

2014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 2014

学科試験 問題

EXAMINATION QUESTIONS

(高等専門学校留学生)

COLLEGE OF TECHNOLOGY STUDENTS

物 理

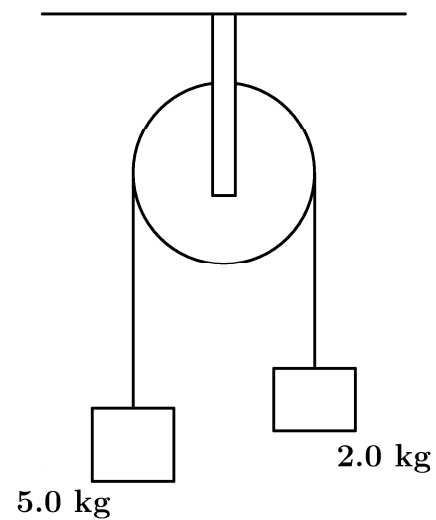
PHYSICS

注意: 試験時間は 60 分

PLEASE NOTE: THE TEST PERIOD IS 60 MINUTES.

|         |             |  |     |  |       |  |
|---------|-------------|--|-----|--|-------|--|
| PHYSICS | Nationality |  | No. |  | Marks |  |
|         | Name        | (Please print full name, underlining family name.) |     |  |       |  |

**1.** A massless cord passing over a frictionless pulley has a block of mass 5.0 kg tied on one end and a block of mass 2.0 kg on the other end. The two blocks move with the same acceleration  $a$ . Let the gravitational acceleration be  $g = 9.8 \text{ m/s}^2$ . Round off your answers to two significant figures.



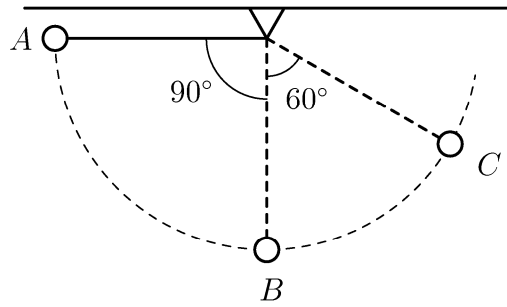
(1) Find the acceleration  $a$  of the blocks.

|     |                |
|-----|----------------|
| (1) | $\text{m/s}^2$ |
|-----|----------------|

(2) Find the tension of the cord  $T$ .

|     |          |
|-----|----------|
| (2) | <b>N</b> |
|-----|----------|

**2.** A pendulum, made up of a ball of mass  $m$  kg suspended from the ceiling by a massless cord of length  $l$  m, is released from rest in a horizontal position (the point  $A$ ). Let the gravitational acceleration be  $g$  m/s<sup>2</sup>.



(1) Find the kinetic energy of the ball at the instant when it passes the point  $B$ .

|     |          |
|-----|----------|
| (1) | <b>J</b> |
|-----|----------|

(2) Find the speed of the ball  $v_B$  at the instant when it passes the point  $B$ .

|     |            |
|-----|------------|
| (2) | <b>m/s</b> |
|-----|------------|

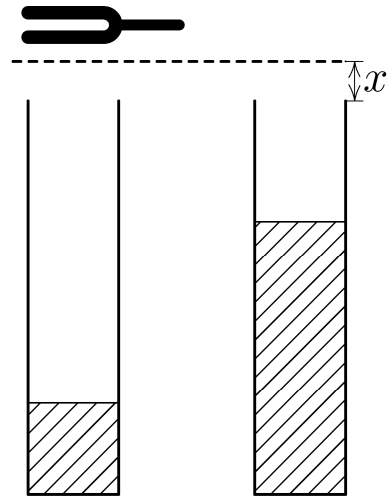
(3) Find the speed of the ball  $v_C$  at the instant when it passes the point  $C$ .

|     |            |
|-----|------------|
| (3) | <b>m/s</b> |
|-----|------------|

(4) Find the tension of the cord  $T$  at the instant when the ball passes the point  $C$ .

|     |          |
|-----|----------|
| (4) | <b>N</b> |
|-----|----------|

**3.** A vertical cylindrical pipe with open top can be partially filled with water. Successive resonances of the air column with the tuning fork are observed when the distance from the top of the pipe to the water surface is 16.7 cm, and 50.7 cm. Let the speed of sound in air be 340 m/s.



(1) Find the wavelength of the sound of the tuning fork.

|     |           |
|-----|-----------|
| (1) | <b>cm</b> |
|-----|-----------|

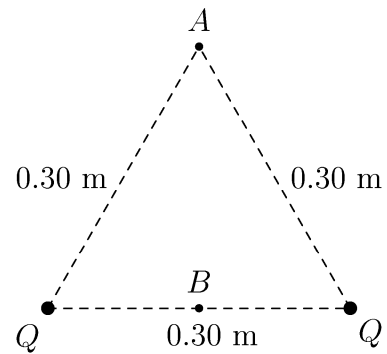
(2) What is the vertical distance  $x$  from the top of the pipe to the antinode above the pipe?

|     |           |
|-----|-----------|
| (2) | <b>cm</b> |
|-----|-----------|

(3) Find the frequency of the tuning fork.

|     |           |
|-----|-----------|
| (3) | <b>Hz</b> |
|-----|-----------|

4. A pair of equal point charges of  $Q = +2.0 \times 10^{-9} \text{ C}$  are separated by a distance 0.30 m. As shown in the figure, the two charges and a point  $A$  are at the corners of an equilateral triangle, and a point  $B$  is the midpoint of the two charges. Let the proportionality constant of Coulomb's law (Coulomb's constant) be  $9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$ . You can use  $\sqrt{2} = 1.41$ ,  $\sqrt{3} = 1.73$  and  $\sqrt{5} = 2.24$  if you need. Round off your answers to two significant figures.



(1) Determine the magnitude of the electric field at the point  $A$ .

|     |     |
|-----|-----|
| (1) | N/C |
|-----|-----|

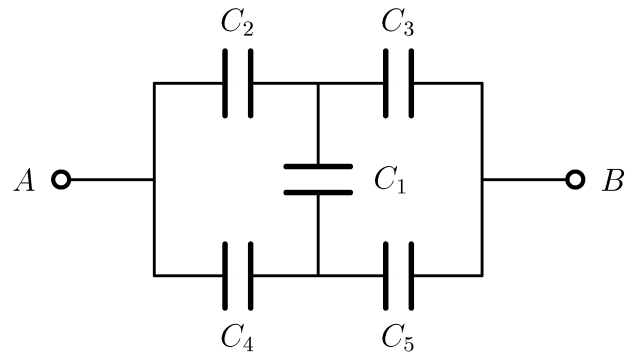
(2) Calculate the electric potential difference between the points  $A$  and  $B$ .

|     |   |
|-----|---|
| (2) | V |
|-----|---|

(3) A particle of electric charge  $q = -3.0 \times 10^{-8} \text{ C}$  at the point  $A$  starts from rest. Calculate the kinetic energy of the particle when it passes the point  $B$ .

|     |   |
|-----|---|
| (3) | J |
|-----|---|

**5.** In the network of capacitors shown in the figure, let  $C_1 = 3.0 \mu\text{F}$ ,  $C_2 = C_4 = 1.0 \mu\text{F}$  and  $C_3 = C_5 = 2.0 \mu\text{F}$ . A potential difference  $60 \text{ V}$  is applied between points  $A$  and  $B$ . Round off your answers to two significant figures.



(1) What is the potential difference across the capacitor  $C_1$ ?

|  |
|--|
| (1) <span style="float: right;">V</span> |
|--|

(2) How much charge is stored on the capacitor  $C_2$ ?

|   |
|---|
| (2) <span style="float: right;"><math>\mu\text{C}</math></span> |
|---|

(3) What is the potential difference across the capacitor  $C_5$ ?

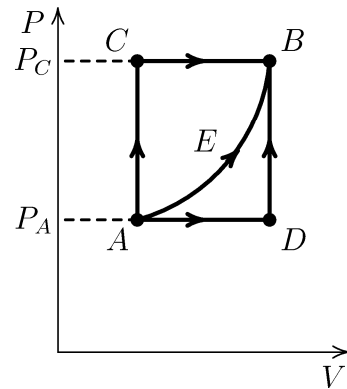
|  |
|--|
| (3) <span style="float: right;">V</span> |
|--|

(4) Determine the equivalent capacitance between points  $A$  and  $B$ .

|   |
|---|
| (4) <span style="float: right;"><math>\mu\text{F}</math></span> |
|---|

**6.** In the process of taking a gas from state  $A$  to state  $B$  along the curved path  $AEB$  shown in the  $PV$  diagram, 100 J of heat are added to the gas and 60 J of work are done *by* the gas.

Assume that the paths  $AC$  and  $DB$  are isochoric (constant volume) processes and the paths  $CB$  and  $AD$  are isobaric (constant pressure) processes.



(1) Calculate the change in internal energy  $U_B - U_A$ .

|     |  |   |
|-----|--|---|
| (1) |  | J |
|-----|--|---|

(2) When the gas is taken along the path  $ACB$ , the work done by the gas is 90 J. How much heat is added to the gas in this process?

|     |  |   |
|-----|--|---|
| (2) |  | J |
|-----|--|---|

(3) If the change in internal energy  $U_B - U_C$  is 20 J, how much heat is added to the gas in the isobaric process from  $C$  to  $B$ ?

|     |  |   |
|-----|--|---|
| (3) |  | J |
|-----|--|---|

(4) If  $P_C = 2.0P_A$ , how much heat is added to the gas in the process  $ADB$ ?

|     |  |   |
|-----|--|---|
| (4) |  | J |
|-----|--|---|