Association of Physics Educators
Mauritius Institute of Education
Ministry of Education and Human Resources
Rajiv Gandhi Science Centre
Mauritius Research Council

PHYSICS OLYMPIAD, 2008

Preliminary Competition

Duration: 10:00 – 13:00 hours

All mobile phones should be switched off.

Anybody caught cheating will be asked to leave the room immediately.

Answer both questions showing clearly all your workings.

Question 1

(a) When an object is thrown at an angle θ to the horizontal, it executes a parabolic trajectory. In order to solve problem related to projectile motion, a two dimensional approach has to be considered.

Considering zero air resistance, sketch good graphs to illustrate the following:

1. Displacement-time graph for vertical component of displacement,
2. Displacement –time graph for horizontal component of displacement,
3. Velocity-time graph for vertical component of velocity,
4. Velocity-time graph for horizontal component of velocity,
5. Acceleration-time graph for horizontal component of acceleration,
6. Acceleration-time graph for vertical component of acceleration.

You are required to provide clear explanation to your answer as well as mathematical support whenever necessary.

(b) A small steel ball is released from a height of 4 m above ground. At a height of 2 m above ground, it makes an elastic collision against a surface set at an angle of 30^{o} to the horizontal.

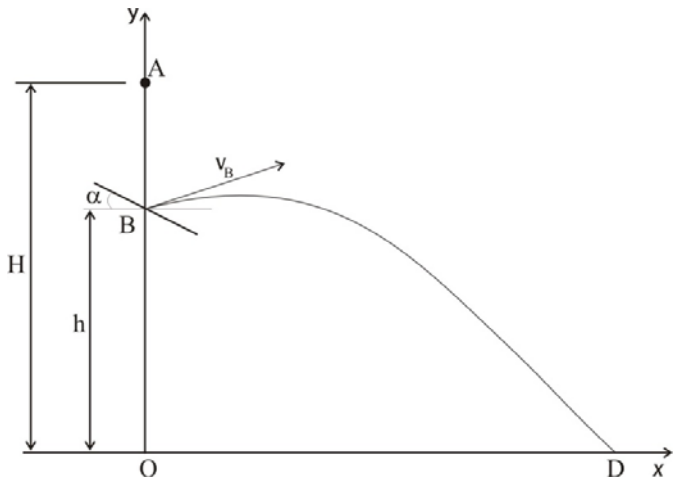

Figure 1

Again, neglecting air resistance, determine:

1. A general formula for the total time it takes for the ball to reach ground,
2. The magnitude of the total time,
3. A general formula for its range,
4. The magnitude of its range.
5. Discuss whether the range would have changed if air resistance was not negligible.

[50 marks]

Question 2

(a) N lamps joined by equal length of conductors of resistance R are connected to a source of e.m.f of magnitude V_0. The current flowing in each lamp is I_0.

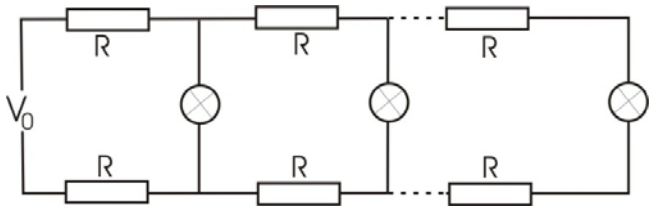

Figure 2

The connecting wires experience heating effect. Considering that the current I_0 is independent of the potential difference across it and that the potential difference in the last lamp is 0.9 V_0, obtain a general formula for the resistance R of the connecting wire.

[Hint:You may use the following summation if you wish $\sum_{n=1}^{N} n = \frac{N(N+1)}{2}$]

(b) The circuit (Figure 3) shows a network of resistors connected to a battery of e.m.f E.

1. Obtain a general equation for the current I flowing from the battery.
2. Given that E = 6 V, R_1 = 2 Ω, R_2 = 6 Ω, R_3 = 3 Ω and R_4 = 1.5 Ω, calculate the magnitude of I.

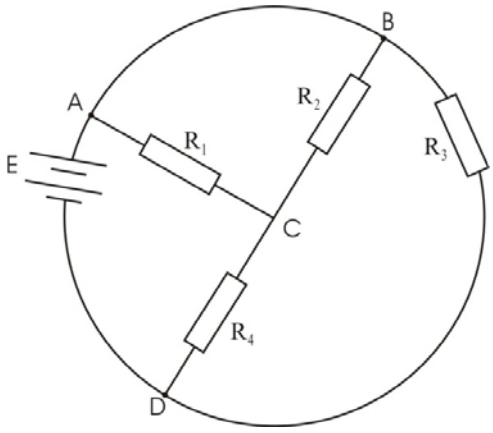

Figure 3

[50 marks]