2020

VIDYASAGAR COLLEGE FOR WOMEN

PHYSICS-HONOURS

PART-1 PAPER-IIA

FULL MARKS: 25 **Maximum Time: 1 Hour**

Answer *all* questions: **5×5**

1. a) Write down the *work-energy* principle and verify it using vector calculus method. 1

b) Prove that the total mechanical energy of a particle moving in a conservative force field remains conserved. 1

c) Show that the force field $\vec{F} = (2xy + z^3)\hat{i} + x^2\,\hat{j} + 3xz^2\,\hat{k}$ is conservative, where $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along *x*, *y*, and *z* axes, respectively. Find the potential associated with the above force field. 1+1

d) A particle of mass *m* moves in the *xy* plane so that its position vector at any instant *t* is given by $\vec{r} = a\cos\omega t\ \hat{i} + b\sin\omega t\ \hat{j}$, where *a*, *b*, and □ are positive constants. (i) Show that the particle moves in an ellipse. (ii) Show that the force acting on the particle is always directed toward the origin. $\frac{1}{2} + \frac{1}{2}$

2. a) Show that Newton's second law of motion remain invariant in non-accelerated frame of reference. 1

b) A projectile launched with initial speed v_0 at an angle α with the horizontal has acting upon it a force due to air resistance equal to $-\beta\vec{v}$, where β is a positive constant and $\vec{v}$ is the instantaneous velocity. Find (i) the velocity and (ii) the position vector at any time, (iii) time to reach the maximum height and (iv) the maximum height. 1+1+1+1

3. A vessel contains n molecules of a perfect gas at temperature T, mass of each molecules is m. The number of molecules having speed lying between c and $c+dc$ is given by $dn_c = 4\pi n\left(\frac{m}{2\pi KT}\right)^{\frac{3}{2}} e^{-\frac{mc^2}{2KT}} c^2 dc = F_c dc$

a) Plot F_c versus c.

b) Calculate most probable speed (c_m). Indicate it on the graph.

c) On the graph shade the area for speed limits of the molecules between $0.5\,C_m$ to $1.5\,C_m$. (1+2+2)

4. Find the critical constant of a real gas whose equation of state is given by $P(V-b) = RT\exp(-a/RTV)$, where a and b are constants. Show that the above equation reduces to the van der Waals' equation of state if a and b are small. 5

5. Derive the relation $D = \frac{1}{3}\lambda\bar{c}$, where D is the co-efficient of diffusion is, λ is the mean free path and $\bar{c}$ is the mean molecular speed. 5

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PART-1 PAPER-IIB

FULL MARKS: 25 **Maximum Time: 1 Hour**

Answer *all* questions: **5×5**

1. a) Write down the working formula for the determination of Moment of Inertia of a body about an axis passing through its centre of gravity knowing the moment of inertia of a body (known body) in terms of the time periods of rotation of the bodies.

b) Does the moment of inertia of a body depend on its axis of rotation? Explain.

c) How do you convert an ammeter into a voltmeter. Explain with a neat and clean diagram. 2+1+2

2.a) What is dispersion? 2

b) How deviation is related with dispersive power of prism? 2

c) What kind of eyepiece is present in telescope? 1

3. (a) What is meant by "Zener voltage" of a Zener diode? Show it clearly by drawing a suitable diagram. 1

(b) Consider a voltage regulator circuit constructed with a Zener diode. Draw the shape of the line-regulation curve of the voltage regulator. 1

(c) At the output of a bridge rectifier with a capacitor filter of 10 μF, the ripple voltage is 5 mV. If the capacitor filter is changed to 100 μF, what will be value of the ripple voltage? 1

(d) Drawing a circuit using block diagrams of a suitable number of Full-Adders, show the addition of the two binary numbers 101 and 110. 2

4. a) Where the Carey Foster Bridge is most sensitive? When do we use meter bridge?

b) In Stefan's law verification set-up do your results indicate that the light bulb behaves as an ideal black body? If it does, over what temperature range, discuss reasons for departure from black body behavior. 2+3

5. a) State Stefan's law of blackbody radiation. How did you verify Stefan's law in your Laboratory (only physical principle required)? 1+1

b) A black body of total area 0.045 m^2 is completely enclosed in a space bounded by 5 cm thick walls of surface area 0.5 m^2 and thermal conductivity 1.07 W/ m K. If the inner surface of the enveloping wall is to be maintained at 215 ^oC and the outer wall surface at 30 ^oC, calculate the temperature of the black body. 1

c) What is a draper point? Why did you us it in your Stefan's law verification experiment? $\frac{1}{2}+\frac{1}{2}$

d) Why vernier callipers was used in measuring the length of a metal bar in your experiment? 1

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