2006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 2006

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.

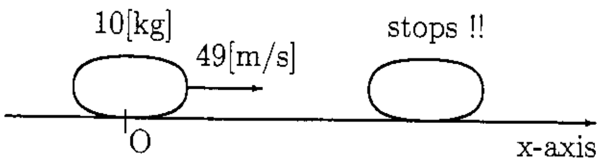
(2006)

PHYSICS

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

Marks	

1 Along a rough horizontal surface, a body of mass 10[kg] starts moving at speed 49[m/s] from the origin of the x-axis. Let the coefficient of kinematic friction between the surface and the body be 0.50, and let the gravitational acceleration be 9.8[m/s^2].



(a) What is the magnitude of the kinematic friction force while sliding?

[N]

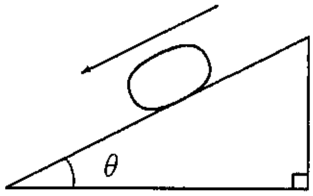
(b) Find the time until the body stops.

[s]

(c) Let the mechanical equivalent of heat be 4.2[J/cal]. 70 percent of lost mechanical energy was converted into heat. Find the generated heat quantity.

[cal]

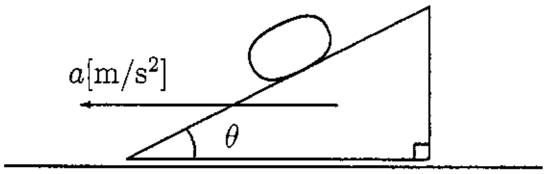
2 A body of mass m[kg] slides down the frictionless slope of a fixed triangular stand whose angle is θ[rad]. Let g[m/s^2] denote the gravitational acceleration.



(a) Find the acceleration of the body while sliding.

[m/s^2]

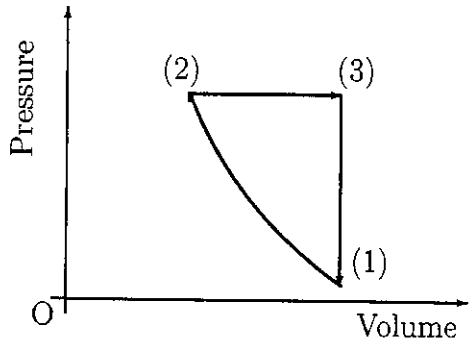
(b) When the stand moves with an acceleration a[m/s^2] on the horizontal plane, the body stands still on the slope of the moving stand.



Find the acceleration a[m/s^2] of the stand.

[m/s^2]

3 The diagram below shows state changes of an ideal gas. The temperatures of states (1), (2) and (3) are T_1[K], T_2[K] and T_3[K] respectively. The state change from (1) to (2) is an adiabatic change (not an isothermal change). The state change from (2) to (3) is a change at constant pressure (isobaric change). The state change from (3) to (1) is a change at constant volume (isochoric change).



(a) Write the size relation between T_1, T_2 and T_3.

< <

(b) Let the quantity of the ideal gas be 1[mol], and let R[J/mol・K] denote the gas constant. Find the work which the gas did on the outside during the state change from (2) to (3).

[J]

(c) Furthermore, the ideal gas consists of a mono-atomic molecule. Find the work which was done from the outside during the state change from (1) to (2).

[J]

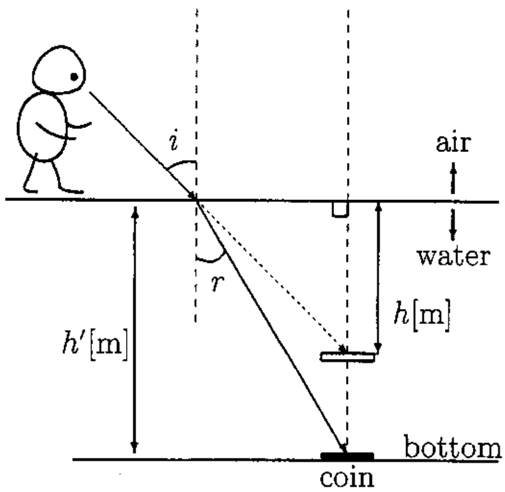
4 Let n denote the refractive index of water.

(a) What fraction of the speed of the light in air is the speed of underwater light?

(b) Let θ denote the critical angle for light going from water to air. Find the value of $\sin\theta$.

$\sin\theta =$

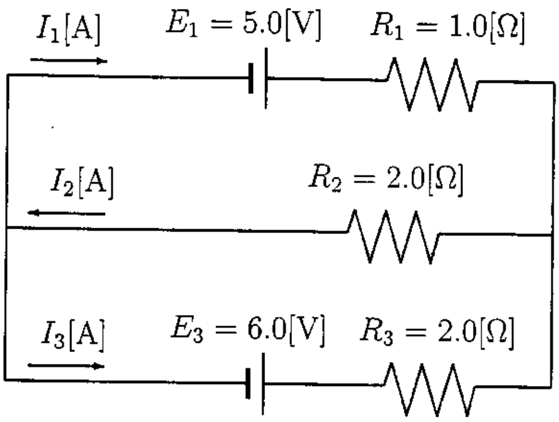
(c) A coin is at the bottom of a pool with a depth of h'[m]. The diagram below shows how the coin can appear to be in a place shallower than its actual depth.



Looking perpendicularly onto the water surface ($i \simeq 0$, $r \simeq 0$), the coin looked as if it were in a place with depth h[m]. Find the ratio h'/h of the two heights.

$\dfrac{h'}{h} =$

5 The circuit shown below contains three resistors, R_1, R_2 and R_2. The currents which flow in those resistors are set to I_1[A], I_2[A] and I_3[A] respectively, and the directions of the currents are assumed as shown in the diagram.



(a) Write the formula relating I_1, I_2 and I_3.

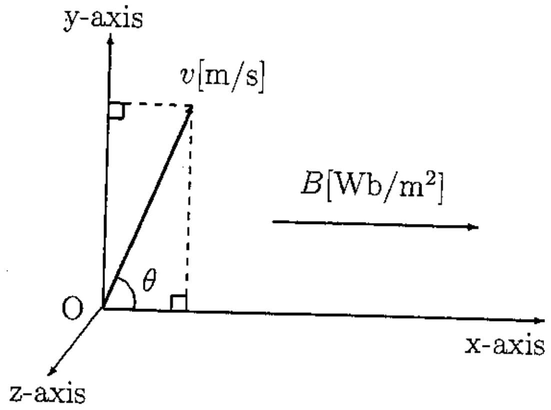
(b) Find the actual direction of I_1 and find the value of I_1.

← , →	[A]

(c) When the battery E_3 was replaced with a new battery E_x of different voltage but the same direction, no current flowed in the resistor R_1. Find the voltage of the new battery E_x.

[V]

6 The diagram below shows a uniform magnetic field of magnetic flux density B[Wb/m^2] parallel to the x-axis. On the xy-plane, an electron of electric charge $-e$[C] and mass m[kg] departed from the x-axis in the direction of θ[rad] with a speed of v[m/s]. Then, the electron carried out a spiral movement on a cylinder whose side contains the x-axis.



(a) What is the magnitude of the Lorentz force acting on the electron?

[N]

(b) Find the radius of the cylinder mentioned above.

[m]

(c) Find the time between the electron leaving its starting point and returning to the x-axis again. Let π denote the circular constant.

[s]