2019 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 (MEXT) SCHOLARSHIP 2019

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

(2019)

PHYSICS

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

Marks	

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1. Answer the following questions.

(1) An object with a mass of 2.0 kg is at rest on a horizontal frictionless surface. When the object is pulled with a constant horizontal force of magnitude 5.0 N, answer the following two questions.

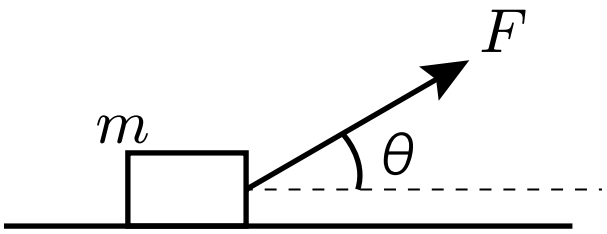
(1-1) What is the speed of the object after 3.0 s?

(1-1) **m/s**

(1-2) What is the speed of the object after it has moved a distance of 5.0 m?

(1-2) **m/s**

(2) A block of mass m[kg] is at rest on a horizontal surface with friction. When the block is pulled at an angle θ[°] above the horizontal with a force F[N], it moves with a constant acceleration in a horizontal direction. What is the magnitude of the kinetic friction force acting on the block? Choose the correct answer below from (a) – (d) and write the letter of your choice. Where μ' is the coefficient of kinetic friction between the block and the surface, and g[m/s^2] is the magnitude of the gravitational acceleration.



(a) $\mu' mg$ [N]

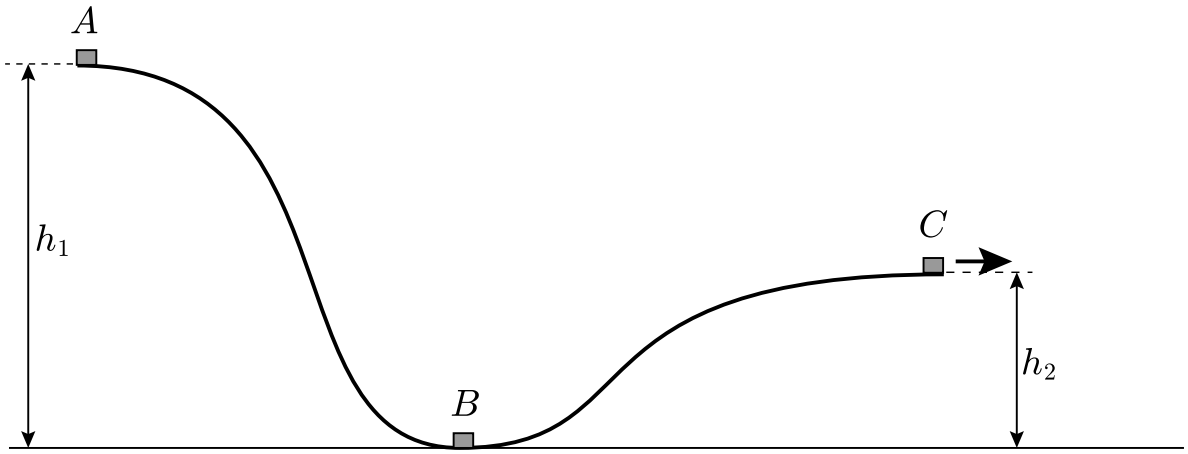
(b) $\mu'(mg - F\sin\theta)$ [N]

(c) $\mu'(mg + F\sin\theta)$ [N]

(d) $\mu' mg\sin\theta$ [N]

(2)

2. As shown in the figure, a block of mass m[kg] starts from rest at point A which is at a height h_1[m] above the ground and slides on a frictionless curved surface. The block is launched horizontally at point C at a height h_2[m] ($h_1 > h_2$). Let g[m/s^2] be the gravitational acceleration, and air resistance is ignored. Answer the following questions.



(1) What is the speed of the block at point B at the ground level? Choose the correct answer below from (a) – (e) and write the letter of your choice.

(a) mgh_1 [m/s] (b) $\sqrt{2gh_1}$ [m/s] (c) $\sqrt{2g(h_1 - h_2)}$ [m/s]

(d) $\sqrt{\frac{gh_1}{2}}$ [m/s] (e) $\sqrt{mgh_1}$ [m/s]

(1)

(2) What is the work done by gravity as the block is moved from point A to point C? Choose the correct answer below from (a) – (d) and write the letter of your choice.

(a) $\sqrt{mg(h_1 - h_2)}$ [J]　　(b) mgh_2 [J]

(c) $mg(h_1 + h_2)$ [J]　　(d) $mg(h_1 - h_2)$ [J]

(2)

(3) How long does the block take to hit the ground after launching from point C? Choose the correct answer below from (a) – (d) and write the letter of your choice.

(a) $\sqrt{\frac{2(h_1 - h_2)}{g}}$ [s]　　(b) $\sqrt{2g(h_1 - h_2)}$ [s]

(c) $\sqrt{\frac{2h_2}{g}}$ [s]　　(d) $\sqrt{\frac{2h_1}{g}}$ [s]

(3)

3. A ball is dropped from rest at a height of 1.0 m above the ground. The ball rebounds from the ground to reach a height of 0.64 m. Answer the following questions. Round off your answers to two significant figures.

(1) What is the coefficient of restitution between the ground and the ball?

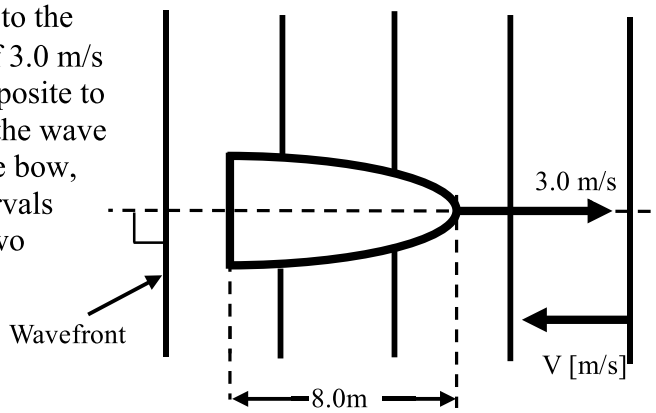
(1)

(2) The same ball is thrown vertically downward at a speed of 2.8 m/s from a height of 0.10 m. Find the maximum height it can reach after hitting the ground. Choose the correct answer below from (a) – (e) and write the letter of your choice.

(a) 0.064 m (b) 0.32 m (c) 0.64 m (d) 0.74 m (e) 1.0 m

(2)

4. A ship, whose length from the bow to the stern is 8.0 m, is traveling at a speed of 3.0 m/s relative to the shore in the direction opposite to the motion of waves. It takes 2.0 s for the wave crest to hit the stern after it has hit the bow, and the wave crests hit the bow at intervals of 0.50 s. Round off your answers to two significant figures.



(1) Calculate the speed V [m/s] of the waves relative to the shore.

m/s

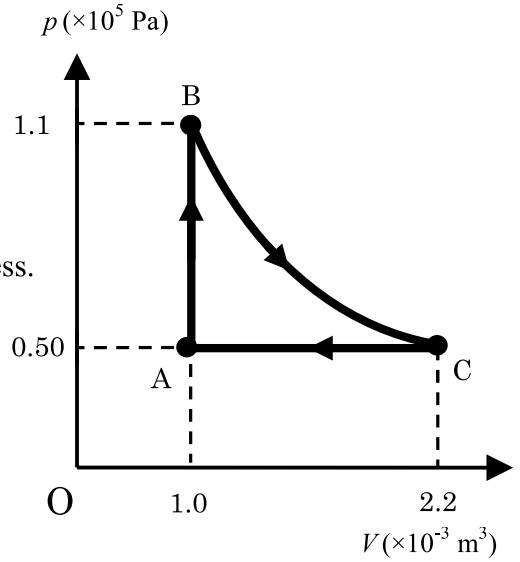
(2) Calculate the wavelength of the waves.

m

(3) Calculate the frequency of the waves.

Hz

5. Consider a system of monoatomic ideal gas. The ideal gas is carried along the path A→B→C→A shown in the *PV* diagram. Assume that the path A→B is an isochoric (constant volume) process, the path B→C is an isothermal process (constant temperature), and the path C→A is an isobaric (constant pressure) process. The temperature of the ideal gas in an initial state is $T = 75$ K . Round off your answers to two significant figures.



(1) Calculate the temperature in the state B.

K

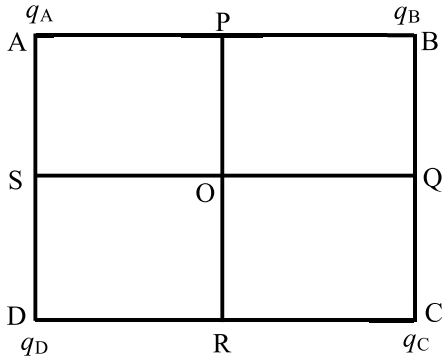
(2) How much work is done on the gas in the process from C to A?

J

(3) What is the change of the internal energy of the gas in the process from C to A?

J

6. Four charges $q_A = 4.0\times10^{-8}$ C, $q_B = 8.0\times10^{-8}$ C, $q_C = -6.0\times10^{-8}$ C and $q_D = 8.0\times10^{-8}$ C are placed at the positions A , B, C and D as shown in the figure. The distance between the positions A and B is 0.40 m. The distance between the positions A and D is 0.30 m.
The points P, Q, R, S are the midpoints of the sides, and the point O is the midpoint of the rectangle ABCD. Let the proportionality constant k of Coulomb's low (Coulomb's constant) be $k = 9.0\times10^{9}\,\mathrm{N\cdot m^2/C^2}$. Round off your answers to two significant figures.



(1) Which is the correct direction of the resultant electric field at the position O? Choose the correct answer from (a) – (h) and write the letter of your choice.

(a) $\overrightarrow{OA}$ (b) $\overrightarrow{OP}$ (c) $\overrightarrow{OB}$ (d) $\overrightarrow{OQ}$ (e) $\overrightarrow{OC}$ (f) $\overrightarrow{OR}$
(g) $\overrightarrow{OD}$ (h) $\overrightarrow{OS}$

(2) Calculate the magnitude of the resultant electric field at the position O.

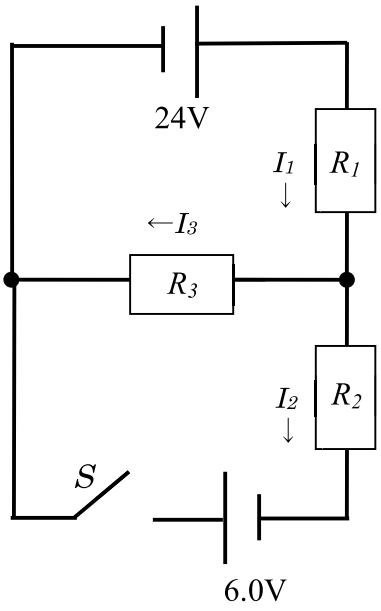
N/C

(3) Calculate the magnitude of the resultant electric potential at the position O. Note that the electric potential at infinity is taken to be 0.

V

7. Consider an electric circuit shown in the figure. Voltages of batteries are 24V and 6.0V, respectively. Internal resistances of these batteries can be ignored. Resistances of R_1, R_2 and R_3 are 15Ω. Initially, a switch S is open as shown in the figure. Round off your answers to two significant figures.

(1) Calculate the magnitude of the current I_1 in the resistor R_1 if the switch S is open.



A

(2) Calculate the total electric power of this circuit if the switch S is open.

W

(3) Calculate the magnitude of the current I_3 in the resistor R_3 if the switch S is closed.

A