



Rwanda Physics Olympiad

National Selection Test

First Round

Date: 24th October 2025

Duration: 2 hours

Instructions

1. This paper consists of multiple choice questions in section A that require only final answers chosen letter and written questions in section B which require detailed answers.
2. In section A each question carries 5 points(marks) and in section B each question carries 8 points(marks).
3. Calculators are permitted.
4. Reference materials are not allowed.
5. Remain silent during the test.
6. Raise your hand if you have a question.

Good luck!

Rwanda Physics Olympiad Organizing Committee

Table 1: Physical Constants

Symbol	Name	Value (SI units)
g	Gravitational acceleration	9.81 m s^{-2}
m_p	Proton mass	$1.67 \times 10^{-27} \text{ kg}$
m_e	Electron mass	$9.11 \times 10^{-31} \text{ kg}$
e	Elementary charge	$1.60 \times 10^{-19} \text{ C}$
k	Coulomb constant ($1/4\pi\epsilon_0$)	$8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$

- A1. A helicopter of mass $m = 2500 \text{ kg}$ is parked on top of a building of height $h = 50 \text{ m}$. What is the potential energy of the helicopter?
- A. $1.2 \times 10^5 \text{ J}$
 - B. $1.5 \times 10^5 \text{ J}$
 - C. $1.5 \times 10^6 \text{ J}$
 - D. $1.0 \times 10^6 \text{ J}$
 - E. $1.2 \times 10^6 \text{ J}$
- A2. A car travels up a hill at a constant speed of 10 m s^{-1} and returns down the hill at a constant speed of 20 m s^{-1} . The distances up and down are the same. What is the average speed for the round trip?
- A. 12.2 m s^{-1}
 - B. 15.8 m s^{-1}
 - C. 13.3 m s^{-1}
 - D. 15.0 m s^{-1}
 - E. 17.5 m s^{-1}
- A3. At a certain time a particle has a speed of 18 m s^{-1} in the positive x -direction. After 2.4 s , its speed is 30 m s^{-1} in the opposite direction. What is the average acceleration during this 2.4 s interval?
- A. 20 m s^{-2}
 - B. -20 m s^{-2}
 - C. 12 m s^{-2}
 - D. -12 m s^{-2}
 - E. -24 m s^{-2}
- A4. Raindrops fall 1700 m from a cloud to the ground. If they were not slowed by air resistance, how fast would the drops be moving when they struck the ground?
- A. 200 m s^{-1}
 - B. 94 m s^{-1}
 - C. 136 m s^{-1}
 - D. 183 m s^{-1}
 - E. 249 m s^{-1}
- A5. An elevator cab and its load have a combined mass of 1600 kg . Find the tension in the supporting cable when the cab, originally moving downward at 12 m s^{-1} , is brought to rest with constant acceleration in a distance of 42 m .
- A. $1.67 \times 10^4 \text{ N}$
 - B. $1.84 \times 10^4 \text{ N}$
 - C. $2.21 \times 10^4 \text{ N}$
 - D. $2.45 \times 10^4 \text{ N}$
 - E. $2.1 \times 10^4 \text{ N}$

- A6. Find the kinetic energy of a proton traveling in a circular orbit of radius 0.5 m at a period of 2 s.
- A. 8.2×10^{-27} J
 - B. 8.2×10^{-26} J
 - C. 2.1×10^{-27} J
 - D. 2.1×10^{-28} J
 - E. 1.5×10^{-28} J
- A7. A stone, thrown vertically upward from ground level, returns to the ground in 4 s (ignore air resistance). If it is thrown up at twice the initial speed, the time taken to return to the ground will be
- A. 6 s
 - B. 8 s
 - C. 12 s
 - D. 16 s
 - E. 10 s
- A8. Two positive charges, $2Q$ and Q are a distance $L = 1$ m apart. charge Q experiences an electrostatic force $F = 2.2$ N. What is the charge Q ?
- A. $3.5 \mu\text{C}$
 - B. $7.8 \mu\text{C}$
 - C. $11.0 \mu\text{C}$
 - D. $15.0 \mu\text{C}$
 - E. $12.4 \mu\text{C}$
- A9. The table shows how the resistive forces on a moving object vary with the object's speed. To what power of v is F proportional?

$v \text{ (m s}^{-1}\text{)}$	$F \text{ (N)}$
10	37
15	83
27	270
35	450

- A. $v^{1/2}$
 - B. $v^{1.5}$
 - C. v
 - D. v^2
 - E. v^3
- A10. A suitcase of mass 10 kg rests on the floor. You grab the handle and pull straight upward with a force of 40 N. What is the normal force from the floor acting on the suitcase?
- A. 0 N
 - B. 20 N
 - C. 40 N
 - D. 60 N
 - E. 80 N

- B1. An appliance draws a current of $I = 5 \text{ A}$. After $t = 5 \text{ min}$, how many electrons have travelled through the appliance?
- A. 8.2×10^{19}
 - B. 5.4×10^{20}
 - C. 9.4×10^{21}
 - D. 3.5×10^{22}
 - E. 4.7×10^{21}
- B2. How far apart must two protons be if the magnitude of the electrostatic force on either one due to the other equals the magnitude of the gravitational force on a proton at Earth's surface?
- A. 0.012 m
 - B. 0.12 m
 - C. 1.2 m
 - D. 12 m
 - E. 120 m
- B3. Two identical small spheres of mass m each carry equal charge $+q$. They hang from the same point by light strings of length L and settle symmetrically as shown in figure 1. Given $L = 0.50 \text{ m}$, $m = 5.0 \text{ g}$, $q = 2 \times 10^{-7} \text{ C}$. Find the equilibrium angle θ that each string makes with the vertical. (You may use the small-angle relations $\sin \theta \approx \tan \theta \approx \theta$ if needed.)
- A. 6.0°
 - B. 9.0°
 - C. 11.0°
 - D. 13.0°
 - E. 15.0°

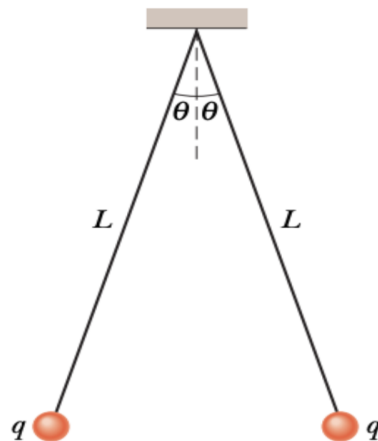


Figure 1: Question B3 - angled charges

- B4. In Figure 2, what is the value of the resistor R_3 , in terms of the resistances R_1 and R_2 , expressed in its simplest form, if the total resistance across AB is equal to R_1 ?

- A. $\frac{R_1 R_2}{R_1 + R_2}$
- B. $\frac{R_2^2}{R_1 + R_2}$
- C. $\frac{R_1^2 R_2}{(R_1 + R_2)^2}$
- D. $\frac{R_1 R_2^2}{(R_1 + R_2)^2}$
- E. $\frac{R_1^2}{R_1 + R_2}$

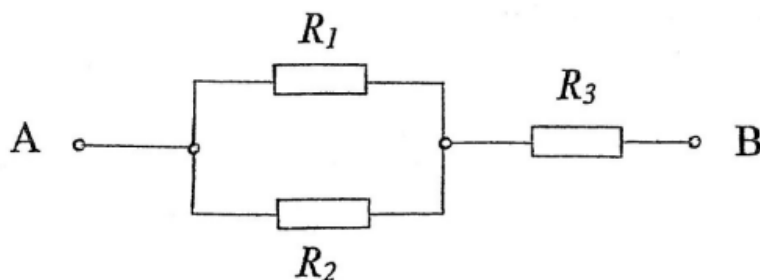


Figure 2: Question B4 - semi parallel resistors

- B5. A typical passenger car has a maximum deceleration while braking of $a = 7.0 \text{ m s}^{-2}$, and a typical reaction time of 0.50 s. The school board wants the speed limit outside an elementary school to be set so that all cars can stop within 4.0 m. Determine the maximum speed limit.

- A. 4.8 m s^{-1}
- B. 6.2 m s^{-1}
- C. 8.5 m s^{-1}
- D. 10.6 m s^{-1}
- E. 12.3 m s^{-1}

- B6. In Figure , two charges $+Q$ and $-Q$ are fixed on the x -axis, separated by a distance $2a$. A test charge q is placed on the perpendicular bisector at a distance r from the midpoint. What is the *magnitude* of the net force on q due to the two charges?

- A. $\frac{kQq}{r^2 + a^2}$
- B. $\frac{kQqa}{r^3}$
- C. $\frac{2kQqa}{(r^2 + a^2)^{3/2}}$
- D. $\frac{2kQqa}{(r^3 + a^3)^{2/3}}$
- E. $\frac{4kQqa}{r^3}$

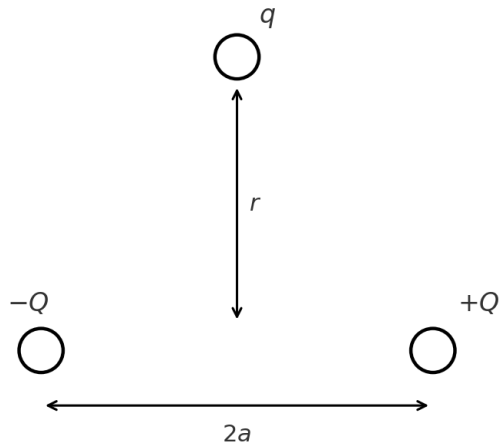


Figure 3: Question B6 - Dipole equatorial setup with distances

B7. Figure 4 shows a circuit with a battery and three resistors.

$$R_1 = 1.0 \, \Omega, \quad R_2 = 2.0 \, \Omega, \quad R_3 = 6.0 \, \Omega$$

We measure the voltage across R_2 to be 12.0 V.

What is the current through R_3 ?

- A. 1.0 A
- B. 3.0 A
- C. 4.0 A
- D. 6.0 A
- E. 9.0 A

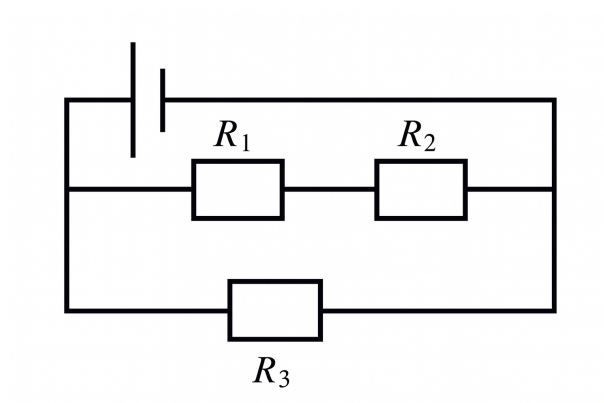


Figure 4: Question B7 - Semi parallel circuit

- B8. Along a straight line, a charge $+q$ is fixed at the origin $x = 0$ and a charge $+3q$ is fixed at $x = L$. See figure 5 for an illustration (scales may be incorrect in the figure). At what position x (measured from the origin toward $+3q$) is the net electric field equal to zero?

- A. $\frac{L}{2}$
- B. $\frac{L}{3}$
- C. $\frac{L}{3\sqrt{2}}$
- D. $\frac{L}{1 + \sqrt{2}}$
- E. $\frac{L}{1 + \sqrt{3}}$

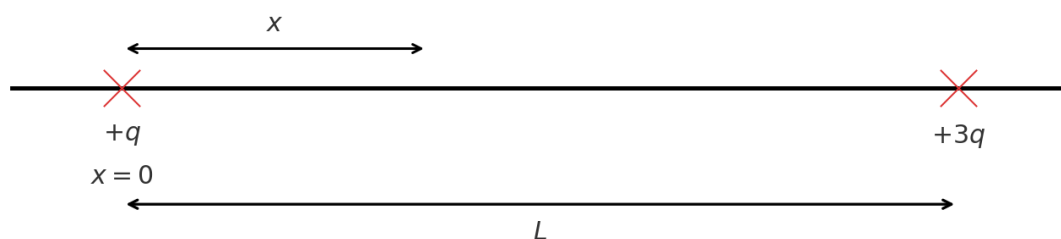


Figure 5: Question B8 - charge equilibrium

- B9. What is the escape speed from the surface of a spherical planet of mass M and radius R ? (*Escape speed* means the minimum speed needed to reach infinitely far away from the planet; ignore atmosphere and the planet's rotation.)

- A. $v_e = \sqrt{\frac{GM}{R}}$
- B. $v_e = \sqrt{\frac{2GM}{R}}$
- C. $v_e = \sqrt{\frac{GM}{2R}}$
- D. $v_e = \frac{GM}{R}$
- E. $v_e = \frac{GM}{R^2}$

- B10. Ball A of mass m moves along a straight line with speed $u = 2$ m/s and collides head-on with ball B of mass $2m$, which is initially at rest. The collision is perfectly elastic and there are no external forces during impact. What is the final velocity of ball A immediately after the collision?

- A. $\frac{2}{3}$ m/s
- B. $-\frac{2}{3}$ m/s
- C. 0 m/s
- D. $\frac{4}{3}$ m/s
- E. $-\frac{4}{3}$ m/s