2007年度日本政府(文部科学省)奨学金留学生選考試験

QUALIFYING EXAMINATION FOR APPLICANTS FOR JAPANESE GOVERNMENT (MONBUKAGAKUSHO) SCHOLARSHIPS 2007

学科試験　　問題

EXAMINATION QUESTIONS

(高等専門学校留学生)

COLLEGE OF TECHNOLOGY STUDENTS

物　　理

PHYSICS

注意　☆試験時間は**60分**。

PLEASE NOTE : THE TEST PERIOD IS **60 MINUTES.**

PHYSICS

Nationality		No.	
Name	(Please print full name, underlining family name)		

Marks	

1 Let $\frac{3}{2}kT$ be the mean kinetic energy of the ideal gas per molecule, T the absolute temperature and N the Avogadro number. Answer the following questions.

(1) How much is the internal energy of the one mole ideal gas?

(1)

(2) How much heat is needed to increase the temperature of one mole ideal gas by one degree at constant volume?

(2)

(3) How much work is done by one mole ideal gas when the temperature of the gas is increased by one degree at constant pressure?

(3)

(4) When the volume of the ideal gas is doubled at constant temperature, how many times does the mean kinetic energy per molecule become greater than before?

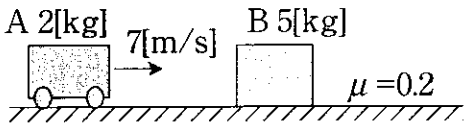
(4)

(5) When the volume of the ideal gas is doubled without transfer of heat, how many times does the mean kinetic energy per molecule become greater than before? In this case, however, the pressure must become 0.3 times lower than before.

(5)

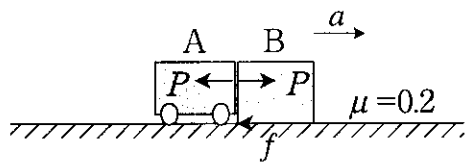
2 A cart A of mass 2.0[kg] which is moving at a speed of 7.0[m/s] on a horizontal floor collides with the object B of mass 5.0[kg] which is standing still on the floor. After that, A and B are united and start sliding. There is no friction between cart and floor and the coefficient of sliding friction between B and floor is 0.20. Set the acceleration by gravity to 9.8[m/s^2].

(1) Find the speed of the object immediately after the collision.



[m/s]

(2) By solving the equations of motion, find the acceleration and the force acting between A and B.



Acceleration [m/s^2]

Force [N]

(3) Find the distance which B slides after the collision.

[m]

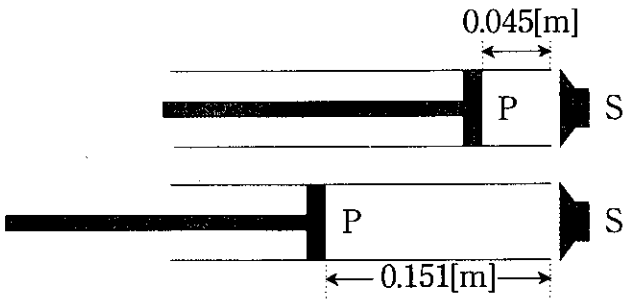
3 The gravitational force exerted on a body of mass m by the earth is $G\frac{mM}{r^2}$, where r is the distance between the body and the center of the earth, M is the mass of the earth and G is the gravitational constant.

(1) When R denotes the radius of the earth, express the acceleration of gravity at the earth's surface, g, in terms of G, M and R. Disregard the influence of earth rotation.

(2) Express the speed of an artificial satellite which carries out uniform circular motion at height R from the surface of the earth in terms of g and R.

(3) Express the mechanical energy of the artificial satellite of (2) in terms of g, m and R, where m is the mass of the artificial satellite and the potential energy is assumed to be zero when the distance r is infinite.

4 As shown in the figure, a sound wave is continuously sent out from speaker S into a pipe of uniform thickness, and the air column in the pipe is made to resonate. When the piston P in the resonance pipe is slowly moved to the left from the right end of the pipe, it resonates at 0.045[m] from the right end, and resonates again at 0.151[m]. Answer the following questions, assuming the frequency of the sound to be 1620[Hz].



(1) What is the wavelength of the stationary wave in the air column?

[m]

(2) What is the open-end correction? The open-end correction is the length by which the loop position of a wave shifts outside from the open end of a pipe.

[m]

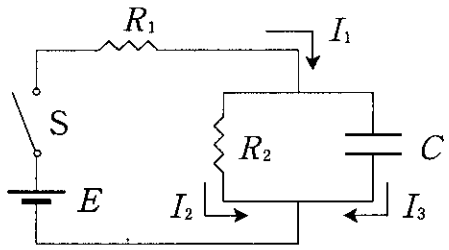
(3) Find the velocity of sound in the air column.

[m/s]

(4) The piston is stopped at the position where the 2nd resonance took place, and when the frequency of the speaker is raised little by little, find the frequency at which resonance occurs again.

[Hz]

5 In the figure below, E is a battery of electromotive force 6.0[V] in which internal resistance can be disregarded. R_1 and R_2 are resistances of 2.0[kΩ] and 4.0 [kΩ], respectively. C is a capacitor of 2.0[μF] and S is a switch. I_1, I_2 and I_3 show the currents flowing in the leads, respectively. The arrows show the positive directions of I_1, I_2 and I_3.



(1) S is opened for a sufficiently long time, then S is closed. How much are I_1, I_2 and I_3, respectively, immediately after closing S?

I_1= [mA]	I_2= [mA]	I_3= [mA]

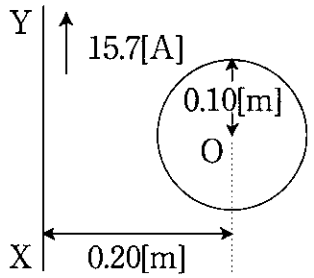
(2) How much are I_1, I_2 and I_3, respectively, when a sufficiently long time has passed after S was closed?

I_1= [mA]	I_2= [mA]	I_3= [mA]

(3) S is opened again. How much are I_1, I_2 and I_3, respectively, immediately after opening S?

I_1= [mA]	I_2= [mA]	I_3= [mA]

6 There is a lead XY of the shape of a long straight line and a doubly-rolled circular lead whose center is O with radius 0.10[m]. They are in the same plane and the distance between XY and O is 0.20[m]. A current of 15.7[A] is flowing in lead XY to the direction shown in the figure below. Set the circle ratio to 3.14.



(1) Find the strength of the magnetic field which the straight line current builds at the center O of the circle.

[A/m]

(2) Find the magnetic flux density at the center O of the circle. Let the magnetic permeability of air be $\mu = 4\pi \times 10^{-7}$[N/A^2].

[Wb/m^2]

(3) When the magnetic field at center O is set to 0 by a current passing in the circular lead, find the magnitude and direction of this current.

[A]

Clockwise CounterClockwise