Student ID Number: _____

PRELIMINARY EXAMINATION

Department of Physics
University of Florida
Part C, August 16, 2019, 09:00–12:00

Instructions

1. You may use a calculator and CRC Math tables or equivalent. No other tables or aids are allowed or required. You may **NOT** use programmable calculators to store formulae.

   (a) All of the problems will be graded and will be tabulated to generate a final score. Therefore, you should submit work for all of the problems.

   (b) For convenience in grading please write legibly, use only one side of each sheet of paper, and work different problems on separate sheets of paper. The sheets for each problem will be stapled together but separately from the other two problems.

   (c) Your assigned student **ID Number**, the **Problem Number**, and the **Page Number** should appear in the upper right hand corner of each sheet. Do **NOT** use your name anywhere on the Exam.

   (d) All work must be shown to receive full credit. Work must be clear and unambiguous. Be sure that you hand your completed work to the Proctor.

   (e) Each problem is worth 10 points.

   (f) Following the UF Honor Code, your work on this examination must reflect your own independent effort, and you must not have given, nor received, any unauthorized help or assistance. If you have any questions, ask the Proctor.

University of Florida Honor Code: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment."*

DO NOT OPEN EXAM UNTIL INSTRUCTED

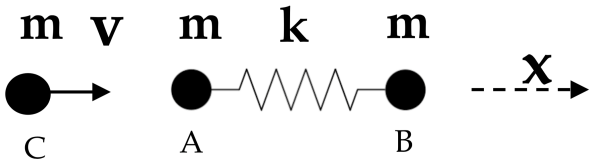
PRELIMINARY EXAMINATION

Department of Physics

University of Florida

Part C, August 16, 2019, 09:00–12:00

C1. The three balls shown in the figure can move only along x direction. The balls A and B are initially at rest. A spring with spring (force) constant k connecting A and B balls is initially in equilibrium. The C-ball, moving with the velocity V, hits the A-ball head-on.



Case 1: The collision is elastic. Describe what happens **after** the collision.

(a) **[2 points]** What is the velocity of the C-ball immediately after the collision?

(b) **[2 points]** What is the maximum compression of the spring?

(c) **[2 points]** What is the frequency of the oscillations for the system of A and B balls?

Case 2: The collision is inelastic and the C and A balls stick together.

(a) **[2 points]** What is the maximum compression of the spring?

(b) **[2 points]** What is the frequency of oscillations for the system of A+C and B balls?

PRELIMINARY EXAMINATION

Department of Physics

University of Florida

Part C, August 16, 2019, 09:00–12:00

C2. A system consists of moon of radius R and mass M, and a planet of mass $9M$ and radius $2R$. Their centers are $15R$ apart. Using Newtons Universal Law of Gravity $F = Gm_1m_2/r^2$, derive in terms of M, G and R:

(a) **[5 points]** The lowest velocity that a projectile could be fired from the planet to the moon. Ignore any rotational effects.

(b) **[5 points]** The period of the moon as it revolves around the center-of-mass of the system.

PRELIMINARY EXAMINATION

Department of Physics

University of Florida

Part C, August 16, 2019, 09:00–12:00

C3. The free energy $F(T, V)$ of an ideal gas is

$$F = -NkT \ln\left[\frac{V}{N}\left(\frac{mkT}{2\pi\hbar}\right)^{3/2}\right],$$

where m, N, k, and $\hbar$ are constants.

(a) **[5 points]** From $dF = -S\,dT - p\,dV$ or otherwise, show that the entropy S and pressure p can be expressed as derivatives of F. Compute S and p. Do you recognize the pressure you obtain?

(b) **[5 points]** The internal energy is given by $U = F + TS$. Compute U. Your answer might appear to be simple, but show from dU that U should be a function of S and V, and write U as a function of S and V. Compute the pressure from U.