2009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 2009

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.

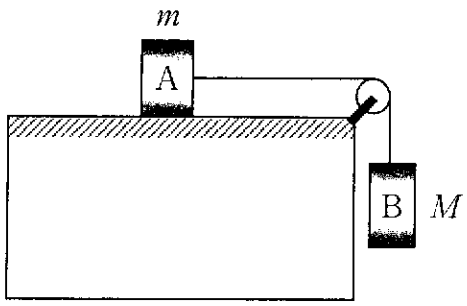
(2009)

PHYSICS

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

Marks	

1 An object A of mass m is connected to an object B of mass M through the light pulley by a light thread. The object A is at rest on a horizontal rough table. The object B is suspended from the pulley. The objects A and B began to move after being released. Let the gravitational acceleration be g, and let the coefficient of sliding friction between the object A and the table be μ'.



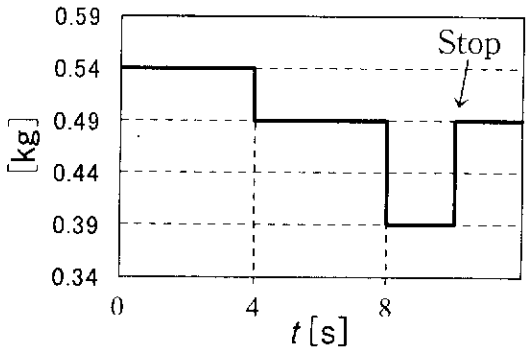
(1) Let the tension of the thread be T, and let the acceleration of object A be a. Find the equation of motion of object A.

(2) Calculate the magnitude a of the acceleration of A or B.

(3) Calculate the magnitude of the tension T of the thread.

(4) After the objects are released, how much of the total mechanical energy of A and B is lost in the first second?

2 A 0.49[kg] object is put on a scale and both are put on the floor of an elevator. A record of the reading on the scale from when the elevator starts to when it stops is shown in the figure. Let the gravitational acceleration be 9.8[m/s^2].



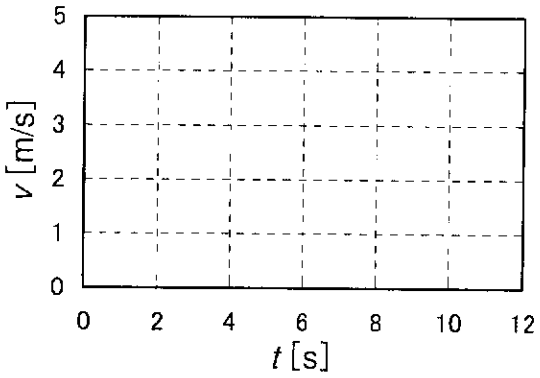
(1) Find the direction and magnitude of the acceleration for the first 4 seconds of motion of the elevator.

Direction	Acceleration
Up Down	[m/s^2]

(2) At what time does the elevator stop?

[s]

(3) Show the speed of the elevator from when it starts until it stops on the graph.



(4) How many meters does the elevator move in total?

[m]

3 Light enters the air from water whose refractive index is 4/3. Let the speed of the light in air be 3×10^8[m/s].

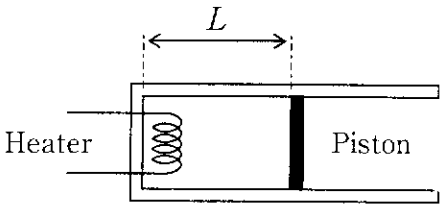
(1) How much is the speed of the light in the water?

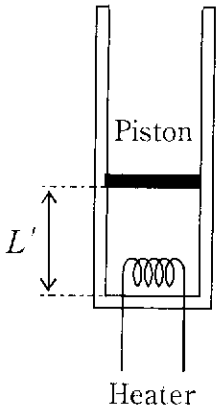
[m/s]

(2) Let the angle of refraction be θ_2 when the angle of incidence is 30 degrees. Find the value of $\sin\theta_2$.

(3) Let the critical angle be θ_0. Find the valuc of $\sin\theta_0$.

4 A piston of mass M[kg] is attached to a cylinder made from thermal insulation. There is no friction between the piston and the cylinder. At first, the cylinder is placed horizontally and n[mol] of an ideal gas of monatomic molecule at the same temperature T_0[K] and the same pressure P_0[Pa] as the atmosphere is contained in the cylinder. The distance from the bottom of the cylinder to the piston is L[m] as shown in the figure. Let the gas constant be R[J/(mol·K)], and let the gravitational acceleration be g[m/s^2].





(1) When this cylinder was stood perpendicularly, the piston fell slowly and stopped at a height of L'[m] from the bottom. How much was the increase in the internal energy inside the cylinder at this time?

[J]

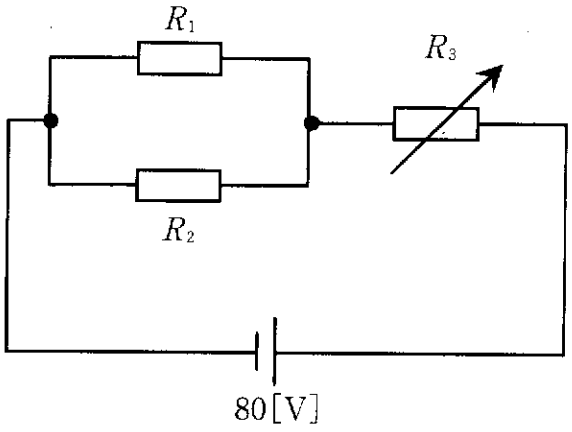
(2) How much was the increase in temperature inside the cylinder at that time?

[K]

(3) After that, when the inside of the cylinder was heated with the heater, the height of the piston returned from L'[m] to L[m]. How much did the temperature in the cylinder increase as compared with the case where the cylinder was placed horizontally?

[K]

5 In the electric circuit shown in the figure, when the value of the variable resistor R_3 is 25Ω, the current which flows into the power supply is 2[A]. Moreover, when the value of the variable resistor R_3 is 5Ω, a current of 1[A] flows into the resistance R_2.



(1) Find the value of the parallel combined resistance of the resistance R_1 and the resistance R_2.

[Ω]

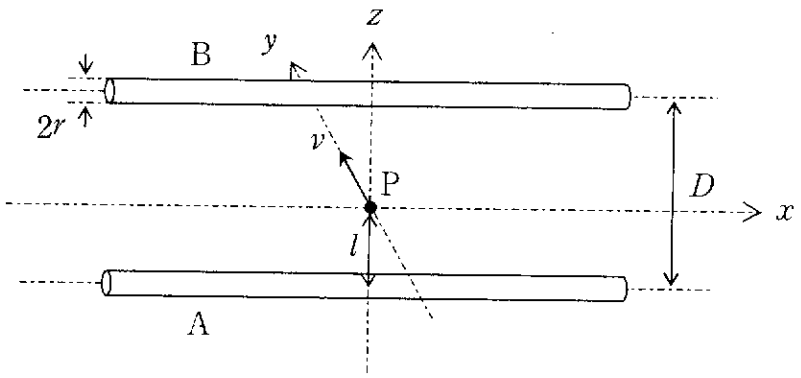
(2) Find the value of the resistance R_2.

[Ω]

(3) When the resistance R_3 is 25Ω, how much electric power is consumed by resistance R_1?

[W]

6 The two parallel lead wires A, B of infinite length with a circular cross-section of radius r[m] are placed in a vacuum. The two parallel leads are D[m] apart. The same current I[A] is flowing in each lead but in the opposite direction. Let the magnetic permeability of the vacuum be μ_0[H/m], and suppose that $D >> r$.



(1) What is the magnitude of the force acting per 1[m] of lead wire A?

[N]

(2) Calculate the magnitude of the magnetic field at position P which is l[m] $(r \leqq l \leqq D-r)$ away from the core of wire A in the plane including the core of lead wires A and B.

[A/m]

(3) When an electric charge of q[C] moves through P at speed v[m/s] in the y direction perpendicular to the x-z plane including leads A and B, what is the magnitude of the force acting on the electric charge q?

[N]