THE UNITED REPUBLIC OF TANZANIA
NATIONAL EXAMINATIONS COUNCIL OF TANZANIA
DIPLOMA IN SECONDARY EDUCATTION EXAMINATION

731/1 **PHYSICS 1**

Time: 3 Hours **ANSWERS** **Year: 2024**

Instructions.

1. This paper consists of sections **A** and **B** with total of **Fourteen (14)** questions.
2. Answer **all** questions
3. Section **A** comprises **Ten (10)** questions with total of **40** marks, while section B has four questions with total of **60** marks..
4. Cellular phones are **note** allowed in the examination room.
5. Write your **examination Number** on every page of your answer booklet(s).

SECTION A (40 Marks)

Answer **all** questions from this section. Each question has **four (4)** marks.

1. You are requested by the students to orient them on the dimensions of various physical constants. How would you orient them on the following constants?

   (a) The dimension of Young's modulus is the same as pressure because it is the ratio of stress to strain, and strain is dimensionless. Its dimensional formula is $ML^{-1}T^{-2}$.

   (b) The coefficient of viscosity has dimensions obtained from force per unit area per velocity gradient. Its dimensional formula is $ML^{-1}T^{-1}$.

   (c) Planck's constant has the dimensions of energy multiplied by time, since it appears in the relation E = hf. Its dimensional formula is ML^2T^{-1}.

   (d) Surface tension is force per unit length. Its dimensional formula is MT^{-2}.

2. (a) Antiseptics used for treating cuts and wounds in human flesh are made of low surface tension because low surface tension liquids spread quickly and easily over the surface of the skin and into the wound, ensuring better coverage and effective disinfection.

   (b) Given:
   Number of small droplets = 10
   Diameter of each small droplet, $d = 10^{-8}$ m
   Surface tension, $T = 23.8 \times 10^{-3}$ Nm^{-1}

   Volume of one small droplet:
   $V = (4/3)\pi r^3 = (4/3)\pi(5 \times 10^{-9})^3 = 5.236 \times 10^{-24}$ m^3

   Total volume of 10 small droplets:
   $V\_total = 10 \times 5.236 \times 10^{-24} = 5.236 \times 10^{-23}$ m^3

   Radius of large droplet:
   $V\_large = (4/3)\pi R^3 = 5.236 \times 10^{-23}$
   $R^3 = (5.236 \times 10^{-23} \times 3)/(4\pi)$
   $R \approx 9.95 \times 10^{-9}$ m

   Surface area difference:
   Surface area of 10 small droplets:
   $A_1 = 10 \times 4\pi r^2 = 10 \times 4\pi(5 \times 10^{-9})^2 = 3.142 \times 10^{-15}$ m^2

   Surface area of large droplet:
   $A_2 = 4\pi R^2 = 4\pi(9.95 \times 10^{-9})^2 = 1.243 \times 10^{-15}$ m^2

   Change in surface area:
   $\Delta A = A_1 - A_2 = 3.142 \times 10^{-15} - 1.243 \times 10^{-15} = 1.899 \times 10^{-15}$ m^2

   Energy liberated:
   $E = T \times \Delta A = 23.8 \times 10^{-3} \times 1.899 \times 10^{-15}$
   $E \approx 4.515 \times 10^{-17}$ J

3. Geography, Geology and Physics teachers believe that, in the interior of the earth, the core is in a molten form. What seismic evidence supports this belief?

   Seismic waves provide evidence for a molten core because primary (P) waves can travel through both liquids and solids, while secondary (S) waves cannot pass through liquids. The observation that S-waves disappear upon reaching a certain depth, known as the shadow zone, indicates the presence of a liquid outer core. Additionally, the refraction of P-waves at this boundary provides further confirmation of a change from solid to liquid material.

4. (a) The pilot obtained the time taken by the bomb to reach the ground by using the vertical motion equation under gravity:
   $h = 0.5gt^2$
   where h is the height and g is the acceleration due to gravity.

   (b) Using the formula:
   $h = 0.5gt^2$
   $8400 = 0.5 \times 9.81 \times t^2$
   $t^2 = 8400 \div 4.905$
   $t^2 \approx 1712.13$
   $t \approx 41.38$ s

   Time taken by the bomb to reach the ground is approximately 41.38 seconds.

5. During winter, Juma complained to her mother that he was feeling cold, her mother advised him to put on a woollen jacket. Briefly explain the reason for that advice.

   A woollen jacket traps a layer of warm air close to the body. Air is a poor conductor of heat, so this trapped air reduces heat loss from Juma's body to the cold surroundings, keeping him warm.

6. The velocity and acceleration of a body executing simple harmonic motion are always out of phase. How would you justify this statement?

   In simple harmonic motion, velocity is maximum when displacement is zero, and acceleration is zero at this point. Conversely, when the body reaches maximum displacement, its velocity is zero and acceleration is maximum in the opposite direction. This means velocity and acceleration reach their respective maximum and zero values at different times, making them 180° (or π radians) out of phase.

7. Silicon and germanium are tetravalent semiconductor elements found in Group Four of the periodic table. Based on their energy gap, briefly explain which element is mostly preferred to manufacture solar cell devices.

   Silicon is mostly preferred for manufacturing solar cell devices because it has a wider energy gap of about 1.1 eV compared to germanium's 0.66 eV. A wider energy gap reduces leakage currents and makes the solar cell more efficient and stable under high temperature conditions, which is essential for reliable solar energy conversion.

8. A student teacher covered one topic in Physics during the teaching practice and wanted to fill the information in the Physics logbook. What components the student teacher would use to fill the information? Give four.

   The date on which the lesson was taught must be recorded to track the progress.

   The topic and sub-topic covered during the lesson should be clearly written.

The teaching methods and materials used should be noted to reflect the lesson approach.

The number of students present and remarks on class performance or challenges encountered should be included.

9. Suppose you were invited to teach a single lesson practice in the nearby school on the sub-topic "Newton's laws of motion." How would you explain to students the implication of first and third laws?

   Newton's first law states that a body remains at rest or continues in uniform motion in a straight line unless acted upon by an external force. I would explain that this means objects do not change their motion unless a force causes them to do so, which is why a ball on a flat surface eventually stops due to friction.

   Newton's third law states that for every action, there is an equal and opposite reaction. I would explain that this implies whenever you push an object, it pushes back with equal force in the opposite direction. For example, when you jump off a boat, the boat moves backward as your body moves forward.

10. After marking the Physics test, a teacher discovered that most of the students scored below the average marks. The teacher wanted to standardize the students' scores. What four steps would you recommend for carrying out such a task? Give them in chronological order.

    First, calculate the mean and standard deviation of the students' raw scores to establish the class's overall performance.

    Second, determine a suitable new mean and standard deviation that reflects the desired standard of performance.

    Third, use the standardization formula:
    New score = [(raw score – old mean) ÷ old standard deviation] × new standard deviation + new mean

    Lastly, adjust and record the standardized scores, then provide feedback to students on their improved performance.

SECTION B (60 Marks)

Answer **all** questions from this section. Each question has **fifteen (15)** marks.

11. (a) The teacher likely selected a **temperature sensor** and a **light sensor**. The temperature sensor detects when the room gets too hot, while the light sensor confirms it is daylight. These two sensors working together would ensure the fan only switches on during hot daylight conditions.

(b) The block diagram for controlling the fan using only one logic gate (NAND) would be:

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        Temperature Sensor →|
|----> NAND gate ----> Fan
        Light Sensor →|
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This arrangement means the fan will turn ON when both sensors detect their conditions (room is hot and it's daylight).

(c) The logic gate applied in (b) is an AND gate equivalent, implemented using NAND gates. An AND gate can be built from NAND gates by connecting the output of a NAND gate to the inputs of a second NAND gate:
AND gate construction using NAND gates:
First NAND gate takes inputs from both sensors.
Second NAND gate takes the output of the first one connected to both its inputs.

Diagram:
Sensor A →|
|---NAND1----|
Sensor B →| |--NAND2-- Fan
|
|

Where NAND1 output is connected to both inputs of NAND2.

12. (a) Since the wires are of the same material and length, resistance is inversely proportional to cross-sectional area. If areas are in the ratio 2:1 (X:Y), the resistance ratio will be 1:2.
By Ohm's law, current is inversely proportional to resistance for the same potential difference.
So, the ratio of currents (I_x:I_y) is 2:1.
(b) Given:
I = 10 A
A = 1 mm² = 1×10^{-6} m²
n = 10^{28} m^{-3}
e = 1.6×10^{-19} C
Use formula:
I = n × A × e × v_d
Rearrange:
v_d = I / (n × A × e)
v_d = 10 / ($10^{28} \times 1 \times 10^{-6} \times 1.6 \times 10^{-19}$)
v_d = 10 / (1.6×10^{3})
v_d ≈ 6.25×10^{-3} m/s

13. **Lesson Plan**
Subject: Physics
Class: Form II
Number of Students: 35
Topic: Current Electricity
Sub-topic: Ohm's Law
Duration: 40 minutes

Lesson Objectives:
By the end of the lesson, students should be able to:
- State Ohm's Law.
- Derive the mathematical expression of Ohm's Law.
- Solve numerical problems using Ohm's Law.

Teaching Aids:
Dry cells, resistor, voltmeter, ammeter, connecting wires, switch, and whiteboard.

Introduction (5 minutes):
Review prior knowledge on current and potential difference.
Ask students how electrical appliances are rated and why.

Lesson Development (25 minutes):
Explain Ohm's Law as the relationship between current and potential difference at constant temperature.
State: V = IR
Demonstrate an experiment with a simple circuit using a resistor, voltmeter, and ammeter.
Record values of voltage and current.
Plot a graph of V against I to show a straight line passing through the origin.
Explain how the slope of the graph represents resistance.
Derive the formula V = IR from the graph.

Application:
Provide three simple calculation problems for students to solve individually.

Conclusion (5 minutes):
Summarize the lesson by asking key questions to recap definitions and formula.
Clarify any misunderstandings.

Assignment (5 minutes):
Students to explain the importance of resistance in household wiring.

14. A Physics teacher has a plan of conducting practical to all Form IV students before the terminal examinations. Explain five factors you would advise the teacher to consider to achieve his plan.

First, the teacher should consider the **availability and condition of apparatus**. He must ensure that all essential instruments and materials are available, functional, and sufficient for the number of students.

Second, the teacher should properly **organize the laboratory space** to safely accommodate all students during practical sessions, ensuring adequate working space and ventilation.

Third, the teacher needs to develop a **practical timetable** that fits within the school's academic schedule and allows each group of students to perform their experiments without rush.

Fourth, it is important to prepare **clear experiment instructions** and procedures in advance, ensuring students understand the objectives and steps of each practical activity.

Lastly, the teacher should plan for **safety measures and supervision**. Proper guidelines for safe use of laboratory equipment and appropriate teacher supervision are essential to prevent accidents and mishandling of apparatus.