2012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 2012

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.**

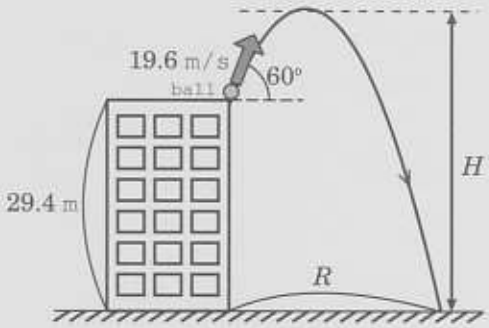
(2012)

PHYSICS

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

Marks	

1. A ball of mass 0.5 kg is thrown at time $t = 0.0$ sec. from the top of the 29.4 m tall building with an initial velocity of 19.6 m/s at an angle of 60° above the horizontal. Let the gravitational acceleration be 9.8 m/s^2. The air resistance can be disregarded. You can use $\sqrt{2} = 1.41$, $\sqrt{3} = 1.73$, $\sqrt{5} = 2.24$ if you need.



(1) What is the maximum height H attained by the ball?

(1)	m

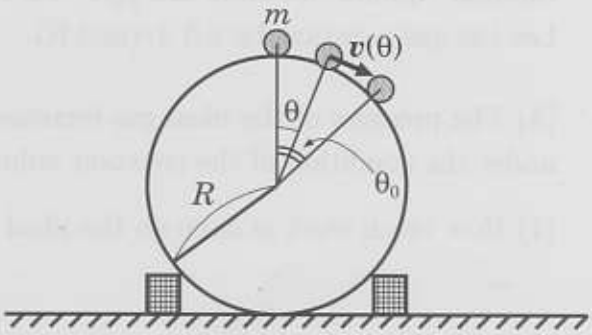
(2) When does the ball land on the ground?

(2)	s

(3) Calculate the horizontal distance R which the ball travels before it reaches the ground.

(3)	m

2. A small ball of mass m is at rest at the top of a fixed frictionless sphere of radius R. If one perturbs the ball slightly, the ball will begin to slide down the surface of the sphere and will eventually lose contact with the sphere at an angle θ_0 with respect to the vertical. Let g be the gravitational acceleration.



(1) Calculate the magnitude of the velocity of the ball, $v(\theta)$, at the angle θ.

(1)

(2) Calculate the normal force of the surface, $N(\theta)$, at the angle θ.

(2)

(3) Find the angle θ_0 at which the ball loses contact with the sphere.

(3)

3. There is a monoatomic ideal gas of 4.0 mol. Pressure and volume in an initial thermal equilibrium state are $p_0 = 1.0 \times 10^5$ Pa and $V_0 = 0.10$ m^3, respectively. Let the gas constant be 8.3 J/(mol·K).

[A] The pressure of the ideal gas increases from $p_0 = 1.0 \times 10^5$ Pa to 2.0×10^5 Pa under the condition of the constant volume $V_0 = 0.10$ m^3.

(1) How much work is done on the ideal gas from the outside?

(1) J

(2) How much internal energy of the ideal gas increases?

(2) J

(3) What is the heat that the ideal gas absorbs from the outside?

(3) J

(4) Calculate the heat capacity C_V at the constant volume of the ideal gas of 4.0 mol.

(4) J/K

[B] The volume of the ideal gas increases from $V_0 = 0.10\ \mathrm{m}^3$ to $0.20\ \mathrm{m}^3$ under the condition of the constant pressure $p_0 = 1.0 \times 10^5\ \mathrm{Pa}$.

(1) How much work is done on the ideal gas from the outside?

(1) J

(2) How much internal energy of the ideal gas increases?

(2) J

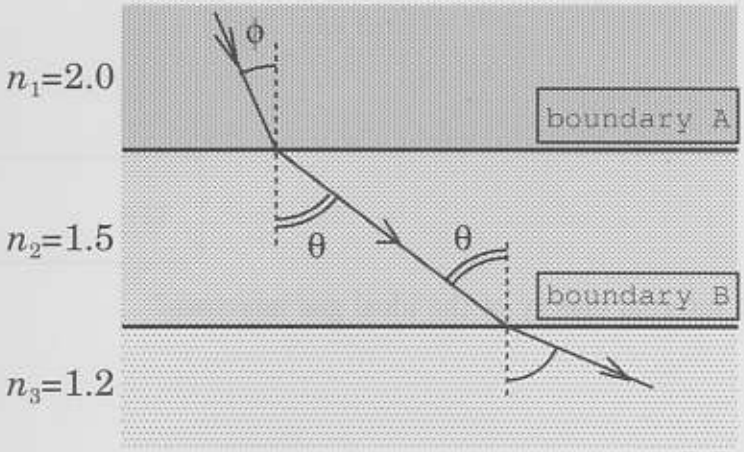
(3) What is the heat that the ideal gas absorbs from the outside?

(3) J

(4) Calculate the heat capacity C_p at the constant pressure of the ideal gas of 4.0 mol.

(4) J/K

4. As shown in the figure, monochromatic light passes in three layers. The absolute refractive indexes of each medium are $n_1 = 2.0$, $n_2 = 1.5$ and $n_3 = 1.2$, respectively. Let the frequency and the speed of monochromatic light in the vacuum be 5.0×10^{14} Hz and 3.0×10^8 m/s, respectively.



(1) Calculate the speed of monochromatic light in the second layer.

(1) m/s

(2) Calculate the wavelength of the light in the second layer.

(2) m

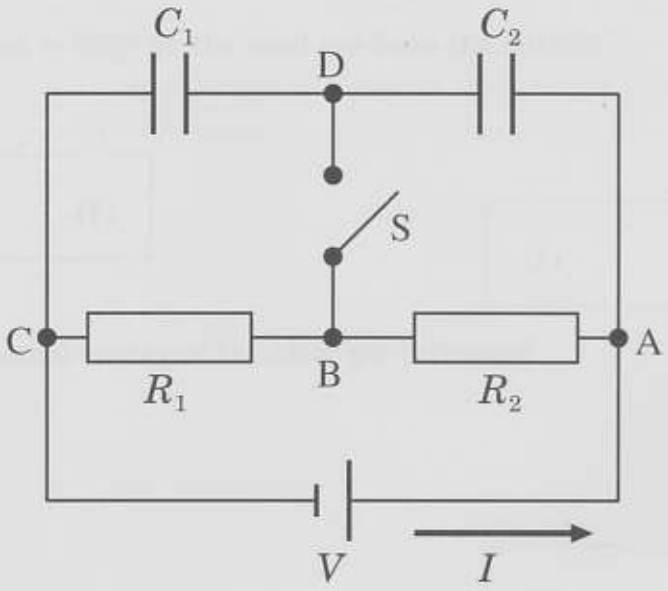
(3) If the angle of incidence θ at the boundary B is larger than the critical angle θ_c, the total reflection occurs. Find the value of $\sin\theta_c$.

(3)

(4) Find the value of $\sin\phi_0$. Here ϕ_0 means the angle of incidence at the boundary A, when the angle of incidence θ at the boundary B is equal to the critical angle θ_c.

(4)

5. Consider an electrical circuit shown in the figure. Voltage of battery V is 12 V. Internal resistance of the battery can be disregarded. Resistances of R_1 and R_2 are 4.0 Ω and 8.0 Ω, respectively. Electric capacities of condensers C_1 and C_2 are 4.0 μF and 8.0 μF, respectively. Initially, a switch S is open and the total charges at the point D are equal to 0.0 C.



(1) Calculate the value of the current I in the circuit.

(1)	A

(2) Calculate the electric potential V_B at the point B in the case that the electric potential at the point C is equal to 0.0 V.

(2)	V

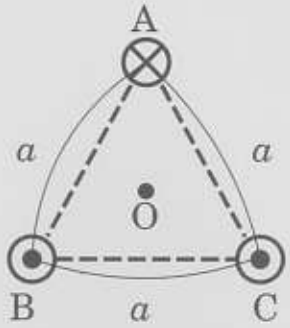
(3) Calculate the electric potential V_D at the point D in the case that the electric potential at the point C is equal to 0.0 V.

(3)	V

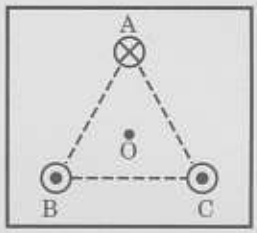
(4) Calculate the total charges which move to B from D if the switch S is closed.

(4)	C

6. Three very long, straight parallel wires A, B and C carrying current $I = 10$ amp. are situated at the corners of an equilateral triangle with a side length of $a = 30$ cm, as shown in the figure. The straight wires A carries current I into the paper and the wires B and C carry I out of the paper. You can use $\sqrt{2} = 1.41$, $\sqrt{3} = 1.73$, $\sqrt{5} = 2.24$ and the circular constant $\pi = 3.14$ if you need.



(1) Draw an arrow to represent the direction of the total magnetic field on the center of gravity of the triangle, O, in the right figure.



(2) Calculate the magnitude of the total magnetic field on the point O.

(2)	A/m