Dhirubhai Ambani Institute of Information and Communication Technology

Ph.D. Entrance Examination (Winter 2021)

Physics (Set - A)

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1. Let x be a non-zero column vector of size $n \times 1$. The rank of matrix $A = x^T x$, where x^T denotes the transpose of x, is

   (a) n
   (b) n^2
   (c) 0
   (d) 1
   (e) None of the above

Answer: (d) 1.

2. Let A and B be two sets such that $A \cup B = A \cap B$. Which of the following statements is true.

   (a) A is an empty set, while B is not
   (b) A and B are identical sets
   (c) B is an empty set, while A is not
   (d) All of the above
   (e) None of the above

Answer: (b) A and B are identical sets.

3. Given a set $S = \{x | x$ is a student in a class$\}$ and a relation ρ defined as $x \rho y$ if and only if x sits in the same row as y. Then the relation is

   (a) reflexive only
   (b) reflexive and symmetric but not transitive.
   (c) reflexive, symmetric, and transitive.
   (d) symmetric, transitive but not reflexive
   (e) None of the above

Answer: (c) reflexive, symmetric, and transitive.

4. The $\lim_{x \to \infty} f(x)$, where $f(x) = \frac{2x^2+5x}{x^2+5}$, is

   (a) ∞
   (b) 1
   (c) 2
   (d) $-\infty$
   (e) None of the above.

Answer: (c) 2

5. The area above the x-axis and below the graph of the function $y = 1 - x^2$ is

   (a) $\frac{3}{4}$

(b) $-\frac{4}{3}$

(c) $\frac{4}{3}$

(d) $\frac{5}{6}$

(e) None of the above.

Answer: (c) $\frac{4}{3}$

6. For a planet in motion around the Sun, a closed trajectory is ensured by the condition that the total conserved energy is:

   (a) Equal to zero

   (b) Greater than zero

   (c) Less than zero

   (d) A constant of the motion

   (e) None of the above

Answer: (c) Less than zero

7. If one were to dig a tunnel towards the centre of the Earth (assumed to be of uniform density), then the force of gravitational attraction at a point r from the centre would:

   (a) Increase as r^{-2}

   (b) Remain constant within the Earth's surface

   (c) Decrease as r

   (d) Vary periodically

   (e) Vary exponentially

Answer: (c) Decrease as r

8. A certain volume of gas V at a pressure, P, and temperature, T, is adiabatically compressed to half its earlier volume. The change in the entropy of the system is:

   (a) 0

   (b) PV/T

   (c) PV^{γ}

   (d) $2\,\text{joules}\,\text{K}^{-1}$

   (e) Varies linearly with T.

Answer: (a) 0

9. A narrow straight channel has an area of cross section that decreases continually. As a result, the speed of a liquid flowing through this channel will:

   (a) Remain unchanged

   (b) Decrease with the decreasing area of the channel

   (c) The liquid flow will stop

   (d) Increase with the decreasing area of the channel

   (e) None of the above

Answer: (d) Increase with the decreasing area of the channel

10. Electromagnetic radiation with a wavelength of 525 nm corresponds to a photon energy of:

    (a) 1.04×10^{-31} J
    (b) 3.79×10^{-28} J
    (c) 3.79×10^{-19} J
    (d) 1.04×10^{-22} J
    (e) Cannot say unless the frequency is known

Answer: (c) 3.79×10^{-19} J

11. An electron in the hydrogen atom has the energy -1.362×10^{-19} J. The value of n is:

    (a) 1
    (b) 2
    (c) 3
    (d) 4
    (e) 5

Answer: (d) 4

12. Two samples of the same radioactive substance is taken. Sample A shows twice the activity rate of sample B. The half life of:

    (a) Sample A is greater than that of sample B
    (b) Sample B is greater than that of sample A
    (c) Both samples have the same half life
    (d) Both samples are of the same amount
    (e) Cannot say unless the initial amount of both samples is known

Answer: (c) Both samples have the same half life

13. The lowest orbital energy is reached when the number of electrons with the same spin is maximized.

    (a) Pauli's exclusion principle
    (b) De Broglie hypothesis
    (c) Heisenberg uncertainty principle
    (d) Hund's rule
    (e) None of the above

Answer: (d) Hund's rule

14. The ultraviolet catastrophe is associated with:

    (a) Wien's displacement law
    (b) Rayleigh-Jeans law
    (c) Wien's distribution law
    (d) Planck's law
    (e) None of the above

Answer: (b) Rayleigh-Jeans law

15. If the temperature of a blackbody is halved the wavelength corresponding to the maximum emission of radiation changes by a factor of:

    (a) 2
    (b) 4
    (c) 12
    (d) 14
    (e) Does not change

Answer: (a) 2

16. Spectral line splitting due to the influence of magnetic fiels is called:

    (a) Boltzmann effect
    (b) Zeeman effect
    (c) Planck effect
    (d) Stark effect
    (e) None of the above

Answer: (b) Zeeman effect

17. A blackbody has a peak in its spectrum at 145 nm. If the Wien constant is 2.9×10^{-3} m K, the surface temperature is:

    (a) 200 K
    (b) 2000 K
    (c) 10000 K
    (d) 1000 K
    (e) None of the above

Answer: (e) None of the above

18. In electromagnetic waves the electric and magnetic field vectors have a phase difference of:

    (a) 0
    (b) $\pi/2$
    (c) π
    (d) $\pi/4$
    (e) $3\pi/4$

Answer: (a) 0

19. Poynting vector gives

    (a) Direction of polarization
    (b) Intensity of magnetic field
    (c) Rate of energy flow
    (d) Intensity of electric field
    (e) None of the above

Answer: (c) Rate of energy flow

20. The maximum wavelength of X-rays that can be diffracted by a crystal of interplanar spacing $d = 2.5$ Å is:

    (a) 2.5 Å
    (b) 1.25 Å
    (c) 5 Å
    (d) 10 Å
    (e) Cannot say with the information provided

Answer: (c) 5 Å