2013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 2013

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.**

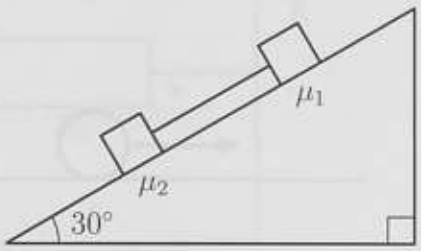
(2013)

PHYSICS

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

Marks	

1. Two blocks, each of mass $m = 2.0$ kg, are connected by a massless cord. They are placed onto an inclined plane of angle 30°. The coefficient of kinetic friction between the upper block and the inclined plane is $\mu_1 = 0.30$, while between the lower block and the inclined plane it is $\mu_2 = 0.10$. After a while, the two blocks move together with the same acceleration a. Let the gravitational acceleration be $g = 10$ m/s^2. You can use $\sqrt{2} = 1.41$, $\sqrt{3} = 1.73$, $\sqrt{5} = 2.24$ if you need. Round off your answers to two significant figures.



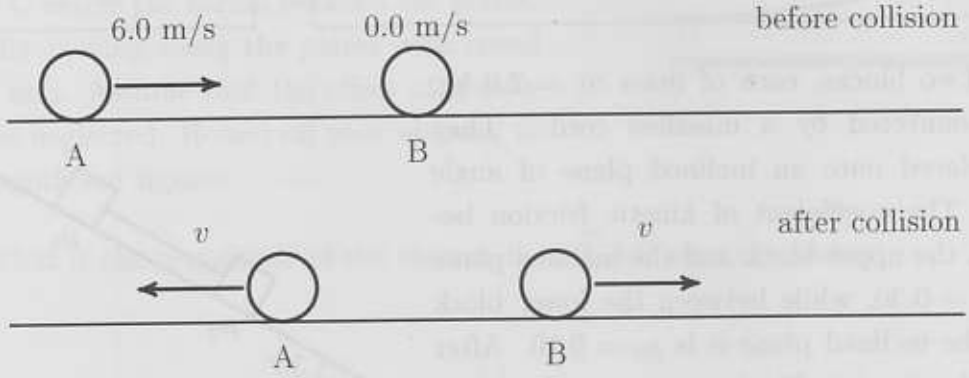
(1) Find the common acceleration a.

(1)	m/s^2

(2) Find the tension of the cord.

(2)	N

2. A body B of mass M is at rest on a frictionless straight line. A body A of mass 2.0 kg moves at a speed of 6.0 m/s to the right along the straight line, and collided with the body B. After the two bodies collide, the body A moves at a speed of v to the left, and the body B moves at the same speed v to the right along the straight line. Let the coefficient of restitution be 1.0 (perfectly elastic collision). Round off your answers to two significant figures.



(1) Find the speed v of the body B after the collision.

(1)	m/s

(2) Find the mass M of the body B.

(2)	kg

(3) Find the magnitude of the impulse acting on the body A during the collision.

(3)	N·s

(4) Find the loss of the kinetic energy of the body A in the collision.

(4)	J

3. Suppose a system of monoatomic ideal gas at pressure $p = 3.0 \times 10^5$ Pa and an initial temperature of $T = 300$ K slowly expands at constant pressure from a volume of 0.50 m^3 to 0.60 m^3. Let the gas constant be $R = 8.3$ J/(mol · K). Round off your answers to two significant figures.

(1) Find the numbers of moles of the gas.

(1)	**mol**

(2) Find the work done by the gas on the environment.

(2)	**J**

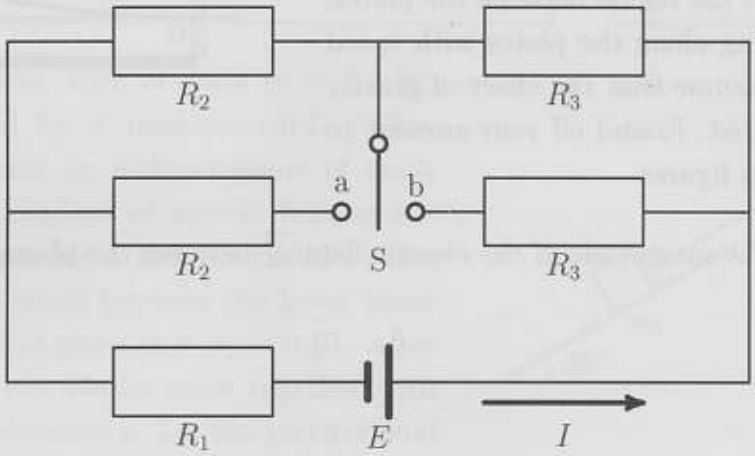
(3) Find the change in the internal energy of the gas.

(3)	**J**

(4) Find the heat absorbed by the gas during the process.

(4)	**J**

4. A battery with $E = 9.0$ V supplies current to the circuit as shown in the figure. When the double-throw switch S is open as shown in the figure, the current in the battery is 1.5 mA. When the switch is closed in position a, the current in the battery is 1.8 mA. When the switch is closed in position b, the current in the battery is 2.0 mA. You can neglect the internal resistance of the battery. Round off your answers to two significant figures.



(1) Find the value of the resistance R_1 in the circuit.

(1)	kΩ

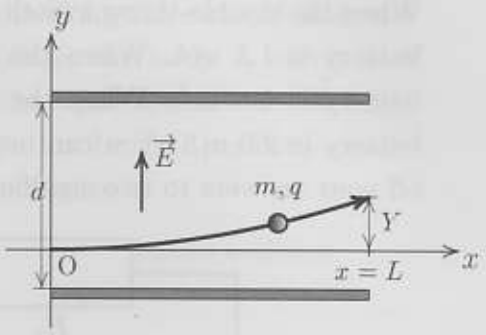
(2) Find the value of the resistance R_2 in the circuit.

(2)	kΩ

(3) Find the value of the resistance R_3 in the circuit.

(3)	kΩ

5. A uniform, upward-pointing electric field $\vec{E}$ has been set up between two parallel plates that have potential difference 5.0×10^3 V. The plates have length $L = 10$ cm and separation $d = 2.0$ cm. A particle with a mass $m = 2.5 \times 10^{-10}$ kg and a positive charge $q = +3.0 \times 10^{-13}$ C enters the region between the plates, initially moving along the plates with speed of 20 m/s. Assume that the effect of gravity can be neglected. Round off your answers to two significant figures.



(1) What is the magnitude of the electric field $\vec{E}$ between the plates?

(1)	N/C

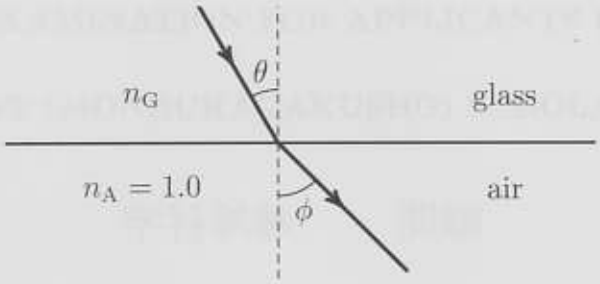
(2) Find the magnitude of electrostatic force on the particle.

(2)	N

(3) What is the vertical deflection Y of the particle at the far edge of the plates?

(3)	m

6. As shown in the figure, a beam of monochromatic light passes from glass into air. When the incident angle of θ equals 30°, the refraction angle of ϕ equals 45°. The absolute refractive index of air n_A is equal to 1.0. Let the frequency of the monochromatic light and the speed of light in vacuum be 5.0×10^{14} Hz, 3.0×10^8 m/s, respectively. You can use $\sqrt{2} = 1.41, \sqrt{3} = 1.73, \sqrt{5} = 2.24$ if you need. Round off your answers to two significant figures.



(1) Find the absolute refractive index of glass n_G.

(1)

(2) Find the speed of light in the glass.

(2)	m/s

(3) Find the wavelength of the monochromatic light in the glass.

(3)	m

(4) The angle of incidence producing an angle of refraction equal to 90° is the critical angle θ_C. Find $\sin\theta_C$.

(4) $\sin\theta_C =$