response variable is sound speed.				
	a) Functional relationship is correct and the comment is true for the relationship	b) Functional relationship is incorrect but the comment is true for the relationship	c) Functional relationship is correct but the comment is false for the relationship	d) Neither the functional relationship is correct nor the comment is true	a
25	Relate 'sampling design' and its 'method'				Answer
	Sampling Design		Method		
	A. Deliberate		i. Sample collected as information received and survey progresses		
	B. Simple random		ii. sample drawn from a heterogeneous group		
	C. Stratified		iii purposive selection of particular units		
	D. Sequential		iv. very item in the population has an equal chance of inclusion		
	a) A-iii, B-iv, C-ii, D-i	b) A-ii, B-iv, C-iii, D-i	c) A-i, B-iii, C-ii, D-iv	d) A-iii, B-ii, C-iv, D-i	a
26	Number of observations in a normal distribution is 1000. How many observations will be there between $\mu+1\sigma$ and $\mu-1\sigma$				Answer
	a) 500	b) 680	c) 720	d) 950	b
27	Which of the following are reasons for citing a paper? A. use its ideas, definitions, terms in a Research B. provides upcoming facts regarding undergoing Research Question. C. to adopt part/full methodology it adopted for a certain task. D. to refer to data also used in Current Research.				Answer
	a) A, B, C	b) B, C, D	c) A, C, D	d) A, B, D	
28	Scholars who wish to meet publication expectations mostly resort to a variety of techniques to increase their output and crank up their citation ranking, which are not considered ethical. Identify these techniques: A. Gift authorship B. Extensive experiments C. Salami Slicing D. Extensive referencing				Answer
	a)A, B, C	b) A, B, D	c) B, C, D	d) A, C, D	
29	Match the references (APA 7 style):				Answer
	A. Journal Article	i. Edwards, A. A., Steacy, L. M., Siegelman, N., Rigobon, V. M., Kearns, D. M., Rueckl, J. G., & Compton, D. L. (2022). Unpacking the unique relationship between set for variability and word reading development: Examining word- and child-level predictors of performance. <i>Journal of Educational Psychology</i> , 114(6), 1242–1256. https://doi.org/10.1037/edu0000696			
	B. Authored Book	ii. Levenson, H., Jinich, S., Vaz, A., & Rousmaniere, T. (2025). <i>Deliberate practice in emotionally focused couple therapy</i> . American Psychological Association. https://doi.org/10.1037/0000436-000			
	C. Webpage	iii. Zeleke, W. A., Hughes, T. L., & Drozda, N. (2020). Home–school collaboration to promote mind–body health. In C. Maykel & M. A. Bray (Eds.), <i>Promoting mind–body health in schools</i> :			

		Interventions for mental health professionals (pp. 11–26). American Psychological Association. https://doi.org/10.1037/0000157-002																																											
	D. Edited Book Chapter	iv. Taras, Z. (2024, May 30). <i>Situational irony can be funny, tragic or even terrifying</i> . howstuffworks. https://entertainment.howstuffworks.com/arts/literature/situational-irony.htm																																											
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30	Which one of the following refers to positive skewness?																																												
	a) 	b) 	c) 	d) 	c																																								
31	How much is the degree of freedom for the following data table?				Answer																																								
	<table><tr><th>S. No.</th><th>X_i</th><th>Hypothesised mean $m_{H_0} = 578 \text{ kg.}$</th><th>$D_i = (X_i - \mu_{H_0})$</th><th>$D_i^2$</th></tr><tr><td>5</td><td>572</td><td>578</td><td>-6</td><td>36</td></tr><tr><td>6</td><td>578</td><td>578</td><td>0</td><td>0</td></tr><tr><td>7</td><td>570</td><td>578</td><td>-8</td><td>64</td></tr><tr><td>8</td><td>572</td><td>578</td><td>-6</td><td>36</td></tr><tr><td>9</td><td>596</td><td>578</td><td>18</td><td>324</td></tr><tr><td>10</td><td>544</td><td>578</td><td>-34</td><td>1156</td></tr><tr><td>$n = 10$</td><td></td><td></td><td>$\sum D_i = -60$</td><td>$\sum D_i^2 = 1816$</td></tr></table>				S. No.	X_i	Hypothesised mean $m_{H_0} = 578 \text{ kg.}$	$D_i = (X_i - \mu_{H_0})$	D_i^2	5	572	578	-6	36	6	578	578	0	0	7	570	578	-8	64	8	572	578	-6	36	9	596	578	18	324	10	544	578	-34	1156	$n = 10$			$\sum D_i = -60$	$\sum D_i^2 = 1816$	
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32	Find out the Null hypothesis for the given table				Answer																																								
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	a) $\mu_{H_0} = 578\text{kg.}$	b) $\mu_{H_0} \neq 578\text{kg.}$	c) $\mu_{H_0} = -578\text{kg.}$	d) $\mu_{H_0} = \pm 578\text{kg.}$	a																																								
33	What will be sum of the deviations of observations from the regression line?				Answer																																								
	a) $-\infty$	b) 0	c) $+\infty$	d) undefined	b																																								
34	Derive from the following diagram				Answer																																								
	 Assertion: In this normal distribution 5 percent of the sample are rejected.																																												

	Justification: It shows a two tailed hypothesis test model at 90 percent confidence level				
	a) Assertion is true and justification explains the Assertion	b) Assertion is false but justification explains the Assertion	c) Assertion is true and justification is true but does not explain the Assertion	d) Assertion is true and justification for the Assertion is incorrect	d
35	Match into pairs for the Statistical method with appropriate details mentioned:				Answer
	Statistical method		Details		
	A. Correlation		i. Order 2, 3, 4,		
	B. Polynomial regression		ii. More than two population on same characteristics		
	C. ANOVA		iii. Test of homogeneity		
	D. Chi square		iv. Requires only two variables		
	a) A-i, B-ii, C-iii, D-iv	b) A-iv, B-i, C-ii, D-iii	c) A-iv, B-ii, C-i, D-iii	d) A-iii, B-i, C-ii, D-iv	b
36	Which of the following is diamagnetic?				Answer
	a) CO ₂	b) O ₂	c) NO	d) O ₂ ⁻	(a)
37	Match the following ligands with their denticity:				Answer
	A. NH ₃		i. Quadridentate		
	B. EDTA		ii. Monodentate		
	C. Oxalate		iii. Hexadentate		
	D. Porphyrin		iv. Bidentate		
	a) A-ii, B-iii, C-iv, D-i	b) A-ii, B-iii, C-i, D-iv	c) A-iv, B-iii, C-ii, D-i	d) A-ii, B-i, C-iv, D-iii	(a)
38	In which of the following compounds is the metal-metal bonding present ?				Answer
	a) NaCl	b) ZnO	c) Al ₂ O ₃	d) Cr ₂ Cl ₆	(d)
39	A solution contains 0.1 mol of a non-volatile solute in 1 L of water at 298 K. Calculate the osmotic pressure:				Answer
	a) 2.44 atm	b) 1.33 atm	c) 0.22 atm	d) 0.11 atm	(a)
40	According to Henry's law, the solubility of a gas in a liquid is:				Answer
	a) Independent of pressure.	b) Directly proportional to pressure.	c) Inversely proportional to pressure.	d) Exponential with pressure.	(b)
41	If $f(x) = \begin{cases} \{ x - 2 \}/(x - 2), & x \neq 0 \\ 0, & \text{otherwise} \end{cases}$				Answer
	a) -1	b) 1	c) 0	d) does not exist	d
42	If $y = x^5 - 5x^4 + 5x^3 - 1$, then the value of $\frac{d^6y}{dx^6}$ is				Answer

	a) $120x - 120$	b) 120	c) 0	d) cannot be evaluated.	c								
4 3	Which of the following is/are not true for a function f defined on closed interval $[a, b]$ to satisfy Rolle's theorem? A. f is continuous on closed interval $[a, b]$. B. f is differentiable on the open interval (a, b) C. $f(a) = f(b)$ D. $f(k) = 0$ for at least one $k \in [a, b]$.				Answer								
	a) A and B	b) only D	c) B and C	d) Only C	b								
4 4	A group which satisfies commutatively property is known a												
	a) Abelian group	b) Quotient group	c) Coset group	d) Normal group	a								
4 5	Let M^T denotes transpose matrix of M and I is identity matrix. Match the following: <table><tr><td>A. M is idempotent</td><td>i. $M = M^T$</td></tr><tr><td>B. M is symmetric</td><td>ii. $M = -M^T$</td></tr><tr><td>C. M is skew-symmetric</td><td>iii. $M^2 = I$</td></tr><tr><td>D. M is involution</td><td>iv. $M^2 = M$</td></tr></table>				A. M is idempotent	i. $M = M^T$	B. M is symmetric	ii. $M = -M^T$	C. M is skew-symmetric	iii. $M^2 = I$	D. M is involution	iv. $M^2 = M$	Answer
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	a) A-iv, B-i, C-iii, D-ii	b) A-i, B-iv, C-ii, D-iii	c) A-iv, B-i, C-ii, D-iii	d) A-iv, B-ii, C-i, D-iii	c								
4 6	Relate the statements: A: Assertion—SSDs are faster than HDDs. B: Justification—Because SSDs use flash memory instead of spinning disks.				Answer								
	a) Both A and B are true, and B is the correct explanation of A	b) Both A and B are true, but B is NOT the correct explanation of A	c) A is true, but B is false	d) A is false, but B is true	(a)								
4 7	Match the pairs: <table><tr><td>A. Machine Learning</td><td>i Enables machines to understand and process human language</td></tr><tr><td>B. Natural Language Processing (NLP)</td><td>ii Uses data to learn and improve predictions automatically</td></tr><tr><td>C. Computer Vision</td><td>iii Analyzes and interprets visual data like images and videos</td></tr><tr><td>D. Expert Systems</td><td>iv Mimics human decision-making using rules and knowledge base</td></tr></table>				A. Machine Learning	i Enables machines to understand and process human language	B. Natural Language Processing (NLP)	ii Uses data to learn and improve predictions automatically	C. Computer Vision	iii Analyzes and interprets visual data like images and videos	D. Expert Systems	iv Mimics human decision-making using rules and knowledge base	Answer
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C. Computer Vision	iii Analyzes and interprets visual data like images and videos												
D. Expert Systems	iv Mimics human decision-making using rules and knowledge base												
	a) A – iv, B – i, C – iii, D – ii.	b) A – iv, B – iii, C – i, D – ii.	c) A – ii, B – i, C – iii, D – iv.	d) A – iii, B – i, C – iv, D – ii.	(c)								
4 8	Which programming language is widely used for AI and ML development?				Answer								
	a) Python	b) JavaScript	c) C#	d) HTML	(a)								
4 9	Which of the following statement is true:				Answer								
	a) A byte is made up of 16 bits.	b) ROM is volatile memory that loses data when power is switched off.	c) A compiler translates high-level code into machine code line by line.	d) A firewall is used to protect a computer network from	(d)								

				unauthorized access.	
50	What is a network of networks called?				Answer
	a) Intranet	b) Internet	c) WAN	d) LAN	(b)

51	The zeroth law of thermodynamics establishes the concept of:				Answer								
	a) Internal energy	b) Temperature	c) Entropy	d) Pressure	(b)								
52	The chemical potential is defined as: A. Energy per particle at constant entropy and volume B. Entropy per particle at constant energy and volume C. Gibbs free energy per mole at constant pressure and temperature D. Internal energy divided by temperature				Answer								
	a) Statement A	b) Statement B	c) Statement C	d) Statement D	(a)								
53	The partition function Z is fundamentally related to:				Answer								
	a) Probability of microstates	b) Energy fluctuations	c) Statistical weight of states	d) All of the above	(d)								
54	Match the following: <table><tr><td>A. Internal Energy</td><td>1. T, V, N</td></tr><tr><td>B. Helmholtz Free Energy</td><td>2. S, V, N</td></tr><tr><td>C. Gibbs Free Energy</td><td>3. S, P, N</td></tr><tr><td>D. Enthalpy</td><td>4. T, P, N</td></tr></table>				A. Internal Energy	1. T, V, N	B. Helmholtz Free Energy	2. S, V, N	C. Gibbs Free Energy	3. S, P, N	D. Enthalpy	4. T, P, N	Answer
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B. Helmholtz Free Energy	2. S, V, N												
C. Gibbs Free Energy	3. S, P, N												
D. Enthalpy	4. T, P, N												
	a) A-1, B-2, C-3, D-4	b) A-2, B-1, C-4, D-3	c) A-1, B-3, C-2, D-4	d) A-3, B-2, C-1, D-4	(b)								
55	Match the following: <table><tr><td>A. Zeroth law</td><td>1. Entropy $\rightarrow 0$ as $T \rightarrow 0$ K</td></tr><tr><td>B. First law</td><td>2. Conservation of energy</td></tr><tr><td>C. Second law</td><td>3. Entropy always increases</td></tr><tr><td>D. Third law</td><td>4. Defines temperature via thermal equilibrium</td></tr></table>				A. Zeroth law	1. Entropy $\rightarrow 0$ as $T \rightarrow 0$ K	B. First law	2. Conservation of energy	C. Second law	3. Entropy always increases	D. Third law	4. Defines temperature via thermal equilibrium	Answer
A. Zeroth law	1. Entropy $\rightarrow 0$ as $T \rightarrow 0$ K												
B. First law	2. Conservation of energy												
C. Second law	3. Entropy always increases												
D. Third law	4. Defines temperature via thermal equilibrium												
	a) A-3, B-4, C-1, D-2	b) A-2, B-4, C-1, D-3	c) A-4, B-2, C-3, D-1	d) A-1, B-3, C-2, D-4	(c)								
56	Match the following: <table><tr><td>A. Microcanonical Ensemble</td><td>1. μ, V, T fixed</td></tr><tr><td>B. Canonical Ensemble</td><td>2. N, P, T fixed</td></tr><tr><td>C. Grand Canonical Ensemble</td><td>3. N, V, E fixed</td></tr><tr><td>D. Isothermal–Isobaric Ensemble</td><td>4. N, V, T fixed</td></tr></table>				A. Microcanonical Ensemble	1. μ, V, T fixed	B. Canonical Ensemble	2. N, P, T fixed	C. Grand Canonical Ensemble	3. N, V, E fixed	D. Isothermal–Isobaric Ensemble	4. N, V, T fixed	Answer
A. Microcanonical Ensemble	1. μ, V, T fixed												
B. Canonical Ensemble	2. N, P, T fixed												
C. Grand Canonical Ensemble	3. N, V, E fixed												
D. Isothermal–Isobaric Ensemble	4. N, V, T fixed												
	a) A-3, B-4, C-1, D-2	b) A-2, B-4, C-1, D-3	c) A-4, B-2, C-3, D-1	d) A-1, B-3, C-2, D-4	(a)								

57	The entropy change when heat Q is absorbed reversibly at temperature T is:				Answer
	a) $\Delta S=0$	b) $\Delta S=Q \cdot T$	c) $\Delta S=T/Q$	d) $\Delta S=Q/T$	(d)
58	The average energy of a quantum harmonic oscillator at temperature T is:				Answer
	a) $k_B T$	b) $\frac{1}{2} k_B T$	c) $\frac{h\nu}{\exp\left(\frac{h\nu}{k_B T}\right)-1} + \frac{1}{2} h\nu$	d) $nh\nu$	(c)
59	For an ideal Fermi gas at $T=0$, all states are filled up to:				Answer
	a) Boltzmann energy	b) Fermi energy	c) Chemical potential	d) Ground state only	(b)
60	Bose-Einstein condensation occurs when:				Answer
	a) System is extremely hot	b) Thermal de Broglie wavelength is comparable to interparticle distance	c) Fermions are used	d) There are no quantum effects	(b)
61	The Ising model is used to study:				Answer
	a) Electrical conductivity	b) Gas diffusion	c) Blackbody radiation	d) Magnetism (spin interactions)	(d)
62	The principal quantum number n determines:				Answer
	a) Orientation of orbital	b) Energy level and size of orbital	c) Spin of electron	d) Magnetic moment of atom	(b)
63	Fine structure in atomic spectra arises due to:				Answer
	a) Spin-orbit interaction	b) Nuclear spin	c) External electric field	d) Lattice vibrations	(a)
64	Answer the following Assertion–Reason: Assertion (A): JJ coupling is dominant in heavy atoms. Reason (R): Spin–orbit interaction becomes stronger for high atomic numbers.				Answer
	a) A true, R false	b) A false, R true	c) Both A and R are true, R explains A	d) Both A and R are true, R not explanation	(c)

6 5	Match the following:				Answer
A. Zeeman Effect		1. Electric field			
B. Stark Effect		2. Strong magnetic field			
C. Paschen–Back Effect		3. Magnetic field			
D. Hyperfine Structure		4. Nuclear spin interaction			
	a) A–3, B–1, C–2, D–4	b) A–1, B–3, C–4, D–2	c) A–2, B–1, C–3, D–4	d) A–4, B–2, C–1, D–3	(a)
6 6	Match the following:				Answer
A. Vibrational		1. Photon scattering			
B. Rotational		2. Microwave region			
C. Electronic		3. UV–Visible region			
D. Raman		4. Infrared (IR) region			
	a) A–3, B–1, C–4, D–2	b) A–2, B–4, C–1, D–3	c) A–4, B–2, C–3, D–1	d) A–1, B–3, C–2, D–4	(c)
6 7	Match the following:				Answer
A. Chemical Shift		1. Electron spin resonance			
B. Population Inversion		2. Nuclear magnetic resonance			
C. ESR		3. Shift due to chemical environment			
D. NMR		4. More atoms in excited state than ground			
	a) A–3, B–4, C–1, D–2	b) A–2, B–4, C–1, D–3	c) A–4, B–2, C–3, D–1	d) A–1, B–3, C–2, D–4	(a)
6 8	A hydrogen atom emits radiation at 656.3 nm (H_α line). This corresponds to the transition:				Answer
	a) $n=3 \rightarrow n=1$	b) $n=2 \rightarrow n=1$	c) $n=3 \rightarrow n=2$	d) $n=4 \rightarrow n=2$	
6 9	Which selection rule is correct for rotational transitions in a rigid diatomic molecule?				Answer
	a) $\Delta J = 0$	b) $\Delta J = \pm 1$	c) $\Delta J = \pm 2$	d) $\Delta J = \text{any integer}$	
7 0	The Doppler broadening of a spectral line increases with:				Answer
	a) Increase in temperature	b) Decrease in temperature	c) Increase in pressure	d) Decrease in atomic mass	
7 1	For NMR, the Larmor frequency is given by:				Answer
	a) $\nu = \frac{g\mu_B B}{h}$	b) $\nu = \frac{\gamma B}{2\pi}$	c) $\nu = \frac{hc}{\lambda}$	d) $\nu = \frac{E}{h}$	
7 2	The wave function $\psi(x, t)$ represents:				Answer

	a) Energy of the system	b) Probability density directly	c) Probability amplitude	d) Momentum of the particle	(c) Probability amplitude
7 3	Normalization of wave function means:				Answer
	a) $\int \psi ^2 dx = 1$	b) $\int \psi dx = 0$	c) $\int \psi dx = 1$	d) $\int \psi dx = 1$	(a) $\int \psi ^2 dx = 1$
7 4	The principle that two identical fermions cannot occupy the same quantum state is called				
	a) Uncertainty principle	b) Exclusion principle	c) Superposition principle	d) Correspondence principle	b) Exclusion principle
7 5	Which of the following statements are true? A. Observables in quantum mechanics correspond to Hermitian operators. B. Eigenvalues of operators give possible measurement outcomes. C. Operators always commute with each other. D. Momentum and position operators do not commute.				Answer
	a) A, B and D	b) A and C	c) B and C	d) All are true	a) A, B and D
7 6	Which of the following statements are true? A. A wave function may be complex. B. The probability density is given by $ \psi ^2$. C. A wave function can always be negative but never complex. D. Normalization ensures total probability equals 1.				
	a) A, B and D	b) A and C	c) B and C	d) All are true	a) A, B and D
7 7	Which of the following statements are true? A. The time-independent Schrödinger equation applies to stationary states. B. The solutions give energy eigenvalues and eigenfunctions. C. The Schrödinger equation is a postulate of Newtonian mechanics. D. The time-dependent Schrödinger equation describes the evolution of the wave function.				Answer
	a) A, B and D	b) A and C	b) B and C	c) All are true	a) A, B and D
7 8	A: Assertion : The ground state energy of a particle in a box cannot be zero B: Justification : According to the uncertainty principle, a particle cannot have both definite position and momentum simultaneously.				Answer
	a) Both A and B are true, and B is the correct explanation of A	b) Both A and B are true, but B is not the correct explanation of A	c) A is true, B is false	d) A is false, B is true	a) Both A and B are true, and B is the correct explanation of A
7 9	Match the operators with their forms:				Answer
	A Position operator		i	$-i\hbar \frac{\partial}{\partial x}$	
	B Momentum operator		ii	$\hat{x}$	
	C Energy operator		iii	$i\hbar \frac{\partial}{\partial t}$	
	D Kinetic energy operator		iv	$-\frac{\hbar^2}{2m} \nabla^2$	

	a) A-iv, B-i, C-iii, D-ii	b) A-ii, B-i, C-iii, D-iv	c) A-iii, B-ii, C-iv, D-i	d) A-i, B-iii, C-ii, D-iv	b) A-ii, B-i, C-iii, D-iv
8 0	Match the operators with their forms:				Answer
A Principal quantum number		i $0, 1, 2, \dots, n - 1$			
B Azimuthal (orbital) quantum number		ii $+\frac{1}{2}, -\frac{1}{2}$			
C Magnetic quantum number		iii $1, 2, 3, \dots$ (positive integers)			
D Spin quantum number		iv $-l, \dots, 0, \dots, +l$			
	a) A-iv, B-i, C-iii, D-ii	b) A-iii, B-i, C-iv, D-ii	a) A-iv, B-i, C-iii, D-ii	b) A-ii, B-i, C-iii, D-iv	b) A-iii, B-i, C-iv, D-ii
8 1	The de Broglie wavelength of a particle of mass m and velocity v is given by:				Answer
	a) $\lambda = h/mv$	b) $\lambda = hv$	a) $\lambda = mc^2/h$	b) $\lambda = hv/c$	(a) $\lambda = h/mv$

82	What is displacement current?				b)
	a) The current due to free charges only	b) The current that produces a magnetic field in a capacitor even when no conduction current flows	c) The current in a wire	d) The current due to ions in a solution	The current that produces a magnetic field in a capacitor even when no conduction current flows
83	The Poynting vector is				c)
	a) The vector representing electric potential	b) The vector representing magnetic flux density	c) The vector representing the directional energy flux (power per unit area) of an electromagnetic field	d) The vector representing charge density	The vector representing the directional energy flux (power per unit area) of an electromagnetic field
84	The total number of electric field lines passing normally through that surface is called				d)
	a) flux	b) dipole	c) magnetic flux	d) electric flux	electric flux

85	Match the physical quantities with their SI units:				a)								
	<table><tr><td>1.Magnetic flux</td><td>a) Charge metre (Cm)</td></tr><tr><td>2.Electric dipole moment</td><td>b) Weber (Wb)</td></tr><tr><td>3.Electric potential</td><td>c) Volt (V)</td></tr><tr><td>4. Electric charge</td><td>d) Coulomb (C)</td></tr></table>				1.Magnetic flux	a) Charge metre (Cm)	2.Electric dipole moment	b) Weber (Wb)	3.Electric potential	c) Volt (V)	4. Electric charge	d) Coulomb (C)	
1.Magnetic flux	a) Charge metre (Cm)												
2.Electric dipole moment	b) Weber (Wb)												
3.Electric potential	c) Volt (V)												
4. Electric charge	d) Coulomb (C)												
	a) 1 → b, 2 → a, 3 → c, 4 → d	b) 1 → a, 2 → b, 3 → c, 4 → d	c) 1 → c, 2 → a, 3 → b, 4 → d	d) 1 → b, 2 → d, 3 → c, 4 → a	1 → b, 2 → a, 3 → c, 4 → d								
86	Match the phenomena with the correct physics branch:				a)								
	<table><tr><td>1. Skin effect</td><td>a) The tendency of alternating current to flow near the surface of a conductor</td></tr><tr><td>2. Electromagnetic wave</td><td>b) A wave consisting of oscillating electric and magnetic fields, perpendicular to each other</td></tr><tr><td>3. Ampere’s Circuital Law</td><td>c) The line integral of magnetic field around a closed loop is proportional to the current enclosed</td></tr><tr><td>4. Poynting vector</td><td>d) The rate of energy flow per unit area in an electromagnetic wave</td></tr></table>				1. Skin effect	a) The tendency of alternating current to flow near the surface of a conductor	2. Electromagnetic wave	b) A wave consisting of oscillating electric and magnetic fields, perpendicular to each other	3. Ampere’s Circuital Law	c) The line integral of magnetic field around a closed loop is proportional to the current enclosed	4. Poynting vector	d) The rate of energy flow per unit area in an electromagnetic wave	
1. Skin effect	a) The tendency of alternating current to flow near the surface of a conductor												
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4. Poynting vector	d) The rate of energy flow per unit area in an electromagnetic wave												
	a) 1 → a, 2 → b, 3 → c, 4 → d	b) 1 → b, 2 → a, 3 → c, 4 → d	c) 1 → a, 2 → b, 3 → d, 4 → c	d) 1 → a, 2 → d, 3 → c, 4 → b	1 → a, 2 → b, 3 → c, 4 → d								
87	A parallel plate capacitor has plate area A and separation d. It is filled with a dielectric of permittivity ε. If the electric field between the plates is E, what is the energy density stored in the capacitor?				a)								
	a) εE ² /2	b) εE/2	c) E ² /2ε	d) εE ²	εE ² /2								
88	A capacitor of capacitance 10μF is charged to a potential difference of 100V. What is the energy stored in it?				a)								
	a)0.05J	b)0.1J	c)0.25J	d)0.5J	0.05J								
89	A plane electromagnetic wave is propagating in the +z direction. If the electric field is along the xxx-axis, then the magnetic field will be:				a)								
	a) Along the y-axis	b) Along the z-axis	c) Opposite to the x-axis	d) Zero everywhere	Along the y-axis								
90	Assertion (A): The displacement current is necessary to modify Ampere’s law. Reason (R): Without the displacement current term, Ampere’s law would not be consistent with the continuity equation for current.				a)								
	a) Both A and R are true, and R is the correct explanation of A.	b) A is true, but R is false.	c) A is false, but R is true.	d) Both A and R are true, but R is not the correct explanation	Both A and R are true, and R is the correct explanation of A.								

				of A.									
91	Assertion (A): In an electromagnetic wave, the electric and magnetic fields are perpendicular to each other and to the direction of propagation. Reason (R): The perpendicular arrangement of E and B fields is a consequence of Maxwell's equations in free space.				d)								
	a) A is false, but R is true.	b) A is true, but R is false.	c) Both A and R are true, but R is not the correct explanation of A.	d) Both A and R are true, and R is the correct explanation of A.	Both A and R are true, and R is the correct explanation of A.								
92	Match the Electromagnetic Quantities with their Corresponding Units. <table><tr><td>1.Electric field</td><td>a) Tesla (T)</td></tr><tr><td>2.Magnetic flux density</td><td>b) Volt per meter</td></tr><tr><td>3.Electric displacement</td><td>c) Coulomb per square meter</td></tr><tr><td>4.Magnetic field intensity</td><td>d) Ampere per meter</td></tr></table>				1.Electric field	a) Tesla (T)	2.Magnetic flux density	b) Volt per meter	3.Electric displacement	c) Coulomb per square meter	4.Magnetic field intensity	d) Ampere per meter	a)
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4.Magnetic field intensity	d) Ampere per meter												
	a)1-b, 2-a, 3-c, 4-d	b)1-b, 2-a, 3-d, 4-c	c)1-b, 2-d, 3-c, 4-a	d)1-d, 2-a, 3-c, 4-b	1-b, 2-a, 3-c, 4-d								

93	The Miller indices (1 0 0) represent which plane in a cubic crystal?				Plane parallel to y and z-axis
	a) Diagonal plane	b) Plane parallel to y and z-axis	c) Plane parallel to x and y-axis	d) Plane passing through the origin	b
94	Examine the following statements: A Due to weak dispersion forces (London forces), molecular solids like I ₂ have low melting point. B In ice, each molecule of H ₂ O combines tetrahedrally with four H ₂ O molecules and form ionic solid. C Strong Coulombic forces exist between constituent ions in the substances like NaCl and MgCl ₂ . D As the constituent particles in NaCl and KCl are ions, they are good conductors of electricity in the solid state.				A-True, B-False, C-True, D-False
	a) A-True, B-False, C-True, D-False	b) A-False, B-False, C-True, D-False	c) A-True, B-False, C-True, D-True	d) A-True, B-False, C-False, D-False	a

95	Type Questions here for matching pairs:				A-iii, B- iv, C-ii, D-i
A Sodium chloride		i hydrogen bonding			
B Dimond		ii metallic bonding			
C Magnesium		iii ionic bonding			
D H ₂		iv covalent bonding			
	a) A-ii, B- iv, C- iii, D-i	b) A-iii, B- iv, C- ii, D-i	c) A-iv, B- iii, C- ii, D-i	d) A-i, B- iv, C- ii, D-iii	b
96	The value of magnetic moment is zero in the case of antiferromagnetic substances because the domains: A get oriented in the direction of the applied magnetic field B get oriented opposite to the direction of the applied magnetic field C are oppositely oriented with respect to each other without the application of magnetic field D cancel out each other's magnetic moment				A-False, B- False, C- True, D- True
	a) A-True, B- False, C- False, D-False	b) A-True, B- False, C-True, D-False	c) A-False, B- False, C-True, D-True	d) A-True, B- False, C- False, D-True	c
97	Choose the correct answer out of the following choices. A: Assertion: Graphite is a good conductor of electricity however diamond belongs to the category of insulators. B: Justification: Graphite is soft in nature on the other hand diamond is very hard and brittle.				A and B both are correct statements but B is not correct explanatio n for A.
	a) A and B both are correct statements and B is correct explanation for A.	b) An and B both are correct statements but B is not correct explanation for A.	c) A is correct statement but B is wrong statement.	d) A is wrong statement but B is correct statement.	b
98	The energy gaps (Eg) between valence band and conduction band for diamond, silicon and germanium are in the order of				Eg (diamond) > Eg (silicon) > Eg (germaniu m)
	a) Eg (diamond) > Eg (silicon) > Eg (germanium)	b) Eg (diamond) < Eg (silicon) < Eg (germanium)	c) Eg (diamond) = Eg (silicon) = Eg (germanium)	d) Eg (diamond) > Eg (germanium) > Eg (silicon)	a

99	Match the concepts in Column A with the related phenomena or definitions in Column B:				A-i, B-ii, C-iv, D-iii
	A Meissner Effect		i Expulsion of magnetic field		
	B Band Gap		ii Energy separation in solids		
	C Brillouin Zone		iii Paired electrons in superconductor		
	D Cooper Pair		iv First zone in reciprocal space		
	a) A-i, B-ii, C-iv, D-iii	b) A-ii, B-iii, C-i, D-iv	c) A-iii, B-i, C-ii, D-iv	d) A-iv, B-i, C-iii, D-ii	a
100	Which one of the following shows antiferromagnetism?				MnO
	a) MnO	b) TiO ₂	c) O ₂	d) Fe	a
101	Cations are present in the interstitial sites in				Frenkel defect
	a) Frenkel defect	b) Schottky defect	c) vacancy defect	d) metal deficiency defect	a
102	Features are not shown by quartz glass are that: A it is a crystalline solid B refractive index is same in all the directions C is opaque D it is also called super cooled liquid				A-False, B-True, C-False, D-True
	a) A-True, B-True, C-True, D-False	b) A-True, B-False, C-True, D-False	c) A-False, B-True, C-False, D-True	d) A-True, B-True, C-False, D-True	c
103	The energy band gap in conductors is:				Zero
	a) Large	b) Small	c) Zero	d) Infinity	c
104	Which of the following best describes the Meissner effect?				Superconductors expel magnetic fields
	a) Superconductors emit light	b) Superconductors become magnetic	c) Superconductors expel magnetic fields	d) Superconductors allow magnetic fields inside	c
105	The BCS theory explains superconductivity on the basis of				Electron-lattice interaction
	a) Electron-lattice interaction	b) Hole conduction	c) Magnetic ordering	d) Photon-electron interaction	a

106	Consider the following statements about a PN junction diode: 1. In forward bias, the resistance is low. 2. In reverse bias, a small leakage current flows.				Answer								
	a) 1 and 2 both are True	b) 1 and 2 both are False	c) Only 2 is True	d) Only 1 is True	(a)								
107	Assertion (A): In a common-emitter configuration, the transistor shows high voltage gain. Reason (R): The output resistance in common-emitter mode is very high. Choose the correct option on the basis on above statements:				Answer								
	a) Both A and R are true, and R is the correct explanation of A.	b) Both A and R are true, but R is not the correct explanation of A.	c) A is true, but R is false.	d) A is false, but R is true.	(c)								
108	Match the electronic components with their functions: <table><tr><td>A. Resistor</td><td>i Stores charge</td></tr><tr><td>B. Capacitor</td><td>ii Provides resistance</td></tr><tr><td>C. Diode</td><td>iii Acts as a switch/amplifier</td></tr><tr><td>D. Transistor</td><td>iv. Allows current in one direction</td></tr></table>				A. Resistor	i Stores charge	B. Capacitor	ii Provides resistance	C. Diode	iii Acts as a switch/amplifier	D. Transistor	iv. Allows current in one direction	Answer
A. Resistor	i Stores charge												
B. Capacitor	ii Provides resistance												
C. Diode	iii Acts as a switch/amplifier												
D. Transistor	iv. Allows current in one direction												
	a) A(ii), B(i), C(iv), D(iii)	b) A(i), B(iii), C(ii), D(iv)	c) A(iii), B(ii), C(i), D(iv)	d) A(i), B(ii), C(iii), D(iv)	(a)								
109	In a CRO (Cathode Ray Oscilloscope), the time base circuit is used to:				Answer								
	a) Control vertical deflection	b) Control horizontal deflection	c) Increase sensitivity	d) Measure resistance	(b)								
110	Match the types of logic gates with their truth table outputs: <table><tr><td>A. AND Gate</td><td>i. Output is high only when both inputs are high</td></tr><tr><td>B. OR Gate</td><td>ii. Output is high if any input is high</td></tr><tr><td>C. NOT Gate</td><td>iii. Output is the inverse of input</td></tr><tr><td>D. NAND Gate</td><td>iv. Output is opposite of AND gate</td></tr></table>				A. AND Gate	i. Output is high only when both inputs are high	B. OR Gate	ii. Output is high if any input is high	C. NOT Gate	iii. Output is the inverse of input	D. NAND Gate	iv. Output is opposite of AND gate	Answer
A. AND Gate	i. Output is high only when both inputs are high												
B. OR Gate	ii. Output is high if any input is high												
C. NOT Gate	iii. Output is the inverse of input												
D. NAND Gate	iv. Output is opposite of AND gate												
	a) A(ii), B(i), C(iv), D(iii)	b) A(i), B(ii), C(iii), D(iv)	c) A(ii), B(i), C(iii), D(iv)	d) A(ii), B(iii), C(iv), D(i)	(b)								

111	Which logic gate gives output 1 only when all inputs are 1?				Answer
	a) OR	b) AND	c) NAND	d) XOR	(b)
112	In a photoelectric effect experiment, increasing the intensity of light:				Answer
	a) Increases the stopping potential	b) Decreases the kinetic energy of emitted electrons	c) Increases the number of emitted electrons	d) Has no effect on the number of electrons	(c)
113	In a Scanning Electron Microscope (SEM), why is it necessary to have a conductive coating on non-conductive samples?				Answer
	a) To enhance the atomic number contrast	b) To prevent charging of the sample surface	c) To increase the electron wavelength	d) To allow transmission of electrons through the sample	(b)
114	The operational amplifier (op-amp) cannot be used as a voltage follower.				Answer
	a) True	b) False	c) Only in AC circuits	d) Only in DC circuits	(b)
115	Assertion (A): In a multimeter, the resistance measurement is affected if the circuit is powered. Reason (R): The multimeter passes a small current through the resistor to measure its resistance. Choose the correct option on the basis on above statements:				Answer
	a) Both A and R are true, and R is the correct explanation of A.	b) Both A and R are true, but R is not the correct explanation of A.	c) A is true, R is false.	d) A is false, R is true.	(a)
116	If a student wants to study internal structures at atomic scale, which instrument is logical?				Answer
	a) TEM	b) SEM	c) Optical Microscope	d) Mass Spectrometer	(b)
117	A small compass needle deflects when a current-carrying wire is brought nearby. Why does the deflection angle increase if the wire is brought closer?				Answer
	a) Magnetic field strength	b) Magnetic field strength	c) Magnetic field is	d) Compass sensitivity increases	(b)

	increases with distance	decreases with distance	independent of distance		
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118	The curl of a gradient of any scalar field ϕ is:				Always zero								
	a) Equal to $\nabla^2 \phi$	b) Always zero	c) A constant vector	d) Undefined	b)								
119	What is the dimension of force in terms of Mass (M), Length (L), and Time (T)?				$MLT^{(-2)}$								
	a) $MLT^{(-2)}$	b) $ML^2T^{(-2)}$	c) $MLT^{(-1)}$	d) $ML^2T^{(-1)}$	a)								
120	Choose the correct option about the following statements: A: The variance of a binomial distribution is greater than the mean B: In a binomial distribution, variance is $np(1-p)$ and mean is np (symbols having their usual meanings)				A is false, but R is true.								
	a) Both A and R are true, and R is the correct explanation of A.	b) Both A and R are true, but R is not the correct explanation of A.	c) A is false, but R is true.	d) Both A and R are false.	c)								
121	Match Column A with Column B: <table border="1"><tr><td>A Dirichlet conditions (for Fourier Series)</td><td>i $2\pi\delta(\omega)$</td></tr><tr><td>B Fourier Transform of a delta function</td><td>ii 1</td></tr><tr><td>C Laplace Transform of e^{-at}, where $a>0$</td><td>iii $1/(s+a)$</td></tr><tr><td>D Fourier Transform of a constant function</td><td>iv Function must be absolutely integrable over a period</td></tr></table>				A Dirichlet conditions (for Fourier Series)	i $2\pi\delta(\omega)$	B Fourier Transform of a delta function	ii 1	C Laplace Transform of e^{-at} , where $a>0$	iii $1/(s+a)$	D Fourier Transform of a constant function	iv Function must be absolutely integrable over a period	A-iv, B-ii, C-iii, D-i
A Dirichlet conditions (for Fourier Series)	i $2\pi\delta(\omega)$												
B Fourier Transform of a delta function	ii 1												
C Laplace Transform of e^{-at} , where $a>0$	iii $1/(s+a)$												
D Fourier Transform of a constant function	iv Function must be absolutely integrable over a period												
	a) A-iv, B-i, C-iii, D-ii	b) A-iv, B-ii, C-iii, D-i	c) A-iv, B-ii, C-i, D-iii	d) A-iv, B-i, C-ii, D-iii	b)								
122	Let $f(z)= z ^2$, where $z=x+iy$. $f(z)$ analytic				nowhere								
	a) along the real axis	b) everywhere	c) nowhere	d) only at the origin	c)								

123	Match the functions with where they commonly appear:				A-i, B-ii, C-iii, D-iv
	A Hermite polynomials		i Harmonic oscillator		
	B Bessel functions		ii Cylindrical symmetry		
	C Laguerre polynomials		iii Hydrogen atom (radial part)		
	D Legendre polynomials		iv Spherical symmetry		
	a) A-i, B-ii, C-iii, D-iv	b) A-ii, B-i, C-iii, D-iv	c) A-i, B-ii, C-iv, D-iii	d) A-i, B-iii, C-ii, D-iv	a)
124	Which of the following statements is true about Taylor and Laurent series? A Laurent series includes negative powers of z; Taylor series does not. B Both series are valid for functions analytic everywhere in C. C Taylor series converges only if the function has a pole at the center. D Laurent series cannot represent functions with isolated singularities.				Laurent series includes negative powers of z; Taylor series does not.
	a) A	b) B	c) C	d) D	a)
125	Assertion (A) and Reason (R) are given below. Read them carefully and choose the correct option. A: The Poisson distribution can be derived as a limiting case of the Binomial distribution when the number of trials becomes very large and the probability of success becomes very small. R: The Poisson distribution is used to model the number of occurrences of an event in a fixed interval of time or space, given a constant average rate.				Both A and R are true, but R is not the correct explanation of A
	a) Both A and R are true, and R is the correct explanation of A	b) Both A and R are true, but R is not the correct explanation of A	c) A is true, but R is false	d) A is false, but R is true	b)
126	Match Column A (Situations / Concepts) with Column B (Descriptions)				A-iv, B-i, C-ii, D-iii
	A Tossing a fair coin once		i Continuous random variable		
	B Temperature measured over time in a lab experiment		ii Discrete random variable		
	C Number of defective bulbs in a box of 10		iii Symmetric bell-shaped distribution		
	D Height distribution of students in a college		iv Binary outcome random variable		
	a) A-i, B-iv, C-ii, D-iii	b) A-iv, B-i, C-iii, D-ii	c) A-iv, B-i, C-ii, D-iii	d) A-iv, B-ii, C-i, D-iii	c)

127	Find the Laplace transform of $t^2 e^{3t}$.				$\frac{2}{(s-3)^3}$
	a) $\frac{2}{(s-3)^3}$	b) $\frac{6}{(s-3)^3}$	c) $\frac{2}{(s+3)^3}$	d) $\frac{6}{(s+3)^3}$	a)
128	Matching Pair				A-ii, B-i C-iv, D-iii
A Laplacian operator on scalar ϕ		i Converts a surface integral of curl of a vector field into a line integral over its boundary			
B Stokes' theorem		ii $\nabla^2 \phi = \nabla \cdot (\nabla \phi)$			
C Divergence theorem		iii Faraday's law			
D curl of an electric field		iv Gauss' Theorem			
	a) A-iii, B-i C-iv, D-ii	b) A-i, B-ii, C-iv, D-iii	c) A-ii, B-i, C-iv, D-iii	d) A-ii, B-i C-iii, D-iv	c)
129	The solution of the initial value problem: $y' + y = x$; $y(0) = 1$ is				$y(x) = x - 1 + 2e^{-x}$
	a) $y(x) = x + 1$	b) $y(x) = x - 1 + 2e^{-x}$	c) $y(x) = x + 1 + 2e^{\{x\}}$	d) $y(x) = e^{\{x\}}(x + 1)$	b)

130	Which of the following quantities is conserved if the Lagrangian does not depend explicitly on time?				Total energy
	a) Linear momentum	b) Angular momentum	c) Total energy	d) Generalized coordinate	c)
131	If a system is invariant under spatial translations, what is the conserved quantity?				Linear momentum
	a) Angular momentum	b) Linear momentum	c) Hamiltonian	d) Acceleration	b)
132	State whether the following statements are True or False A Newton's first law defines an inertial frame. B A net force is required to keep an object in uniform motion. C Newton's third law involves equal and opposite forces on two bodies. D Newton's second law connects force with the rate of change of momentum.				A-True, B-False, C-True, D-True
	a) A-True, B-False, C-True, D-True	b) A-False, B-True, C-True, D-True	c) A-False, B-True, C-False, D-True	d) A-True, B-True, C-True, D-True	a)
133	Choose the correct answer regarding the following statements: A: In elastic collisions, the total kinetic energy is conserved in the center-of-mass (CM) frame.				Both A and R are true, but R is not the correct

	R: The total momentum of the system is zero in the CM frame.				explanation of A
	a) Both A and R are true, and R is the correct explanation of A	b) Both A and R are true, but R is not the correct explanation of A	c) A is true, but R is false	d) A is false, but R is true	b)
134	Match the approximations given in Column A with the physical problems given in Column B:				A-i, B-ii, C-iii, D-iv
	A Linear restoring force		i Simple harmonic motion		
	B Taylor expansion of potential		ii Near equilibrium to find force		
	C Ignore damping & driving		iii For ideal conservative systems		
	D Equal masses & springs		Iv Symmetry in coupled systems		
	a) A-i, B-ii, C-iii, D-iv	b) A-iv, B-ii, C-iii, D-i	c) A-i, B-iv, C-iii, D-ii	d) A-i, B-ii, C-iv, D-iii	a)
135	A planet revolves around the Sun in an elliptical orbit under the influence of gravity. As it moves from one position in its orbit to another, which of the following quantities remains constant throughout the motion?				The rate at which it sweeps out area with respect to the Sun
	a) Its orbital speed	b) Its distance from the Sun	c) The rate at which it sweeps out area with respect to the Sun	d) Its gravitational potential energy	c)
136	Match the term with its description				A-ii, B-iii, C-iv, D-i
	A Phase space		i Frequency of a normal mode of vibration		
	B Stability of equilibrium		ii Space of position and momentum variables		
	C Coupled oscillators		iii Whether small disturbances grow or decay		
	D Normal frequency		iv Oscillators linked so they affect each other		
	a) A-ii, B-iv, C-iii, D-i	b) A-ii, B-i C-iv, D-iii	c) A-i, B-iii, C-iv, D-ii	d) A-ii, B-iii, C-iv, D-i	d)
137	A neutral, non-relativistic particle of mass $m=1\text{kg}$ moves in a potential $V(x) = \alpha x^4$ with $\alpha = 2\text{ N/m}^3$. What is the equation of motion of the particle				$\ddot{x} + 8x^3 = 0$
	a) $\ddot{x} + 8x^3 = 0$	b) $\ddot{x} - 8x^3 = 0$	c) $\ddot{x} + 4x^3 = 0$	d) $\ddot{x} - 4x^3 = 0$	a)

138	Consider the following statements regarding the moment of inertia tensor and rotational motion: A The moment of inertia tensor depends on the choice of origin. B The kinetic energy of a rotating rigid body can be written as $T = \vec{\omega}^T \tilde{I} \vec{\omega}$ C If a rigid body is symmetric about an axis, that axis is always a principal axis. D The moment of inertia tensor changes with time for a freely rotating rigid body.				A – True, B – True, C – True, D – False
	a) A – True, B – False, C – True, D – False	b) A – False, B – True, C – True, D – True	c) A – True, B – True, C – False, D – False	d) A – True, B – True, C – True, D – False	d)
139	Choose the correct answer regarding the following statements: A: The angular velocity vector always lies along one of the principal axes of the rigid body. R: The angular momentum vector is always aligned with angular velocity for any rigid body.				A is false, but R is true
	a) Both A and R are true, and R is the correct explanation of A	b) Both A and R are true, but R is not the correct explanation of A	c) A is true, but R is false	d) A is false, but R is true	d)
140	State whether the following statements are True or False: A In small oscillations, the potential energy can be approximated as a quadratic function near equilibrium. B All normal modes of a conservative system always oscillate at the same frequency. C The number of normal modes in a system of N degrees of freedom is N. D In normal mode motion, all parts of the system oscillate with the same frequency but different amplitudes.				A – True, B – False, C – True, D – True
	a) A – True, B – False, C – True, D – True	b) A – True, B – True, C – True, D – False	c) A – False, B – False, C – True, D – True	d) A – True, B – False, C – False, D – True	a)
141	In a certain frame, a photon and an electron are moving in the same direction. The speed of the photon is:				Exactly c
	a) Equal to the speed of the electron	b) Slightly less than c	c) Exactly c	d) Frame-dependent	c)

142	Match the terms in columns provided below:				A-ii, B-iii, C-i, D-iv
	A Minkowski spacetime		i The set of spacetime events that can influence or be influenced by a light signal		
	B 4-momentum		ii A geometric framework where space and time are treated as unified entities		
	C Light cone		iii Relativistically invariant magnitude		
	D Frame-dependent simultaneity		iv Events that are simultaneous in one inertial frame may not be in another		
	a) A-ii, B-iii, C-i, D-iv	b) A-iii, B-ii, C-i, D-iv	c) A-iv, B-iii, C-i, D-ii	d)A-ii, B-i, C-iii, D-iv	a)
143	The Hamiltonian $H(q,p)=p^2/2m + V(q)$ for a particle of mass ‘m’ is conserved if				V(q) does not explicitly depend on time
	a) V(q) explicitly depends on time	b) V(q) does not explicitly depend on time	c) p explicitly depends on time	d) q explicitly depends on time	b)

144	The binding energy per nucleon curve reaches its maximum around:				Answer: Iron-56
	a) Hydrogen	b) Helium-4	c) Iron-56	d) Uranium- 238	(c)
145	The semi-empirical mass formula explains nuclear stability based on:				Answer: Liquid drop model
	a) Pauli exclusion principle	b) Fermi- Dirac statistics	c) Shell Model	d) Liquid drop model	(d)
146	Neutrino oscillations imply:				Answer: Neutrinos have small but finite mass
	a) Neutrinos are massless	b) Lepton number is not conserved	c) Neutrinos have small but finite mass	d) Time reversal symmetry	(c)

147	A is the assertion and B is the justification: A: Free neutrons are unstable with half-life ~15 minutes B: Beta decay converts neutron to proton, emitting electron and antineutrino.				Answer: Assertion true, reason true, reason correct explanation								
	a) Assertion true, reason true, reason correct explanation	b) Assertion true, reason true, but not correct explanation	c) Assertion true, reason false	d) Assertion false	(a)								
148	A gamma photon with energy 1.02 MeV interacts to produce an electron-positron pair. What happens if energy is exactly 1.02 MeV?				Answer: Pair is produced with zero kinetic energy								
	a) Pair is not produced	b) Pair is produced with zero kinetic energy	c) Pair is produced with additional photons	d) Process forbidden	(b)								
149	<table><tr><td>1) Positron</td><td>A) Beta-plus</td></tr><tr><td>2) Electron</td><td>B) Beta-minus</td></tr><tr><td>3) Helium nucleus</td><td>C) Alpha-decay</td></tr><tr><td>4) Photon</td><td>D) Gamma-decay</td></tr></table>				1) Positron	A) Beta-plus	2) Electron	B) Beta-minus	3) Helium nucleus	C) Alpha-decay	4) Photon	D) Gamma-decay	Answer: 1–A, 2–B, 3–C, 4–D
1) Positron	A) Beta-plus												
2) Electron	B) Beta-minus												
3) Helium nucleus	C) Alpha-decay												
4) Photon	D) Gamma-decay												
	a) 1–C, 2–D, 3–B, 4–A	b) 1–B, 2–A, 3–C, 4–D	c) 1–A, 2–B, 3–C, 4–D	d) 1–D, 2–B, 3–A, 4–C	(c)								
150	The strong interaction is mediated by:				Answer: Gluons								
	a) Photon	b) Gluons	c) W and Z bosons	d) Graviton	(b)								