

2025 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 THE JAPANESE
GOVERNMENT (MEXT) SCHOLARSHIP 2025

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.

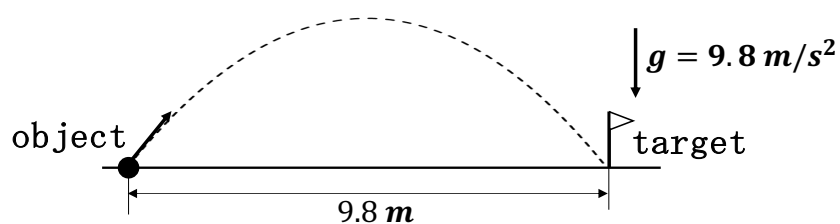
PHYSICS

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

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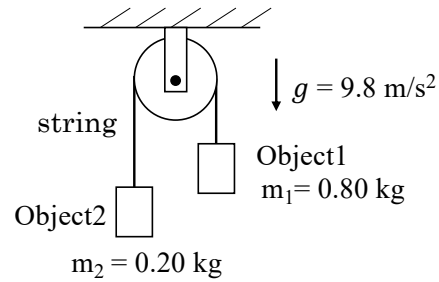
- 1.** A small object can be thrown obliquely upward into the air at any angles. Suppose air resistance can be ignored and the gravitational acceleration g is 9.8 m/s^2 . Express your answer to two significant figures.

- (1) Calculate the minimum initial velocity of the object to reach a target 9.8 m away on the same ground level.



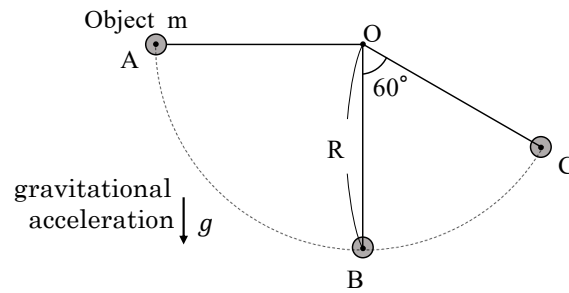
- (2) Calculate the time of flight of the object from its point of launch until it hits the target for the condition chosen in (1).

2. Two objects are connected by a light inextensible string passing over a light frictionless pulley as shown in the figure. The masses of object 1 and object 2 are $m_1 = 0.80 \text{ kg}$ and $m_2 = 0.20 \text{ kg}$, respectively. Suppose air resistance can be ignored and the string does not slip on the pulley. The gravitational acceleration g is 9.8 m/s^2 . Express your answer to two significant figures.



- (1) Find the magnitude of acceleration of the objects.
- (2) Find the tension of the string.

3. One end of an inextensible string with length R is fixed at point O . A small object with mass m is attached to another end of string and is kept in rest at horizontal position A as shown in the figure below. The object starts to move in a vertical circular path. Suppose air resistance can be ignored and the gravitational acceleration g acts downward.



- (1) Find the tension of the string at the lowest point B .
- (2) Find the tension of the string at the point C where the string makes an angle of 60° with the vertical line.

4. Answer the following questions.

- (1) Find the traveling speed of a transverse wave described by the following equation

$$y = 10\sin\left(2.0x - \frac{t}{2.0}\right),$$

where y is displacement of medium (in meter: m), x is the position (in meter: m), and t is time (in second: s). Express your answer to two significant figures.

- (2) When this transverse wave is superimposed with another wave traveling in the opposite direction described by $y = 10\sin\left(2.0x + \frac{t}{2.0}\right)$, what is the equation for the resultant wave? Choose the correct answer below from (a)-(f) and write the letter of your choice.

(a) $y = 20\sin\left(2.0x - \frac{t}{2.0}\right)$

(b) $y = 20\sin(2.0x)\cos\left(\frac{t}{2.0}\right)$

(c) $y = 20\sin\left(\frac{t}{2.0}\right)\cos(2.0x)$

(d) $y = 10\sin(x)\cos(t)$

(e) $y = 20\cos\left(2.0x - \frac{t}{2.0}\right)$

(f) $y = 10\sin\left(2.0x - \frac{t}{2.0}\right)\cos\left(2.0x - \frac{t}{2.0}\right)$

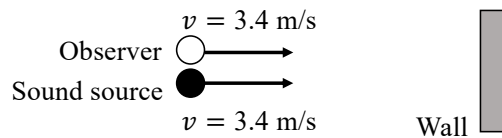
5. Suppose the speed of sound is 340 m/s. Answer the following questions.

- (1) The sound emitted from a moving sound source has a frequency of 900 Hz. Find the speed of sound source towards the stationary observer when the observed frequency of sound is 1000 Hz. Choose the correct answer below from (a)-(f) and write the letter of your choice.



- | | | |
|------------|------------|------------|
| (a) 17 m/s | (b) 24 m/s | (c) 30 m/s |
| (d) 34 m/s | (e) 38 m/s | (f) 42 m/s |

- (2) When a source emitting sound at frequency 100 Hz is moving towards a fixed reflecting wall with speed 3.4 m/s, what is the beat frequency detected by the observer moving with the sound source. Express your answer to two significant figures.



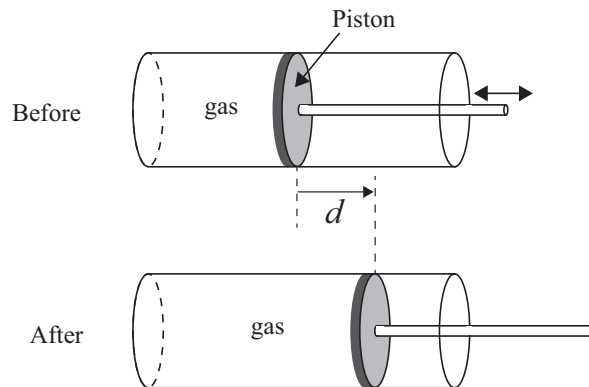
6. An ideal gas is enclosed in a cylinder with a movable frictionless piston with an area of cross-section $S = 4.0 \times 10^{-2} \text{ m}^2$. The initial pressure is $P_0 = 1.0 \times 10^5 \text{ Pa}$, the initial volume of the gas is $V_0 = 2.0 \times 10^{-3} \text{ m}^3$. Answer the following questions.

(1) Calculate the force that the gas exerts on the piston in the initial state. Choose the correct answer below from (a)-(f) and write the letter of your choice.

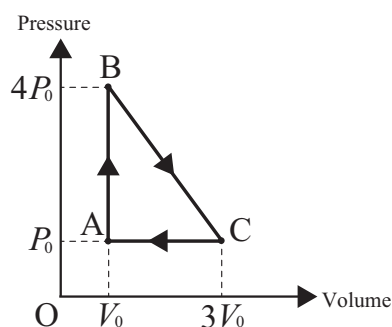
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|------------------------------------|------------------------------------|---------------------------------|
| (a) $4.0 \times 10^{-7} \text{ N}$ | (b) $8.0 \times 10^{-5} \text{ N}$ | (c) $2.0 \times 10^2 \text{ N}$ |
| (d) $4.0 \times 10^3 \text{ N}$ | (e) $2.5 \times 10^6 \text{ N}$ | (f) $5.0 \times 10^7 \text{ N}$ |

(2) Calculate the distance d the piston moves if the absolute temperature is doubled from the initial state with keeping the pressure unchanged. Choose the correct answer below from (a)-(f) and write the letter of your choice.

- | | | |
|------------------------------------|------------------------------------|------------------------------------|
| (a) $1.0 \times 10^{-2} \text{ m}$ | (b) $2.5 \times 10^{-2} \text{ m}$ | (c) $5.0 \times 10^{-2} \text{ m}$ |
| (d) 0.20 m | (e) 0.25 m | (f) 20 m |



7. A monoatomic ideal gas is carried along the path $A \rightarrow B \rightarrow C \rightarrow A$ shown in the pressure-volume diagram. When $P_0 = 1.0 \times 10^5$ Pa, $V_0 = 2.0 \times 10^{-3}$ m³, answer the following questions.



- (1) Calculate the work done on the gas in the process $C \rightarrow A$. Choose the correct answer below from (a)-(f) and write the letter of your choice.

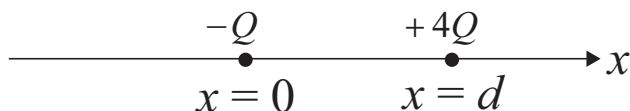
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|--------------------------|--------------------------|--------------------------|
| (a) 2.0×10^2 J | (b) 4.0×10^2 J | (c) 6.0×10^2 J |
| (d) -2.0×10^2 J | (e) -4.0×10^2 J | (f) -6.0×10^2 J |

- (2) Calculate the heat added to the gas during process $A \rightarrow B$. Choose the correct answer below from (a)-(f) and write the letter of your choice.

- | | | |
|--------------------------|--------------------------|-------------------------|
| (a) 0 J | (b) 9.0×10^2 J | (c) 1.2×10^3 J |
| (d) -9.0×10^2 J | (e) -1.2×10^3 J | (f) 6.0×10^2 J |

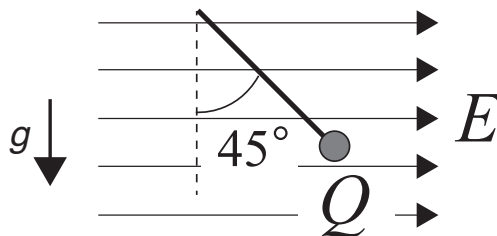
8. Answer the following questions.

- (1) A point charge $-Q$ is located at the origin, while a second point charge $+4Q$ is located at $x = d$ on the x -axis, as shown below. Where is the net electric field zero along the x -axis? Choose the correct answer below from (a)-(f) and write the letter of your choice.



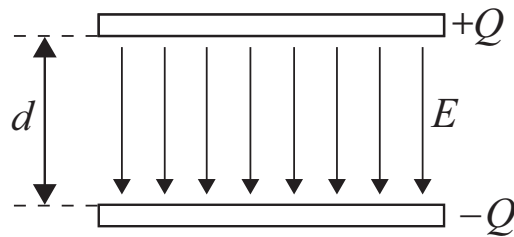
- (a) $x = -d$ (b) $x = -\frac{d}{3}$ (c) $x = \frac{d}{3}$
 (d) $x = d$ (e) $x = 2d$ (f) $x = \frac{4d}{3}$

- (2) A small conducting sphere of mass m with positive charge Q is suspended from an insulating string and placed in a uniform horizontal electric field as shown below. If the string makes an angle of 45° with the vertical, what is the magnitude of the electric field? Choose the correct answer below from (a)-(f) and write the letter of your choice. Suppose the gravitational acceleration g acts downward.



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

9. Two parallel conducting plates, each of area $S = 0.20 \text{ m}^2$, are separated by a distance of $d = 2.0 \times 10^{-2} \text{ m}$ with air. One plate has charge $+Q$, the other has charge $-Q$. The electric field between two parallel plates is $E = 5.0 \times 10^2 \text{ N/C}$ and the permittivity of the air is $\epsilon = 8.9 \times 10^{-12} \text{ F/m}$. Neglecting the edge effects, answer the following questions.



- (1) Find the potential difference between the plates. Choose the correct answer below from (a)-(f) and write the letter of your choice.

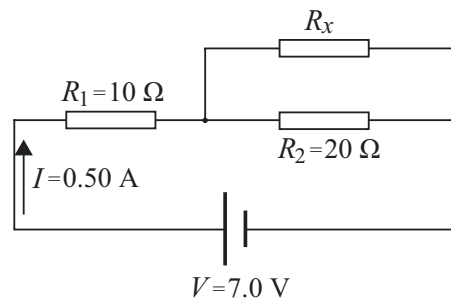
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|---------------------------------|---------------------------------|---------------------------------|
| (a) $5.0 \times 10^2 \text{ V}$ | (b) $2.5 \times 10^4 \text{ V}$ | (c) $2.5 \times 10^3 \text{ V}$ |
| (d) $1.0 \times 10^2 \text{ V}$ | (e) 50 V | (f) 10 V |

- (2) Find the capacitance of this arrangement of plates. Choose the correct answer below from (a)-(f) and write the letter of your choice.

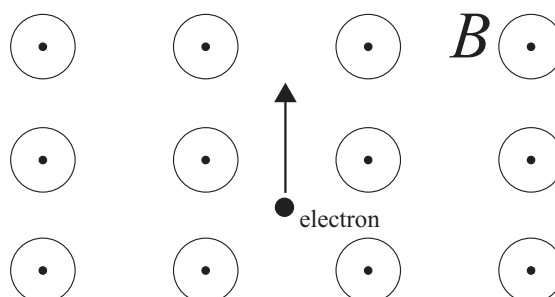
- | | | |
|-------------------------------------|-------------------------------------|-------------------------------------|
| (a) $8.9 \times 10^{-13} \text{ F}$ | (b) $8.9 \times 10^{-12} \text{ F}$ | (c) $8.9 \times 10^{-11} \text{ F}$ |
| (d) $4.4 \times 10^{-10} \text{ F}$ | (e) $4.4 \times 10^{-9} \text{ F}$ | (f) $4.4 \times 10^{-8} \text{ F}$ |

10. Answer the following questions.

- (1) The circuit is constructed with three resistors and a battery as shown. The battery voltage is $V = 7.0 \text{ V}$, the values for the resistors are $R_1 = 10 \text{ } \Omega$, $R_2 = 20 \text{ } \Omega$ and R_x is unknown. The current is flowing through circuit is $I = 0.50 \text{ A}$. Find the value of the unknown resistor R_x . Choose the correct answer below from (a)-(f) and write the letter of your choice.



- (a) $2.0 \text{ } \Omega$ (b) $5.0 \text{ } \Omega$ (c) $10 \text{ } \Omega$
(d) $20 \text{ } \Omega$ (e) $50 \text{ } \Omega$ (f) $100 \text{ } \Omega$
- (2) An electron is in a uniform magnetic field B that is directed out of the plane of the page, as shown. When the electron is moving in the plane of the page in the direction indicated by the arrow, find the direction of the forces acting on the electron. Choose the correct answer below from (a)-(e) and write the letter of your choice.



- (a) toward the left
(b) toward the right
(c) toward the bottom of the page
(d) toward the top of the page
(e) none of the above