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B. Sc. (CBCS) (Semester-V)
Examination NOVEMBER 2022
Physics
Classical Mechanic & Thermal Physics

[Duration : 2 Hours] **[Total Marks :80]**

Instructions :
1) **All** questions are **compulsory**.
2) Figures to the **right** indicate marks.
3) **Symbols** have their usual meaning.
4) Use of non-programmable **calculator** is allowed
5) Draw **neat** diagrams **wherever** necessary.

1. Answer any four of the following. **(4x4=16)**
   a) In an inverse square law force field, draw the graph of effective potential energy $V_e(r)$ verses r for $k < 0$ and explain the possible motion of the particle for Total energy $E_1 < 0$ and $E_2 = 0$.
   b) Set up the equation of motion for a rocket accelerating by emitting burnt exhaust gases when there is no external force of gravity.
   c) What is a central force? Distinguish between bounded and unbounded motion with an example. In an inverse square law force field obtain the expression for the effective potential energy.
   d) Distinguish between inertial and non-inertial frame of reference with proper example.
   e) A frame of reference S* rotates with respect to fix frame S with common origin. If $\frac{d}{dt} = \frac{d^*}{dt} + \omega . x$ then obtain the relation between second time derivative in frame S and the second time derivative with respect to S*
   f) Obtain the expression for energy theorem from Euler's equation.

2. Answer any four of the following. **(4x4=16)**
   a) Distinguish between Otto and Diesel Engine. Draw the Otto cycle and write the expression for the efficiency.
   b) Explain in brief the working of vapor compression machine.
   c) Show that the total heat function enthalpy remains constant in the adiabatic throttling process
   d) Draw the phase diagram and specific heat-temperature graph for Helium. What is the λ point? Give any two conclusions from the graph.
   e) Calculate all possible ways of distribution of 4 particles in 5 energy levels, if they are (i) Fermions (ii) Bosons.
   f) Five Marksmen shoot simultaneously on a target and probability for each of them to hit the target is $\frac{1}{5}$.what the probability is for at least one marksman hitting the target?

3. A) Explain how to reduce two body problem to an equivalent one body problem by setting up the equation of motion. (6)

OR

A) Find the expression for the force on the conveyer belt required to maintain the belt velocity constant when material is being continuously dropped at a steady rate on the belt. Show that the power delivered by the force is twice the rate at which the kinetic energy of the system increases. Where does the other half of power go? (6)

B) Obtain an equation of motion, when there is a simultaneous rotation and translation of the two frame of references. (6)

4. A) State and prove Kepler's third law of motion. (6)

OR

A) For a positive branch of hyperbola show that $r = \frac{\alpha(\epsilon^2-1)}{1+\epsilon cos\theta}$ and find its turning points. (6)

B) Obtain the Euler's equations of motion for a rigid body. (6)

5. A) With the help of neat diagram explain the principle of cascaded cooling for liquefaction of Oxygen. (6)

OR

A) p) Explain the property **"Rolling film"** of liquid Helium-II. (3)

q) Calculate the cooling produced by adiabatic demagnetization of a paramagnetic salt as the field is reduced from 20000 Orested to zero at initial temperature of 2K. Given: Curie constant per gram mole per cc=0.042 erg, degree per gram orsted and C_H=0.42 Joules Gram^{-1} degree^{-1} (3)

B) What is Joule Kelvin effect. Assuming Enthalpy is constant in J-K throttling process obtain an expression for Joule Kelvin coefficient. (6)

6. A) a) Condition for most probable distribution is $\sum i \; In\, n_i\, \delta n_i + \sum_i In\, g_i . \delta n_i = 0$. Using this prove that the most probable number of balls in any i^{th} cell$n_i = \frac{a_i}{A} N$. (3)

b) Calculate the root mean square velocity of H_2 at 27°C. Given : Boltzmann constant
k=1.38×10^{-23} Joules/°K and mass of Hydrogen molecule = 3.34×10^{-27} Kg. (3)

OR

A) p) For a Binomial distribution show that root mean square deviation $\sigma = \sqrt{Npq}$. (3)

q) An urn contains 20 white and 10 black identical balls. Find the probability of successively drawing one white ball and one black ball under the condition that, after the first trial ball does not return to the urn. (3)

B) Boltzmann distribution of molecular speed is $n(v)dv = \left[\sqrt{2\pi N}\left[\frac{m}{\pi KT}\right]^{3/2}\right] v^2 e^{\frac{-mv^2}{2kT}}\, dv$. Obtain an expression for average speed and most probable molecular speed. (6)