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UG/1st Sem/PHS(H)/T/19

2019

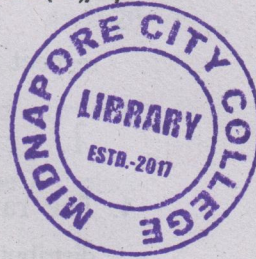
B.Sc.

1st Semester Examination

PHYSICS (Honours)

Paper - C 1-T

(Mathematical Physics)



Full Marks : 40

Time : 2 Hours

*The figures in the margin indicate full marks.
Candidates are required to give their answers
in their own words as far as practicable.*

Group - A

Answer any *five* questions : $5 \times 2 = 10$

1. Find whether $d\phi$ is an exact differential where

$$d\phi = (x^2 - y)dx + xdy.$$

2. Show that $\vec{\nabla} \cdot (\vec{\nabla} \times \vec{A}) = 0$ for any vector \vec{A} .

[Turn Over]

(2)

3. If the magnitude of a vector \vec{A} is constant with respect to time, show that $\frac{d\vec{A}}{dt}$ is perpendicular to \vec{A} .

4. The random variable x_1 follows a Gaussian distribution with mean μ and standard deviation σ_1 . A second random variable x_2 also follows a Gaussian distribution with same mean μ but different standard deviation $\sigma_2 (> \sigma_1)$. Roughly sketch the two probability density functions.

5. Show that $\delta(kx) = \frac{\delta(x)}{|k|}$, where k is any non-zero constant.

6. A bag contains 10 black balls and 10 red balls. What is the probability of drawing two balls of the same colour ?

7. Solve the equation : $\frac{dy}{dx} + \log_e x^y = 0$.

8. Derive the expression of the volume element dV in spherical polar coordinates.

(3)

Group - B

Answer any *four* questions. 4×5=20

9. (a) Evaluate $\oint_C \vec{F} \cdot d\vec{r}$ along a closed curve C surrounding the origin and lying in the XY plane for $\vec{F} = \frac{\hat{i}x + \hat{j}y}{x^2 + y^2}$.

(b) If \vec{r} be the position vector of a point on a closed contour C , prove that $\oint_C \vec{r} \cdot d\vec{r} = 0$. 3+2

10. (a) Find the order and degree of the following differential equation :

$$\frac{d^2y}{dx^2} + \left(\frac{dy}{dx}\right)^{1/2} + xy = 0.$$

(b) Solve the differential equation,

$$\frac{d^2y}{dx^2} (e^x + 1) + \frac{dy}{dx} = 0. \quad 2+3$$

11. (a) What do you mean by axial vector ?

[Turn Over]

(4)

(b) Solve the following vector equation for \vec{y} :

$$K\vec{y} + (\vec{y} \cdot \vec{b})\vec{a} = \vec{c}; K \neq 0 \text{ and } K \text{ is a constant}$$

scalar while \vec{a}, \vec{b} and \vec{c} are constant vectors.

2+3

12. Find a set of vectors reciprocal to the set

$$(2\hat{i} + 3\hat{j} - \hat{k}), (\hat{i} - \hat{j} - 2\hat{k}) \text{ and } (-\hat{i} + 2\hat{j} + 2\hat{k}). \quad 5$$

13. The probability that a pen made by a company will be defective is $1/10$. If 12 such pens are manufactured, determine what will be the probability that

(a) Exactly two will be defective,

(b) At least two will be defective, and

(c) None will be defective. 2+2+1

14. (a) If \vec{A} is irrotational, show that $\vec{A} \times \vec{r}$ is solenoidal.

(b) The potential energy function between two atoms in a diatomic molecule is defined for $x > 0$ and

$$\text{given by } U(x) = U_0 \left[\left(\frac{a}{x} \right)^{12} - 2 \left(\frac{a}{x} \right)^6 \right], \text{ where}$$

(5)

U_0 and a are both positive. What will you see the nature of equilibrium during plotting of $U(x)$ vs. x i.e., is it stable or unstable ? 2+3

Group - C

Answer any *one* question : 1×10=10

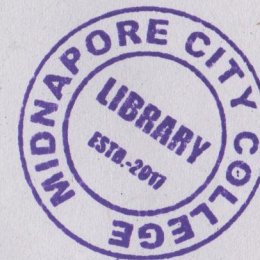
15. (a) State Gauss divergence theorem. 2

(b) If $\vec{A} = ax\hat{i} + by\hat{j} + cz\hat{k}$ where a, b and c are constants. Evaluate $\int_S \vec{A} \cdot d\vec{S}$ where S is the surface of a unit sphere. 3.

(c) What is the main characteristic of Poisson distribution ? Give two physical examples where this distribution is applicable. 1+1

(d) Write the expression of probability $P(r)$ related to Poisson distribution with r -success. 1

(e) Let X follow the Poisson distribution such that $P(X=1) = P(X=2)$. Obtain the value of $P(X=4)$. 2



[Turn Over]

(6)

16. (a) Solve the differential equation :

$$\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = \frac{e^x}{x}; y(1) = 0, y'(1) = 1. \quad 4$$

(b) When a force is called conservative ? Is there any chance to get a corresponding potential function ? — Justify with necessary deduction.

1+1

(c) Determine whether the force field given by

$$\vec{F} = x^2yz\hat{i} - xyz^2\hat{k} \text{ is conservative or not.} \quad 2$$

(d) Evaluate the integral : $\int_{-1}^5 \delta(t-2)2e^{4t} dt$. If the lower limit of integration changes to 3, what will be the value of integration ?

1+1

