2020 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 2020

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

(2020)

PHYSICS

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

Marks	

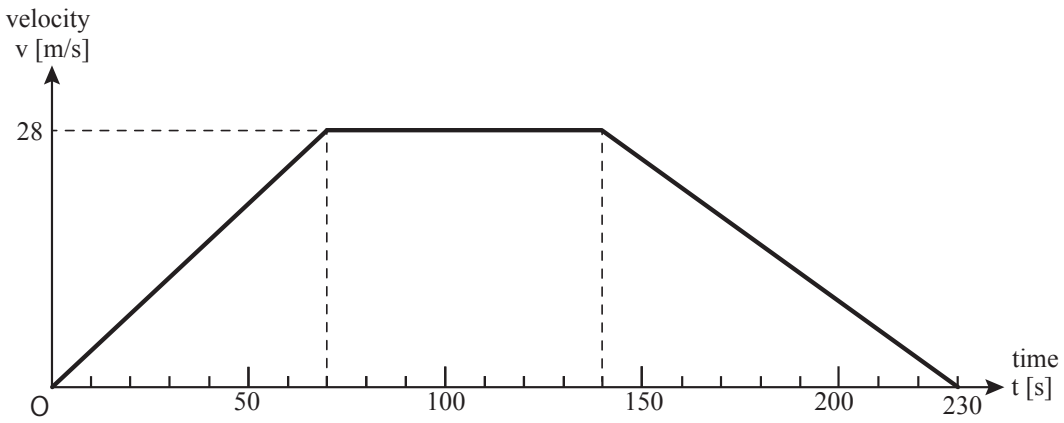
1. Answer the following questions.

(1) A ball is thrown straight up from the ground with an initial velocity of 14 m/s. The magnitude of the gravitational acceleration is 9.8 m/s^2 and air resistance is negligible. Find the maximum height reached by the ball above the ground. Choose the correct answer below (a) – (e) and write the letter of your choice.

(a) 1.0 m (b) 4.9 m (c) 10 m (d) 20 m (e) 40 m

(1)	

(2) The diagram shows a velocity-time graph for a train as it moves on a straight horizontal track.



(2-1) What is the acceleration of the train during the first 70s? Choose the correct answer below from (a) – (e) and write the letter of your choice.

(a) 0.15 m/s^2 (b) 0.28 m/s^2 (c) 0.40 m/s^2 (d) 1.0 m/s^2 (e) 4.0 m/s^2

(2-1)

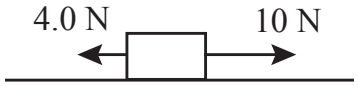
(2-2) What is the distance moved by the train during the 230s? Choose the correct answer below from (a) – (e) and write the letter of your choice.

(a) 42 m (b) 280 m (c) 1200 m (d) 4200 m (e) 6400 m

(2-2)

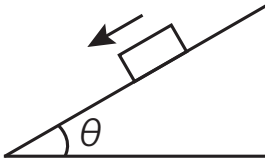
2. Answer the following questions.

(1) An object of mass 2.0 kg is at rest on a frictionless horizontal surface. When the object is pulled with two forces as shown below, it moves with a constant acceleration in a horizontal direction. Calculate the magnitude of the acceleration of the object.



(1)	**m/s**^{2}

(2) An object of mass m slides down an inclined plane with friction. The plane is inclined by an angle θ to the horizontal. What is the magnitude of the acceleration of the object? Choose the correct answer below (a) - (e) and write the letter of your choice. Where μ' is the coefficient of kinetic friction between the object and the surface, and g is the magnitude of the gravitational acceleration.

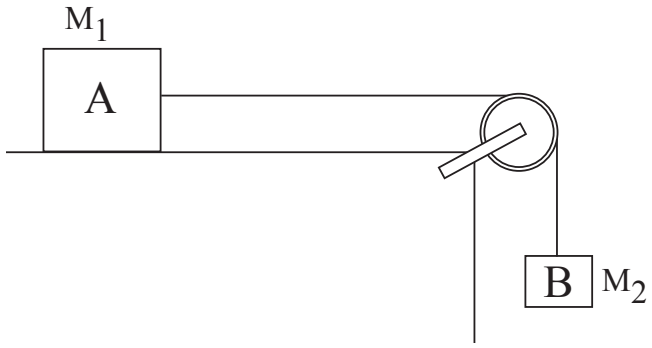


(a) $g(\sin\theta - \mu'\cos\theta)$ (b) $g(\sin\theta + \mu'\cos\theta)$ (c) $\mu' g\cos\theta$

(d) $\mu' g\sin\theta$ (e) $g\sin\theta$

(2)	

(3) An object A of mass M_1 and an object B of mass M_2 are attached to a massless string which passes over a frictionless smooth pulley attached to the edge of a horizontal table. Object A slides on the frictionless surface of the table, and object B is suspended by the string as shown below. What is the tension in the string? Choose the correct answer below (a) - (e) and write the letter of your choice. Where g is the magnitude of the gravitational acceleration.



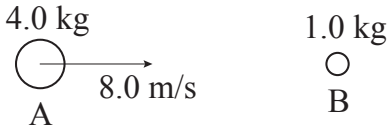
(a) $(M_1 + M_2)g$ (b) $(M_2 - M_1)g$ (c) $\frac{(M_1+M_2)g}{M_1M_2}$

(d) $\frac{M_1g}{M_1-M_2}$ (e) $\frac{M_1M_2g}{M_1+M_2}$

(3)

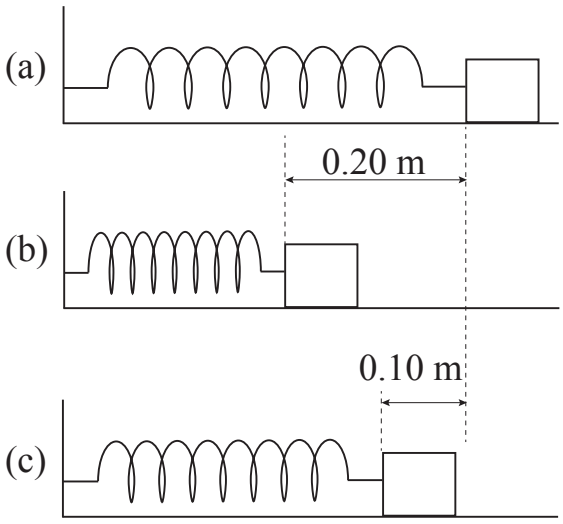
3. Answer the following questions.

(1) An object A with a mass of 4.0 kg moving at a speed of 8.0 m/s to the right collides with an object B with a mass of 1.0 kg at rest as shown below. After the collision, object A moves at 5.0 m/s to the right. What is the speed of object B after the collision?



(1)	**m/s**

(2) An object with a mass of 1.0 kg rests on a frictionless surface and is connected to a horizontal massless spring with a spring constant of 300 N/m (figure (a)). The object is released from rest when the spring is compressed 0.20 m from its natural length (figure (b)). Find the speed of the object when the spring is compressed 0.10 m from its natural length (figure (c)).



(2)	**m/s**

4. Answer the following questions.

(1) A sound wave in air has a frequency of 170 Hz and travels at a speed of 340 m/s. What is the wavelength of this wave?

(1)	**m**

(2) An object with a mass of 4.0 kg on a frictionless, horizontal table is attached to one end of a spring and undergoes simple harmonic motion with a period of 2.0s. What is the period of simple harmonic motion if the object is replaced with an object with a mass of 16 kg?

(2)	**s**

5. Answer the following questions. Round off your answers to two significant figures.

(1) The specific heat capacity of water is 4.2 J/(g·K). 2.0×10^2 g of water at 20 ℃ is mixed with 3.0×10^2 g of water at 80 ℃. Calculate the final temperature of the mixture after thermal equilibrium is established in Celsius. Ignore any heat exchange with the surroundings.

(1)	℃

(2) An ideal gas with an initial volume of 1.5 m^3 at a pressure of 1.0×10^5 Pa and a temperature 3.0×10^2 K is compressed to a volume 1.0 m^3 and heated to a temperature 3.2×10^2 K. Calculate the final pressure of the gas.

(2)	Pa

(3) Consider a system of monoatomic ideal gas. The gas has an initial volume of 5.0×10^{-3} m^3 at a pressure of 6.0×10^4 Pa. The pressure increases to a final pressure of 1.0×10^5 Pa while keeping the volume constant. Calculate the change of the internal energy of the gas in this process.

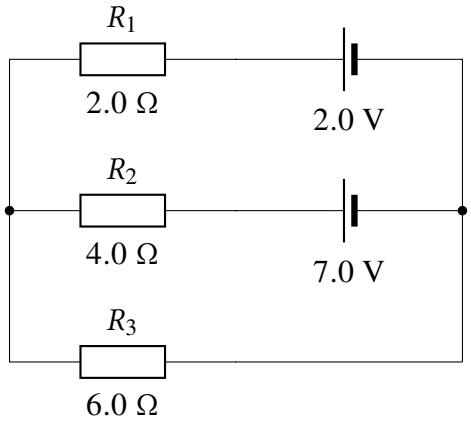
(3) **J**

(4) Consider a system of monoatomic ideal gas. The gas has an initial volume of 2.0×10^{-3} m^3 at a pressure of 2.2×10^5 Pa. The gas expands isothermally to a final pressure of 1.0×10^5 Pa. In this process, the gas gains an amount of heat of 3.5×10^2 J. Calculate the work done by the gas in this process.

(4) **J**

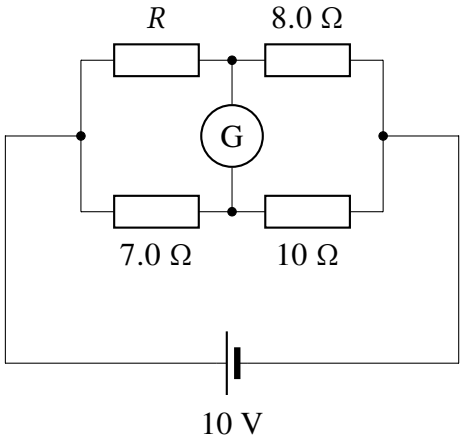
6. Answer the following questions. Round off your answers to two significant figures.

(1) Consider an electric circuit as shown in the figure. Calculate the magnitude of the current in the resister R_3.



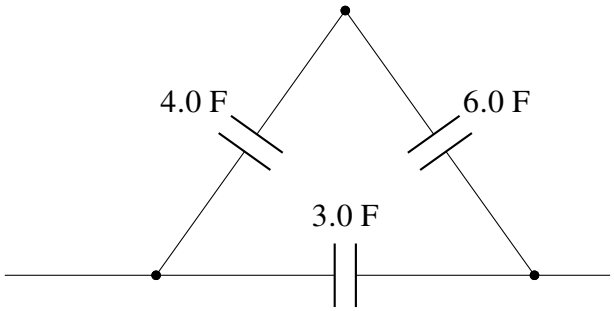
(1)	**A**

(2) Consider an electric circuit with four resistors and a galvanometer G as shown in the figure. When the galvanometer indicates no current flow, find the resistance of R.



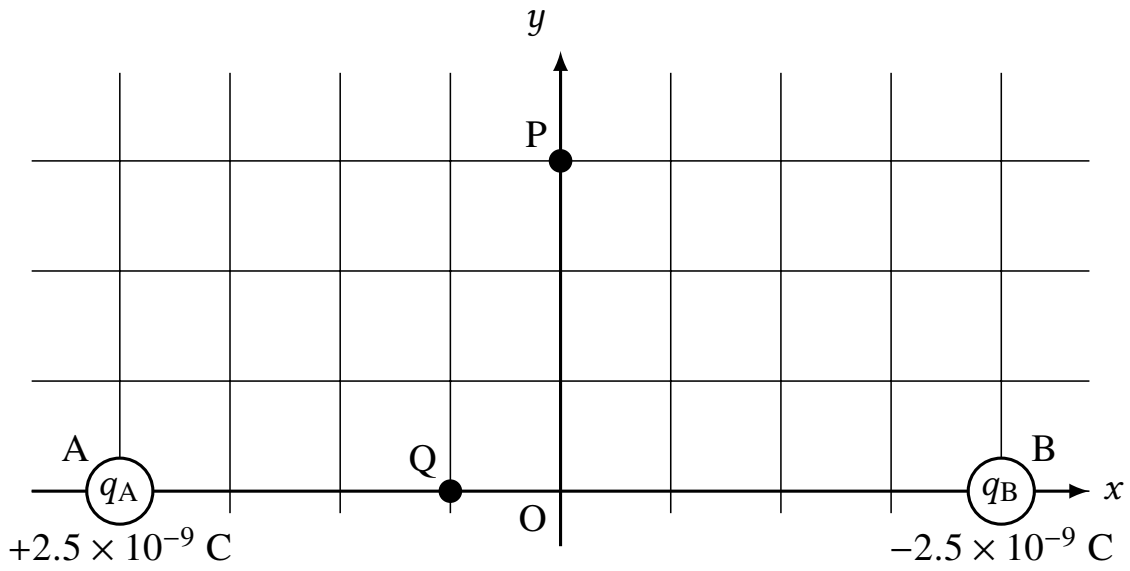
(2) **Ω**

(3) Find the total capacitance of three capacitors connected as shown in the figure.

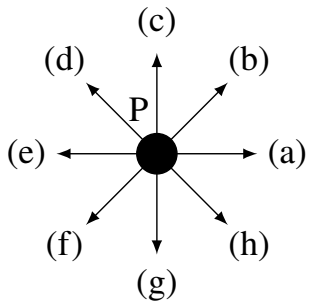


(3) **F**

7. Two point charges $q_A = +2.5 \times 10^{-9}$ C and $q_B = -2.5 \times 10^{-9}$ C are placed at $A = (-4.0\ \text{m}, 0)$ and $B = (4.0\ \text{m}, 0)$, respectively as shown in the figure. Let the proportionality constant k of Coulomb's law (Coulomb's constant) be $k = 9.0 \times 10^9\ \text{N}\cdot\text{m}^2/\text{C}^2$. Answer the following questions. Round off your answers to two significant figures.



(1) Which is the correct direction of the resultant electric field at $P = (0, 3.0\ \text{m})$? Choose the correct answer from (a) – (h) in the following figure and write the letter of your choice.



(1)

(2) Calculate the magnitude of the resultant electric field at $\mathrm{P} = (0, 3.0\ \mathrm{m})$.

(2)	**N/C**

(3) Calculate the magnitude of the electric potential at $\mathrm{Q} = (-1.0\ \mathrm{m}, 0)$. Note that the electric potential at infinity is taken to be 0.

(3)	V