2019 Enrolment The 1st

Japan University Examination

Physics

Examination Date: November 2017

(60 min)

Do not open the examination booklet until the starting signal for the exam is given.
Please read the following instructions carefully.
Please fill in the examinee no. and name below.

Instructions

1. The booklet contains 17 pages.
2. The answer sheet is one piece of one sided paper.
3. In the case that you notice there are parts in the booklet where the print is not clear or there are missing pages or misplaced pages, or the answer sheet is soiled, raise your hand to report to the invigilator.
4. There are 4 questions to be answered.
5. Fill the examinee no. and name in the answer sheet.
6. Use black pencil to write answers in the designated section in the answer sheet.
7. Memos and calculations can be written on the examination booklet.
8. When the signal to end the exam is given, check again to see that the examinee no. and name is filled in and submit the answer sheet and the examination booklet according to the invigilator's instructions.

Examinee'sNo.	Name

Question 1　Please answer the following questions (Q1 to Q5).

Q1　Fix one end of a light, non-stretchable thread to a point O of the ceiling, attach a small ball to the other end of the thread, and hung the thread quietly. Also, fix the thin board horizontally and make the left end of E contacts the thread. At this time, the rest point A of the small ball, the left end E of the board, and point O are on the same vertical line. Next, as shown in Figure 1, pull up the small ball from the rest point A to point B of the height h without loosening the thread, and release it gently. The small ball makes a pendulum motion around point O, and makes a pendulum motion around E after passing the rest point A, reaching the highest point. The height at which the board is fixed is changed at a position higher than point B, in order to test the height from point A at which the small ball can reach. As a description of the highest point, please choose the most appropriate one from ① to ⑤ below. In addition, the air resistance associated with the motion of the small ball is negligible, and the mechanical energy shall not be lost before and after the thread contacts the board.

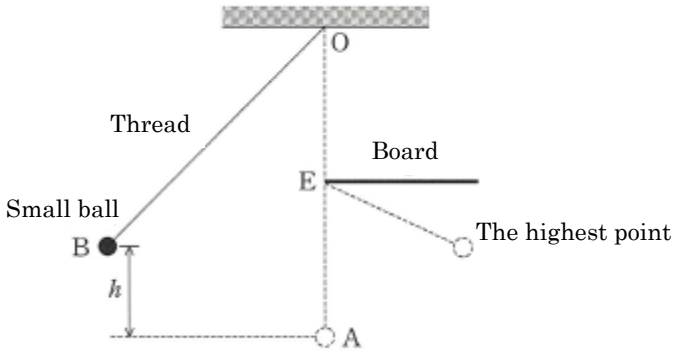


Figure 1

① The height of the highest point from point A is always h.

② The height of the highest point from point A is always lower than h and is constant.

③ The height of the highest point from point A is always higher than h and is constant.

④ As the height of the board increases, the height of the highest point from point A increases as well.

⑤ The height of the highest point from point A decreases as the height of the board increases.

Q2 Please choose one that is **not appropriate** as a description about acoustic waves from ① to ⑤ below.

① In the air, sound travels as the air compresses and expands repeatedly.

② Sounds can travel through the water.

③ Sounds travel through a vacuum at a speed about 340 m/s.

④ The pitch of the sound depends on the frequency of the acoustic wave.

⑤ The difference in timbre of different instruments is due to the different waveforms of acoustic waves.

Q3 Please choose one from the following ① to ④ that is **incorrect** as a description of the changing states of gases.

① When the gas is externally worked without heat exchange with the outside, the temperature of the gas rises.

② While working from the outside at a constant temperature, the gas releases heat.

③ While heating from the outside with a constant volume, the temperature of the gas rises.

④ When the heat added from the outside and the work which the gas has done to the outside are equal, the temperature of the gas rises.

Q4 As shown in Figure 2, a gold leaf electroscope with the gold leaves closed was surrounded with the wire gauze, and a positively charged glass rod was slowly brought close toward the wire gauze from a far place and finally contacted with the wire gauze. As a description of the state of the gold leaves during the process, choose the most appropriate one from ① to ④ below.

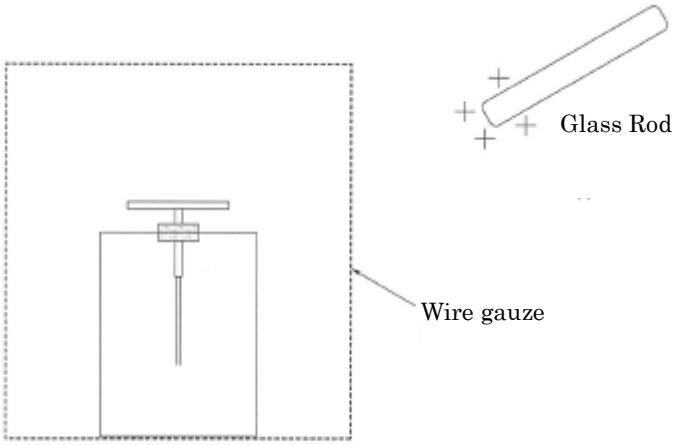


Figure 2

① The gold leaves opened wide gradually, and the gold leaves closed when the glass rod contacted the wire gauze.

② The gold leaves opened wide gradually, and even the glass rod contacted the wire gauze, the gold leaves remained open.

③ The gold leaves were closed before the glass rod contacted the wire gauze, but became open when the glass rod contacted the wire gauze.

④ The gold leaves remained closed when the glass rod came close to the wire gauze and contacted the wire gauze.

Q5 As shown in Figure 3, in a constant and steady magnetic field (magnetic flux), the circular coil A was deformed into the oblong coil B（A ⟹ B）which had a smaller area. Next, coil B was deformed back to the shape of A（B⟹A）. At last, it was deformed into coil C（A⟹C）of a vertically long shape with the same area as coil B. In the process of the first deformation of A ⟹ B, the direction of the induced current flowing in the coil was in the clockwise direction on the paper. Please choose the correct answer from ① to ⑤ to describe the direction of the induced current flowing through the coil in the process the deformation of B⟹A and A⟹C. In addition, the coil was on the paper surface, the direction of the magnetic field was perpendicular to the paper surface, approaching from the front toward the back.

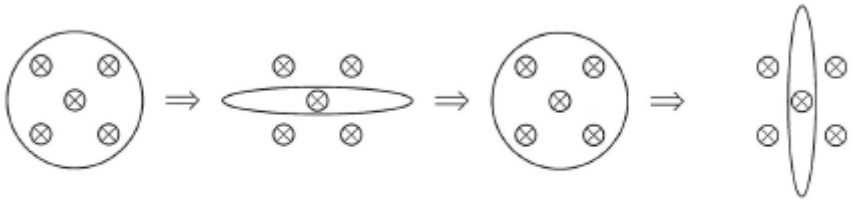


Figure 3

① B ⇒ A flowed clockwise and A ⇒ C flowed counterclockwise.

② B ⇒ A flowed counterclockwise and A ⇒ C flowed clockwise.

③ Either of B ⇒ A and A ⇒ C flowed clockwise.

④ Either of B ⇒ A and A ⇒ C flowed counterlockwise.

⑤ As the magnetic field is constant, no induced current flowed through the coil.

Question 2　Read the following articles (A・B) and answer the following questions (Q1 ～ Q6).

A　As shown in Figure 1, at time $t = 0$ the small ball P was thrown upward from the ground with the initial velocity v_o vertically. At this time, the relation between the velocity v_o of P with the vertical upward direction as the positive direction and the time t is shown in Figure 2. In addition, time $t = 2t_1$ is the time when the velocity of P became 0. And the air resistance that works on P is negligible.

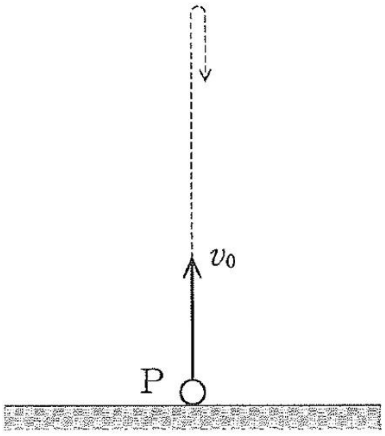


Figure 1

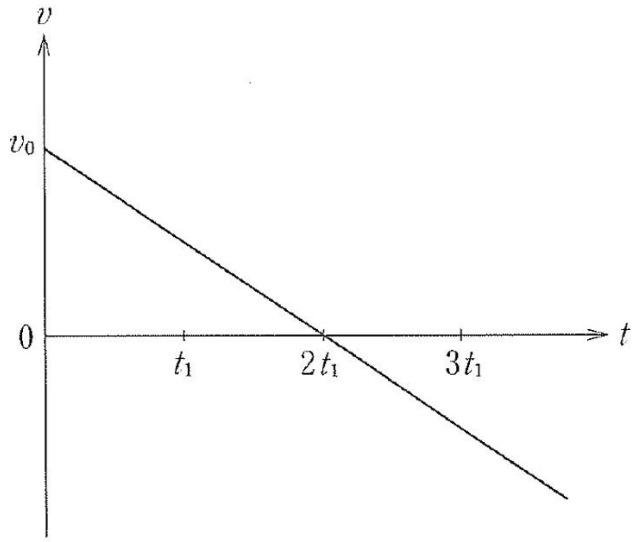


Figure 2

Q1　How much is the gravitational acceleration g? Please choose a correct answer from ① to ⑥ below.

① $\frac{v_0}{2{t_1}^2}$　② $\frac{v_0}{{t_1}^2}$　③ $\frac{2v_0}{{t_1}^2}$

④ $\frac{v_0}{2t_1}$　⑤ $\frac{v_0}{t_1}$　⑥ $\frac{2v_0}{t_1}$

Q2 When the height of the highest point that the small ball reaches is h, how much is the height of P at the time $t = 3t_1$? Please choose a correct answer from ① to ⑤ below.

① $\frac{h}{8}$ ② $\frac{h}{4}$ ③ $\frac{h}{2}$ ④ $\frac{2}{3}h$ ⑤ $\frac{3}{4}h$

B As shown in Figure 3，there is a board whose inclination angle can be changed around the horizontal axis R. Put it horizontally and fix the right end of a light spring fitted with an object of mass m to the board. Assume the spring constant of this spring to be k, the coefficient of friction between the object and the board to be μ, and the gravitational acceleration to be g. And the spring and the object are on the same straight line.

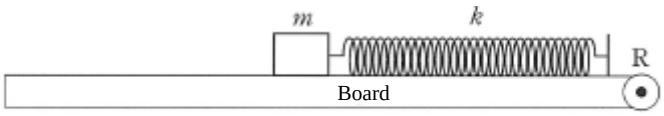


Figure 3

Q3 Move the object horizontally to the left and release the spring of a length of a from the original length of the spring gently, and the object remained still. How much is the friction force of the object received from the board? Please choose a correct answer from ① to ⑤ below.

① $\frac{1}{2}ka$ ② ka ③ μmg ④ $\mu mg - ka$ ⑤ $\mu mg + ka$

Q4 How much is the maximum value a_0 of the spring elongated to keep the object still when moving the object horizontally leftwards and releasing it gently? Please choose a correct answer from ① to ⑥ below.

① $\frac{mg}{2k}$ ② $\frac{mg}{k}$ ③ $\frac{2mg}{k}$

④ $\frac{\mu mg}{2k}$ ⑤ $\frac{\mu mg}{k}$ ⑥ $\frac{2\mu mg}{k}$

Q5 Next, the object is gently placed at a position where the elongation a_o of the spring from the original length, and as shown in Figure 4, the board is gradually inclined from the horizontal. Assume that the description is of the inclination angle θ of the board from the horizontal surface and the force working on the object until the object slides out. Choose one of the following ① to ④ as the most appropriate one.

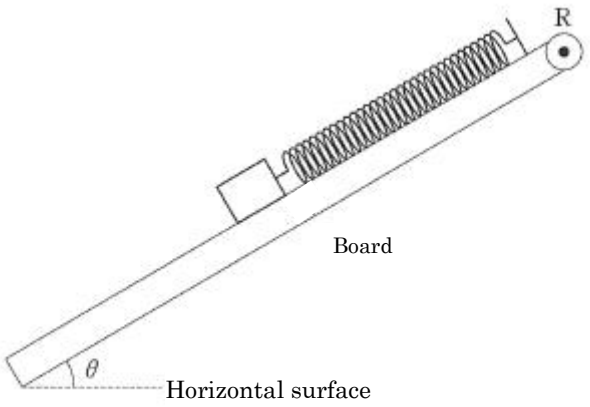


Figure 4

① As θ increases, the gravity working on the object increases as well.

② As θ increases, the normal force working on the object decreases.

③ The power of the friction force which the object receives from the board is always equal to the power of the elastic force exerted by the spring.

④ The power of the friction force which the object receives from the board is always equal to the gravity of component of the inclination direction.

Q6 When the inclination angle θ of the board exceeds an angle of θ_0, the object starts to slide downward along the slope. How much is the coefficient of friction? Please choose a correct answer from ① to ④ below.

① $\dfrac{\sin\theta_0}{1+\cos\theta_0}$ ② $\dfrac{\sin\theta_0}{1-\cos\theta_0}$ ③ $\dfrac{\cos\theta_0}{1+\sin\theta_0}$ ④ $\dfrac{\cos\theta_0}{1-\sin\theta_0}$

Question 3　Read the following articles (A・B) and answer the following questions (Q1 ～ Q6).

A　As shown in Figure 1, there are resistors R_1 and $R_2$with the same resistance value R, a resistor R_3 that the resistance value can be changed, and a circuit connected with a battery. In addition, the voltage between PQ is at a constant voltage V.

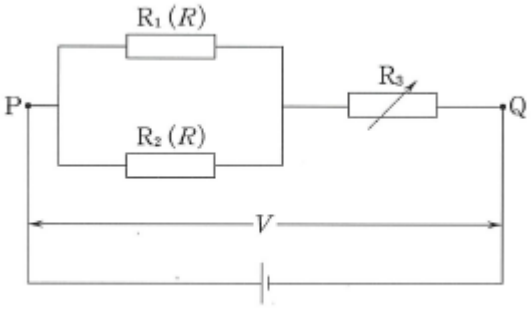


Figure 1

Q1　When the resistance value of resistor R_3 is set to be R, how much is the combined resistance value between PQ? Please choose a correct answer from ① to ⑤ below.

① $\frac{1}{3}R$　② $\frac{2}{3}R$　③ R　④ $\frac{3}{2}R$　⑤ $3R$

Q2　In Question1, how much is the electricity consumption between PQ? Please choose a correct answer from ① to ⑤ below.

① $\frac{RV^2}{3}$　② $\frac{2V^2}{3R}$　③ $\frac{V^2}{R}$　④ $\frac{3V^2}{2R}$　⑤ $3RV^2$

Q3 The resistance value of R_3 is changed so that the electricity consumption of resistor R_3 was maximized. How much is the resistance value of R_3 at this time? Please choose a correct answer from ① to ⑥ below.

① $\frac{1}{4}R$ ② $\frac{1}{2}R$ ③ $\frac{2}{3}R$

④ R ⑤ $2R$ ⑥ $3R$

B As shown in Figure 1, there is a water calorimeter consisting of a glass rod, a container and a thermometer. The glass rod and the container are made of the same material with the specific heat c, and the total mass is m. When the water with a specific heat of $10c$ and a mass of $\frac{1}{4}m$ is put in the calorimeter and after sufficient time passed, the temperature becomes t_0. At this time, put the metal A of the temperature $6\,t_0$ into the water of the calorimeter and slowly stir the water with the glass rod, soon the water temperature reaches $\frac{5}{2}t_0$. Here, assume that the heat capacity of the thermometer and the heat transmission between the calorimeter and the outside are negligible, and the water will not evaporate.

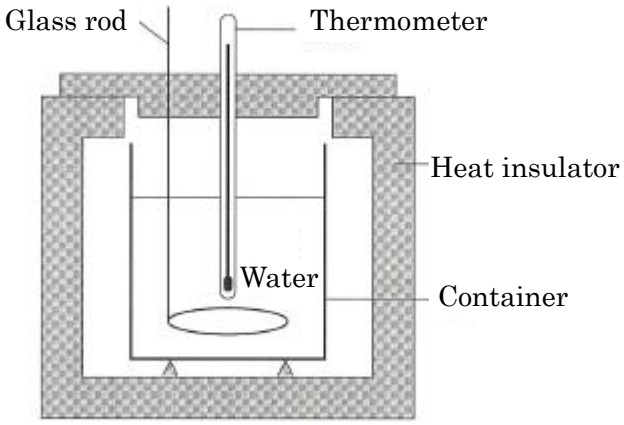
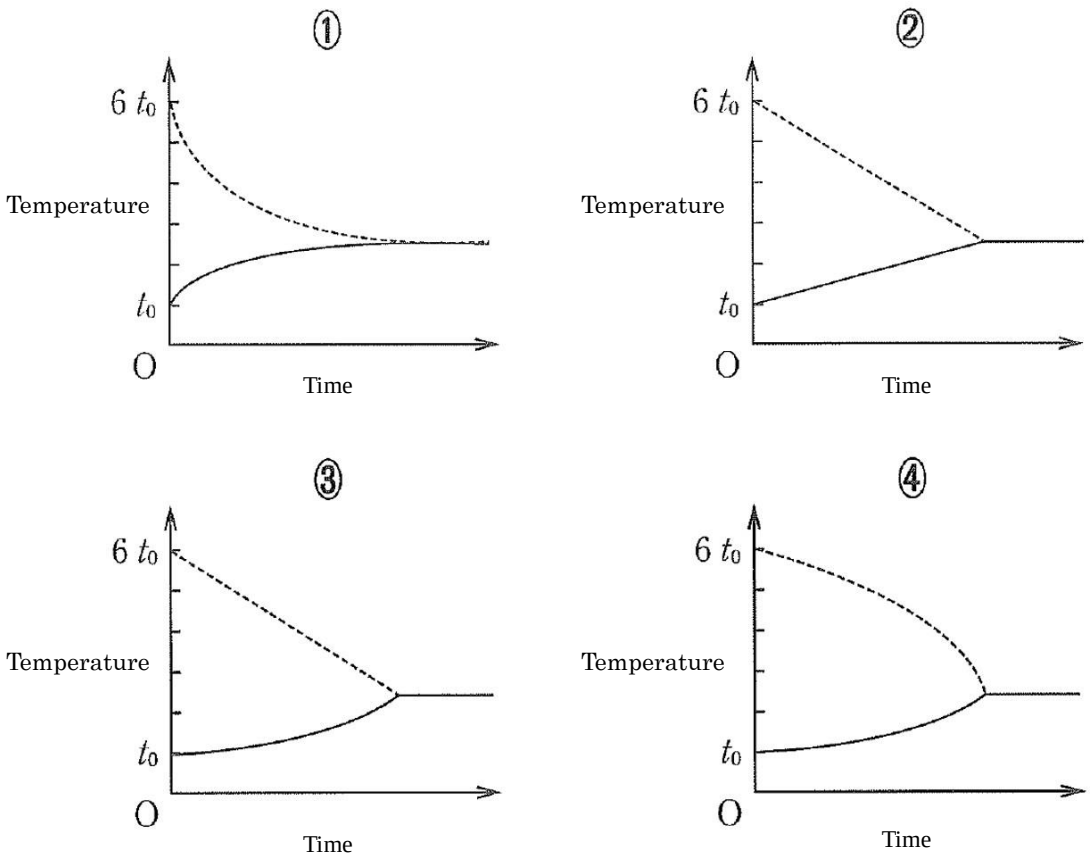


Figure 2

Q4 How will the water temperature and the temperature of metal A change with time after putting A in the water? Please choose a most appropriate answer from ① to ④ below. Here, the water temperature is indicated by a solid line, and the temperature of metal A is indicated by a broken line.



Q5 How much is the heat capacity of metal A? Please choose a correct answer from ① to ⑥ below.

① $\frac{1}{2}mc$ ② mc ③ $\frac{3}{2}mc$ ④ $2mc$ ⑤ $\frac{5}{2}mc$ ⑥ $3mc$

Q6 In this experiment, it is assumed that instead of metal A, metal B with the same mass as metal A and with a specific heat larger than metal A at a temperature of $6t_0$ is put into the water of the calorimeter. What is considered to be the water temperature after sufficient time? Please choose a most appropriate answer from ① to ⑤ below.

① Lower than the water temperature when it is at a temperature of $\frac{5}{2}\ t_0$.

② The water temperature becomes $\frac{5}{2}\ t_0$.

③ Higher than the water temperature when it is at a temperature of $\frac{5}{2}t_0$.

④ The water temperature becomes $6t_0$.

⑤ It is not determined only by the given conditions.

Question 4　Read the following articles (A・B) and answer the following questions (Q1 ～ Q5).

A　As shown in Figure 1, two points of P and Q on a sufficiently wide water surface are vibrated at the period T in the same way, and a wave of the amplitude A is sent out. At this time, it is observed that there are the positions where vibration occurs largely and where vibration hardly occurs on the water surface. Assume that v is the speed of the wave traveling through the water surface.

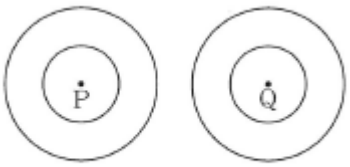


Figure 1

Q1　What is the wavelength of the waves traveling through the water? Please choose a correct answer from ① to ⑥ below.

① $\frac{vT}{2}$　② vT　③ $2vT$

④ $\frac{v}{2T}$　⑤ $\frac{v}{T}$　⑥ $\frac{2v}{T}$

Q2　What is the state of the vibration on line PQ? Please choose a correct answer from ① to ④ below.

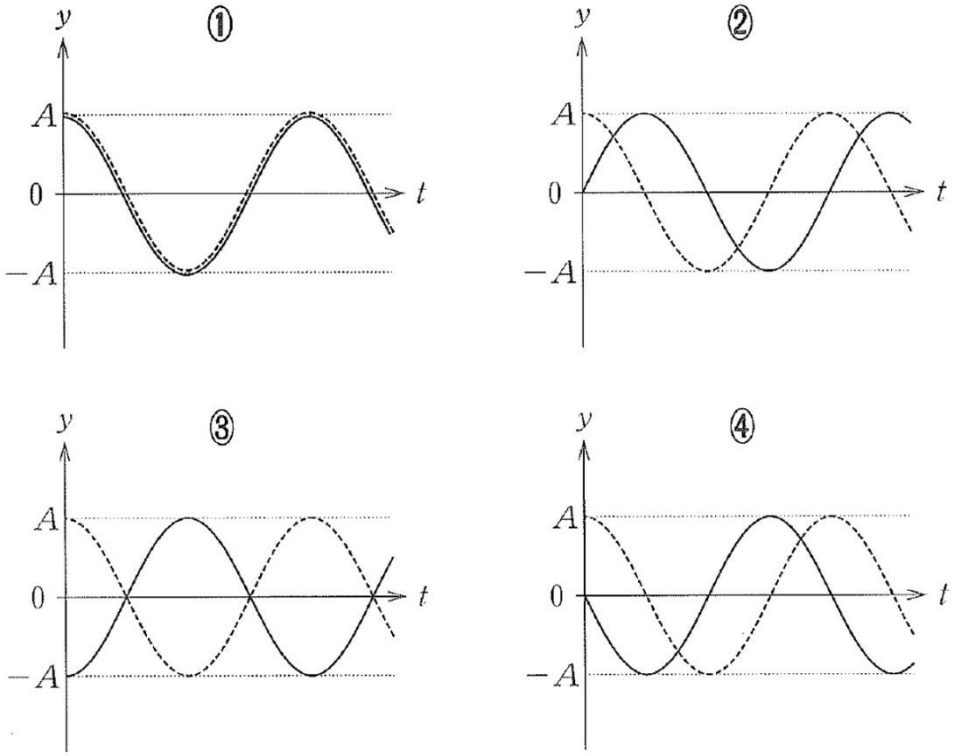
① The waves of the amplitude $2A$ head toward the center from point P and Q.

② The waves of the amplitude $2A$ head toward P and Q from the center.

③ The points that hardly vibrate are spaced at regular intervals of λ.

④ The points that hardly vibrate are spaced at regular intervals of $\frac{\lambda}{2}$.

Q3 Assume that point R to be 2λ away from point P and 3λ away from Q, and point S to be 3.5λ away from point P and λ away from Q on the water surface. How will the displacement y of each wave which is released from P and Q at point R and S change at time t? Please choose the most appropriate graph with t on the horizontal axis and y on the vertical axis from graph ① to ④ below. In addition, the displacement of the wave from point P is indicated by a solid line, and the displacement of the wave from point Q is indicated by a broken line.



B As shown in Figure 2, fix the object perpendicular to the origin O of the x axis. In the positive region of the x-axis, the x-axis is assumed to be the optical axis, a convex lens with a focal distance of 20cm that can move along the x-axis and a screen that is perpendicular to the x-axis that can move along the x-axis are placed. Move the convex lens and the screen to observe each position when a clear image of the object appears on the screen.

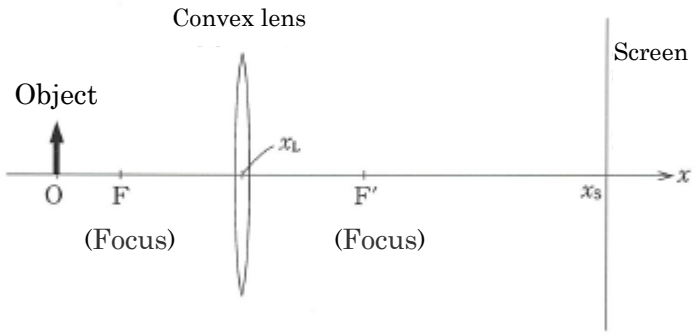


Figure 2

Q4 When the position x_L of the convex lens is x_L = 30cm, where is the position x_s of the screen? Please choose a correct answer from ① to ⑤ below.

① 70 ② 80 ③ 90 ④ 100 ⑤ 120

Q5 After adjust the position of the convex lens and the screen, the size of the image becomes the same as the object. How many times the screen position x_s is the position x_L of the convex lens? Please choose a correct answer from ① to ⑤ below.

① 1.5 ② 2 ③ 2.5 ④ 3 ⑤ 4