B.Sc. Part- I Honours Examination, 2020

Subject Code - PHSA Paper Code- 2A Full Marks - 50

Modalities

1. An examinee shall not attend her/his college in person to sit for the examination of a paper. Examinee shall

   (a) write her/his answer with BLUE/BLACK INK only.

   (b) must attach a scanned copy of her/his registration certificate at the end of the answer script. She/he may attach a scanned copy of the admit card of current examinations, if available.

   (c) scan the whole answer script in a single .pdf file. If it is instructed to use separate answer scripts for different modules/units, if any, examinee must do accordingly, but she/he shall create a single .pdf file for the answer script. There will be exactly one .pdf file for each examinee.

   (d) upload her/his answer script through proper web portal to submit.

2. The full marks and duration of examination of a paper shall be in accord with those specified by the University of Calcutta.

3. For examinations of a practical paper, examinees need not submit their laboratory workbook, neither they have to face any viva. Examinees shall have to answer the questions following the instructions given in the question paper. Examinees shall use her/his own graph-papers to draw graphs (if any) in practical papers and attach them at proper positions of the answer script. Examinees shall draw circuits and graphs with BLUE/BLACK INK only.

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Answer Question 1 and any four from the rest.

1. **Answer any five** (2×5)

(a) Define radius of gyration.

(b) What is the significance of the total area under the Maxwellian velocity distribution curve?

(c) Express van der walls equation of state of a real gas in virial form.

(d) Define mean free path.

(e) Write down Planck's law for the energy distribution of black body radiation.

(f) Write down the similarity between black body radiation and perfect gas.

2. A particle of mass m moves along a trajectory given by $X = X_0 \cos\omega t$, $Y = Y_0 \sin\omega t$,

(a) Find the X and Y component of the force. What is the condition under which the force is a central force? (2+2)

(b) Find the potential energy as a function of X and Y. (2)

(c) Determine the kinetic energy of the particle. Show that the total energy of the particle is conserved. (2+2)

3. A particle of mass 2 moves in a force field depending on time t given by

$\vec{F} = 24t^2\hat{\imath} + (36t - 16)\hat{\jmath} - 12t\hat{k}$

Assuming that at t = 0 the particle is located at $\overrightarrow{r_0} = 3\hat{\imath}-\hat{\jmath}+\widehat{4k}$ and has velocity $\overrightarrow{v_0} = 6\hat{\imath}+15\hat{\jmath}-8\hat{k}$, Find

(a) the velocity at any time t. (2)

(b) the position at any time t. (2)

(c) the kinetic energy of the particle at t = 1 and t = 2. (3)

(d) the work done by the field in moving the particle from the point where t = 1 to the point where t = 2. (3)

4. For a system of particle

(a) define and state the expression of momentum. (2)

(b) define and state the expression of angular momentum. (2)

(c) State the expression of total external torque acting on it. (2)

(d) find the relation between angular momentum and external torque acting on it. (4)

5. Write down the postulates of kinetic theory of gases. Find the expression for Maxwell's law of distribution of velocities. What is Root Mean Square Velocity? (4+5+1)

6. (a) Colloidal particles are suspended in liquid. Using Einstein's theory, find the temperature dependence of the mean square displacement per unit time. (6)

(b) A particle under Brownian motion at 27^0C has an r.m.s speed 1m/sec. Find the mass of the particle. Boltzmann constant $K = 1.3 \times 10^{-23}$ J/K. (4)

7. (a) Define thermal conductivity and co-efficient of thermal conductivity. Write down the S.I unit and dimension of thermal conductivity. (3)

(b) What is radiation pressure? (1)

(c) State the Newton's law of cooling. Derive Newton's law of cooling from Stefan-Boltzmann law. (1+3)

(d) The initial temperature 40^0C of a body reduces to 30^0C in 15 minutes. What will be the temperature of the body after 5 minutes? (2)