# Physics B
Section II

Directions: Answer all seven questions, which are weighted according to the points indicated. The suggested time is about thirteen minutes for answering each question. Each question is worth 10 points. The parts within a question may not have equal weight. Show all your work in this booklet in the spaces provided after each part, NOT in the green insert.

Reference sheets: You may use "Table of Information for 2002" and "Advanced Placement Physics B Equations for 2002" for Section II.

Calculators: You may use an approved calculator for Section II.

1. (10 points)
   For the following situation three blocks of equal mass, 12 kg, are connected by frictionless pulleys and ropes of negligible mass. Assume m_2 and m_3 have the same coefficient of friction.
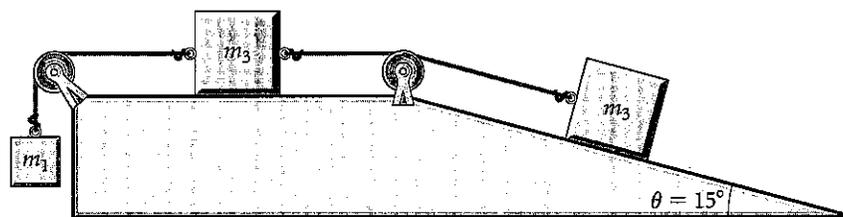

   (a) Draw a free body diagram for each block.
   (b) Resolve the forces on each block into their perpendicular components.
   (c) What must the coefficient of friction be for the blocks to move at a constant velocity?
   (d) If the rope connected to the free-hanging block snaps, quantify the resulting motion of the two remaining blocks using the results of the previous question.
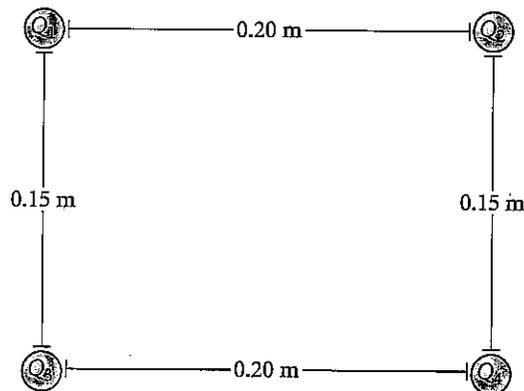
2. (10 points)
   Three ropes pull a metal bar pivoted at one end, as shown on the next page. The rope corresponding to A is attached at length x from the pivot at a 75° angle with a force of F. The rope corresponding to B is attached at length $x/2$ at a 90° angle with a force of $F/3$. The rope corresponding to C is also attached at length $x/2$, but at a 40° angle, with a force of $F/2$. Assume the bar and the ropes are all coplanar.

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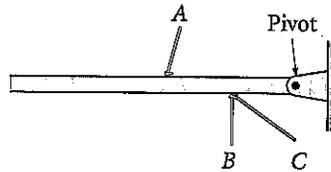
(a) Describe the resulting torque in terms of the values given.

(b) Where and at what distance from the pivot should rope D with a force of $F/2$ be attached at a 30° so that the rod has a net zero torque? Draw a sketch to show this.

(c) State both general conditions for equilibrium.

(d) What happens when only one of the conditions is met? State both cases.

3. (10 points)

A researcher seeks to calculate values for carbon dioxide, CO_2, where the atomic weight of carbon is 12 amu and of oxygen is 16 amu.

(a) Find the root-mean-square velocity of a CO_2 molecule at 27 °C.

(b) Find the average kinetic energy for one CO_2 molecule using two equivalent methods.

(c) Explain the significance of Avogadro's number.

(d) How many molecules of CO_2 would be fill one cubic meter at 27 °C and 1 atm?

4. (10 points)

For the arrangement of charged particles shown, find the magnitude and direction of each of the forces on particle Q_1 as well as the net force where $Q_1 = -5.6\ \mu C$, $Q_2 = +5.0\ \mu C$, $Q_3 = +3.2\ \mu C$, $Q_4 = -8.1\ \mu C$.

5. (10 points)

A DC circuit contains three resistors, as shown below.
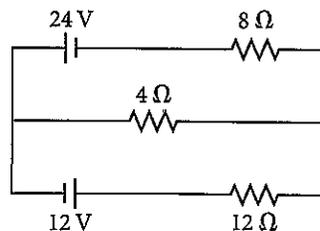
(a) Find the magnitude and direction of currents across each resistor.
(b) State the rules that govern your method.
(c) Why would more than one battery be used in a circuit?

6. (10 points)

At its fundamental frequency, a 40 cm string vibrates with a wave velocity of 296 m/s.

(a) Determine the fundamental frequency.
(b) Find the frequency of the second and third overtones.
(c) For the fundamental frequency and these overtones, state the number of nodes and antinodes each has.
(d) What will be the tension in the string if it has a mass of 0.064 kg?

7. (10 points)

Based on their definitions, trace the hypothetical products for theoretical nucleus $^A_Z N$ of the following types of decay.

(a) alpha decay
(b) a form of beta decay
(c) gamma decay