

2024 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 2024

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

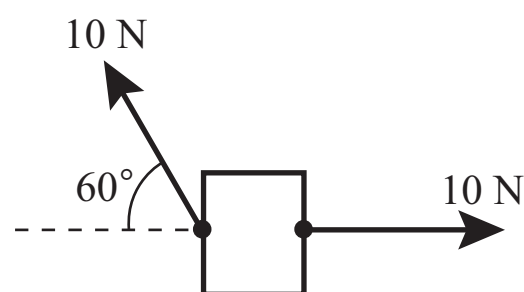
PLEASE NOTE : THE TEST PERIOD IS 60 MINUTES.

PHYSICS

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

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1. An object with a mass of 2.0 kg is at rest on a horizontal frictionless surface. When the object is pulled with two forces as shown, it moves with a constant acceleration in a horizontal direction. Answer the following questions, using the magnitude of the gravitational acceleration 9.8 m/s^2 and $\sqrt{3} = 1.73$.



(1) What is the normal force exerted by the surface on the object. Choose the best one among (a)-(e) and write the letter of your choice.

- (a) 5.0 N (b) 8.7 N (c) 10 N (d) 11 N (e) 17 N

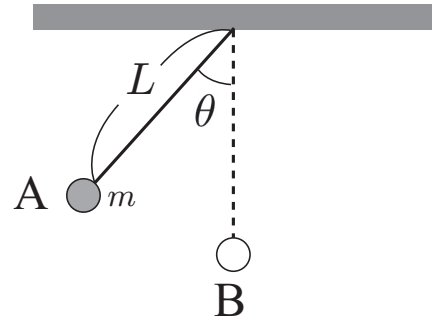
(1)

(2) What is the speed of the object 2.0 s after two forces are applied to the object? Choose the correct answer below from (a)-(e) and write the letter of your choice.

- (a) 1.4 m/s (b) 5.0 m/s (c) 10 m/s (d) 15 m/s (e) 20 m/s

(2)

2. A pendulum consists of a ball of mass m suspended at the end of massless string of length L as shown. The ball is released from rest at an angle θ with the vertical (point A). Answer the following questions. Where g is the magnitude of the gravitational acceleration.



(1) What is the speed of the ball as it passes through the lowest point B? Choose the correct answer below from (a)-(e) and write the letter of your choice.

- (a) $\sqrt{gL}$ (b) $\sqrt{2gL}$ (c) $\sqrt{gL \cos \theta}$
 (d) $\sqrt{2gL(1 - \cos \theta)}$ (e) $\sqrt{2gL(1 - \sin \theta)}$

(1)

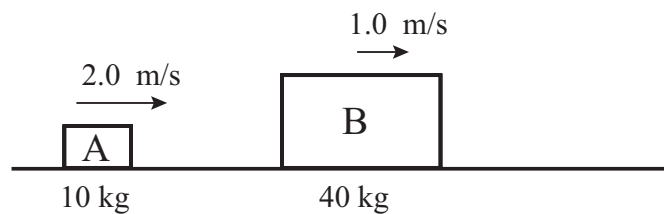
(2) What is the tension in the string as it passes through the lowest point B? Choose the correct answer below from (a)-(f) and write the letter of your choice.

- (a) $mg \cos \theta$ (b) $mg \sin \theta$ (c) $mg(3 - 2 \cos \theta)$
 (d) $3mg$ (e) $2mg$ (f) mg

(2)

3. Answer the following questions.

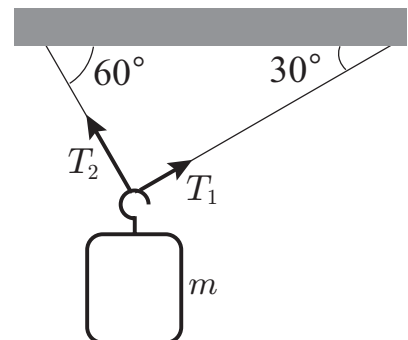
- (1) An object A with a mass of 10 kg moving horizontally to the right with a speed of 2.0 m/s on a table with negligible friction collides with an object B with a mass of 40 kg moving to the right with a speed of 1.0 m/s as shown below. What is the speed of object A after the collision if the collision is completely elastic? Choose the correct answer below (a)-(e) and write the letter of your choice.



- (a) 0.0 m/s (b) 0.40 m/s (c) 1.0 m/s
(d) 1.4 m/s (e) 2.0 m/s

(1)

- (2) An object of mass m is supported by two wires with tensions T_1 and T_2 as shown. What is the magnitude of the tension T_1 when the object is in equilibrium? Choose the correct answer below (a)-(e) and write the letter of your choice. Where g is the magnitude of the gravitational acceleration.

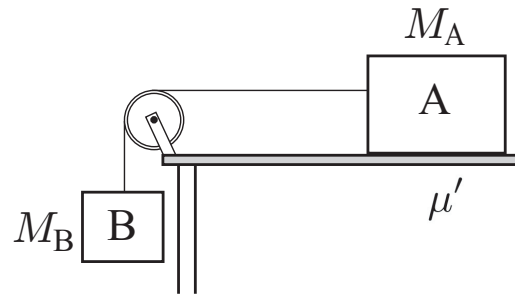


- (a) $\frac{1}{2}mg$ (b) $\frac{\sqrt{2}}{2}mg$ (c) $\frac{\sqrt{3}}{2}mg$
(d) mg (e) $2mg$

(2)

4. Answer the following questions.

(1) An object A of mass M_A and an object B of mass M_B are attached to a massless string which passes over a frictionless smooth pulley attached to the edge of a horizontal table as shown to the right. The coefficient of kinetic friction between the object and the table is μ' . When the object A is sliding on the table, calculate the acceleration of the object A. Choose the correct answer below (a)-(e) and write the letter of your choice. Where g is the magnitude of the gravitational acceleration.



(a) $\frac{(M_B + \mu' M_A)g}{M_A - M_B}$

(b) $\frac{(M_B - \mu' M_A)g}{M_A}$

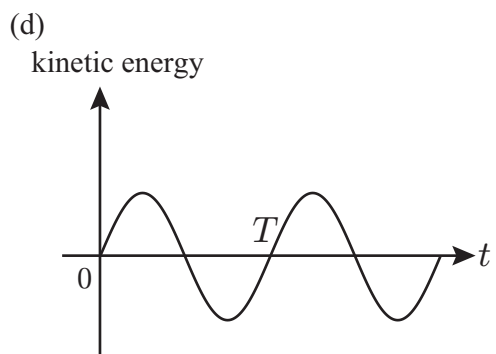
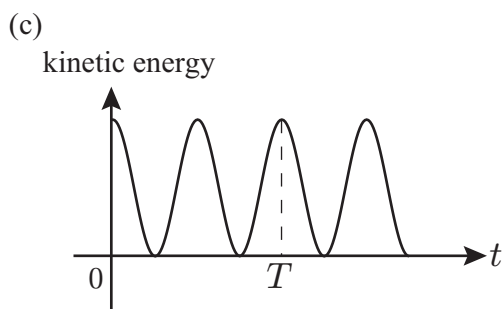
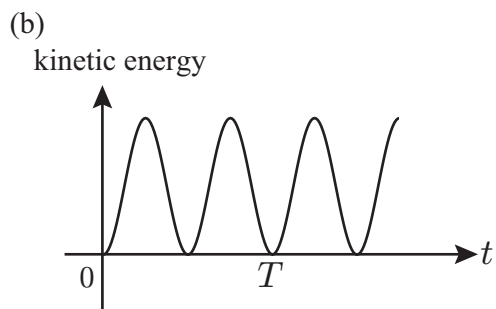
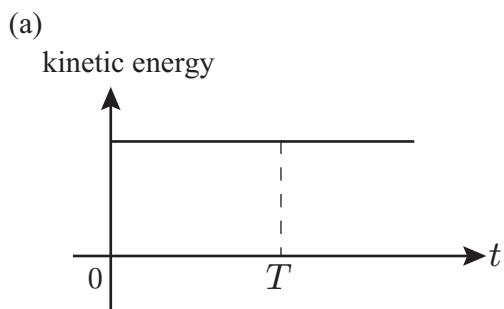
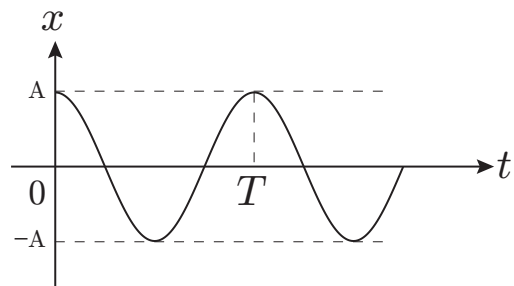
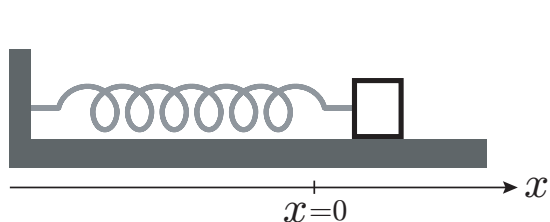
(c) $\mu' g$

(d) $\frac{M_B g}{M_A + M_B}$

(e) $\frac{(M_B - \mu' M_A)g}{M_A + M_B}$

(1)

(2) A block oscillates without friction on the end of a spring as shown below. Its position x as a function of time t is shown in the diagram. Choose the correct graph for the kinetic energy of the block as a function of t below from (a)-(d) and write the letter of your choice.



(2)

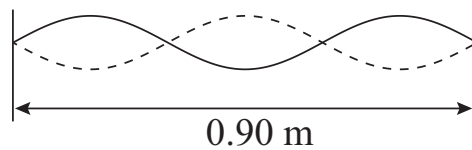
5. Answer the following questions.

(1) What is the speed of a wave that has a wavelength of 2.0 m and a period of 0.020 s?
Choose the correct answer below from (a)-(e) and write the letter of your choice.

- (a) 0.010 m/s (b) 0.040 m/s (c) 20 m/s
(d) 40 m/s (e) 100 m/s

(1)

(2) Consider the standing wave pattern on a string fixed at both ends as shown below. The speed of waves in the string is 120 m/s. What is the frequency of the standing wave? Choose the correct answer below from (a)-(e) and write the letter of your choice.



- (a) 1.1×10^2 Hz (b) 1.2×10^2 Hz (c) 1.3×10^2 Hz
(d) 2.0×10^2 Hz (e) 4.0×10^2 Hz

(2)

6. Answer the following questions.

(1) The temperature of a sample of metal with a mass of 2.0 g increased from 20 °C to 25 °C when the metal absorbs 3.8 J of heat. Calculate the specific heat of the metal. Choose the correct answer below from (a)-(e) and write the letter of your choice.

(a) $3.8 \times 10^{-2} \text{ J/(g} \cdot \text{K)}$

(b) $0.76 \text{ J/(g} \cdot \text{K)}$

(c) $0.38 \text{ J/(g} \cdot \text{K)}$

(d) $3.8 \text{ J/(g} \cdot \text{K)}$

(e) $7.6 \text{ J/(g} \cdot \text{K)}$

(1)

(2) An ideal gas at a pressure of $1.0 \times 10^5 \text{ Pa}$ in a closed container of volume 8.3 m^3 is at a temperature of 100 K. Calculate the number of moles of the gas in the container, using the gas constant $8.3 \text{ J/(mol} \cdot \text{K)}$. Choose the correct answer below from (a)-(e) and write the letter of your choice.

(a) $1.0 \times 10^3 \text{ mol}$

(b) 1.0 mol

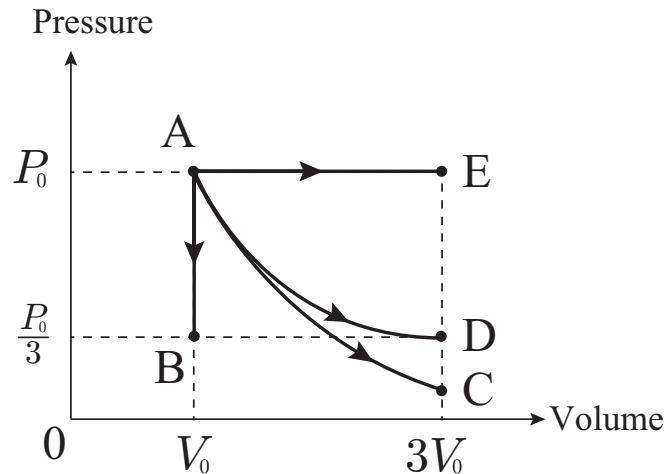
(c) $2.7 \times 10^2 \text{ mol}$

(d) $1.0 \times 10^{-3} \text{ mol}$

(e) $8.3 \times 10^3 \text{ mol}$

(2)

7. Four samples of ideal gas are each initially at a pressure P_0 and volume V_0 , and a temperature T_0 , represented by a point A on the P - V diagram below. The samples are taken in separate from the initial state A to the final states B,C,D and E along the processes shown on the diagram.



(1) Which process is an isothermal process? Choose the correct answer below from (a)-(d) and write the letter of your choice.

- (a) $A \rightarrow B$ (b) $A \rightarrow C$ (c) $A \rightarrow D$ (d) $A \rightarrow E$

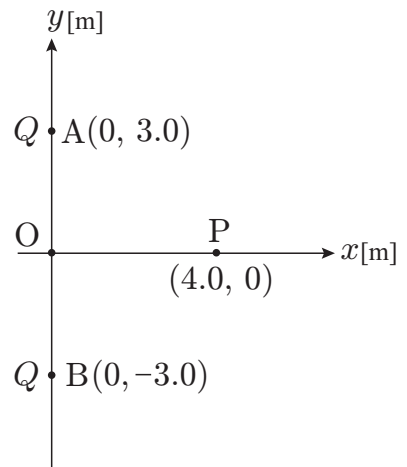
(1)

(2) In which process or processes does the internal energy increase? Choose the correct answer below from (a)-(e) and write the letter of your choice.

- (a) $A \rightarrow B$ (b) $A \rightarrow C$ and $A \rightarrow D$ (c) $A \rightarrow C$ and $A \rightarrow D$ and $A \rightarrow E$
 (d) $A \rightarrow C$ and $A \rightarrow E$ (e) $A \rightarrow E$

(2)

8. Two equal positive charges $Q = 5.0 \times 10^{-8} \text{ C}$ are placed at $A = (0, 3.0 \text{ m})$ and $B = (0, -3.0 \text{ m})$, respectively as shown to the right. Let the proportionality constant k of Coulomb's law be $k = 9.0 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$. Answer the following questions.



- (1) Calculate the resultant electric potential at the origin O due to both the charges. Let the potential to be 0 at infinity. Choose the correct answer below from (a)-(e) and write the letter of your choice.

(a) 0 V (b) 10 V (c) $1.0 \times 10^2 \text{ V}$ (d) $1.5 \times 10^2 \text{ V}$ (e) $3.0 \times 10^2 \text{ V}$

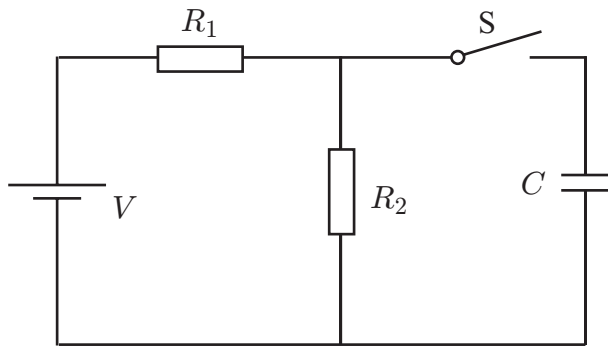
(1)

- (2) Calculate the magnitude of the resultant electric field at $P = (4.0 \text{ m}, 0)$. Choose the best one among (a)-(e) and write the letter of your choice.

(a) 0 N/C (b) 18 N/C (c) 22 N/C (d) 29 N/C (e) 36 N/C

(2)

9. The circuit shown below is constructed with a $V=10\text{ V}$ battery, two resistances of $R_1=4.0\ \Omega$, $R_2=6.0\ \Omega$, and a capacitor of $C=2.0\times 10^{-6}\text{ F}$. Initially the capacitor is uncharged. Answer the following questions.



- (1) Calculate the magnitude of the current in the resistor R_2 when the switch S is open. Choose the correct answer below from (a)-(e) and write the letter of your choice.

(a) 0 A (b) 1.0 A (c) 1.7 A (d) 2.5 A (e) 4.2 A

(1)

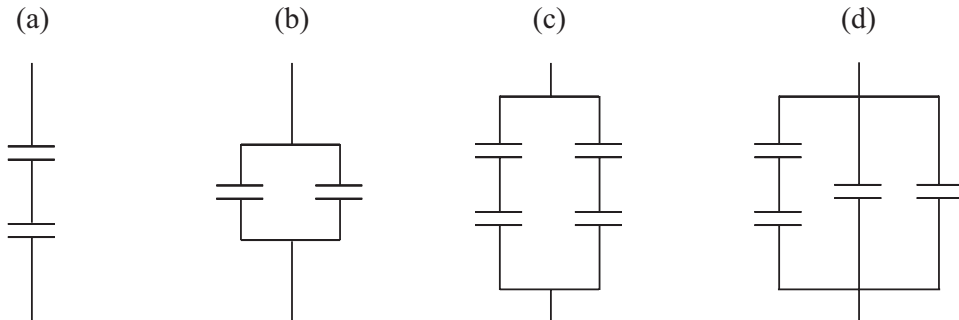
- (2) Switch S is closed. After some time, the currents reach constant values. Calculate the charge on the capacitor C . Choose the correct answer below from (a)-(e) and write the letter of your choice.

(a) $1.2\times 10^{-5}\text{ C}$ (b) $2.0\times 10^{-5}\text{ C}$ (c) $8.0\times 10^{-6}\text{ C}$ (d) $2.0\times 10^{-6}\text{ C}$ (e) 0 C

(2)

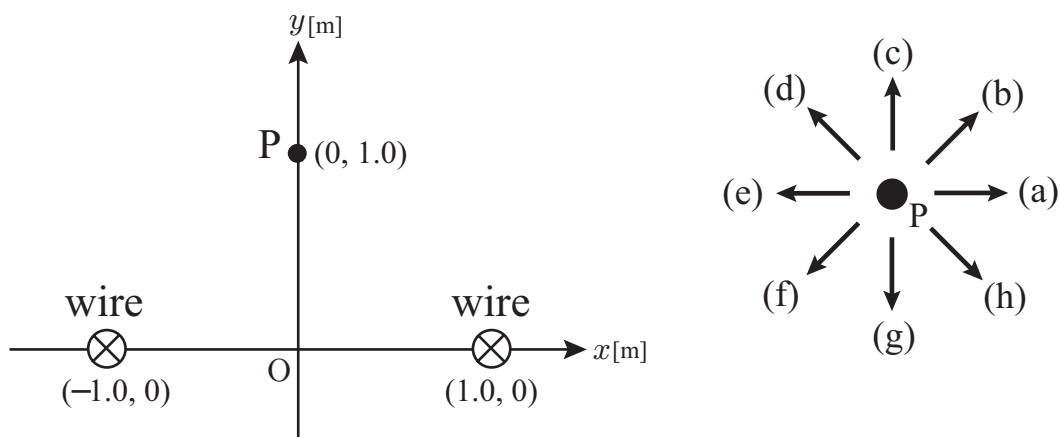
10. Answer the following questions.

(1) Consider the four arrangements of capacitors below. Each capacitor has an equivalent capacitance. Which arrangement has the highest equivalent capacitance? Choose the correct answer below from (a)-(d) and write the letter of your choice.



(1)

(2) Two very long parallel wires carry equal currents in the same direction into the page, as shown. Which is the correct direction of the resultant magnetic field at point P? Choose the correct answer below from (a)-(h) and write the letter of your choice.



(2)