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

731/1 **PHYSICS 1**

Time: 3 Hours **ANSWERS** **Year: 2021**

Instructions.

1. This paper consists of sections A, B and C with a total of **Sixteen (16)** questions.
2. Answer **all** questions from section A and **two (2)** questions from section B and C.
3. Section A carries **forty (40)** marks and section B and C carries **sixty (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 carries 4 marks.

1. Use the equation to compute the dimensions of the constants x and y from $(P + x/y)(V - y) = RT$, given that P is pressure, V is volume, T is temperature and R is universal molar gas constant.

Rearranging the equation:
$(P + x/y)(V - y) = RT$

From dimensional analysis:
$[P] = M\,L^{-1}\,T^{-2}$
$[V] = L^3$
$[R] = M\,L^2\,T^{-2}\,K^{-1}$
$[T] = K$

Left side has dimensions of pressure × volume:
$[M\,L^{-1}\,T^{-2}] \times [L^3] = [M\,L^2\,T^{-2}]$

Right side is:
$[R] \times [T] = [M\,L^2\,T^{-2}\,K^{-1}] \times [K] = [M\,L^2\,T^{-2}]$

So both sides match.

Now for [x/y] to match [P]:
$[x/y] = [M\,L^{-1}\,T^{-2}]$
Since [y] has same dimension as $[V] = [L^3]$

Then, $[x] = [P] \times [V] = [M\,L^{-1}\,T^{-2}] \times [L^3] = [M\,L^2\,T^{-2}]$

Therefore:
$[x] = [M\,L^2\,T^{-2}]$
$[y] = [L^3]$

2. Calculate the speed acquired by the electron when an electron is emitted from a hot cathode in an evacuated tube is accelerated by a potential difference (p.d) of 1.0×10^3 V.

Using the formula:
$eV = \frac{1}{2}\,m\,v^2$

Where:
$e = 1.6 \times 10^{-19}$ C
$V = 1.0 \times 10^3$ V
$m = 9.11 \times 10^{-31}$ kg

$v = \sqrt{(2\,e\,V / m)}$
$= \sqrt{(2 \times 1.6 \times 10^{-19} \times 1.0 \times 10^3 / 9.11 \times 10^{-31})}$
$= \sqrt{(3.2 \times 10^{-16} / 9.11 \times 10^{-31})}$
$= \sqrt{(3.51 \times 10^{14})}$
$= 1.87 \times 10^7$ m/s

Speed = 1.87×10^7 m/s

3. (a) Give the meaning of the term “fixed point” as used in Simple Harmonic Motion.

A fixed point in simple harmonic motion is the point at which the object momentarily comes to rest and reverses direction, typically at the extreme positions of its path.

(b) Deduce the maximum magnitudes of velocity of the bob and acceleration of the bob given that the period and amplitude of swing of a simple pendulum are 2.0 s and 5.0 cm respectively.

Maximum velocity:
$v_{max} = (2\pi A) / T$
$= (2 \times 3.142 \times 0.05) / 2.0$
$= 0.1571$ m/s

Maximum acceleration:
$a_{max} = (4\pi^2 A) / T^2$
$= (4 \times 9.8696 \times 0.05) / (2.0)^2$
$= (1.9739) / 4$
$= 0.4935$ m/s²

4. (a) Explain why a soap solution is a better cleansing agent than ordinary water.

A soap solution is a better cleansing agent because it reduces the surface tension of water, allowing it to spread and penetrate greasy or oily dirt, emulsifying it so it can be rinsed away, whereas ordinary water cannot effectively remove non-polar substances.

(b) Find the energy stored in a steel wire of length 4 m and cross-section area of 3×10^{-6} m² when extended by 1 mm, given the Young’s modulus of steel wire = 2×10^{11} Pa.

Using:
Energy = ½ × (Force × Extension)
Force (F) = Y × A × e / L

$F = 2 \times 10^{11} \times 3 \times 10^{-6} \times (0.001 / 4)$
$= 1.5 \times 10^2$ N

Energy = ½ × F × e
$= ½ \times 1.5 \times 10^2 \times 0.001$
$= 0.075$ J

Energy stored = 0.075 J

5. Differentiate the following terms as applied in Fluid Mechanics:

(a) Viscous fluid and streamline flow.

A viscous fluid resists motion due to internal friction between its layers, while a streamline flow is a smooth, orderly flow of fluid where all particles follow parallel paths without crossing.

(b) Compressible fluid and incompressible fluid.

A compressible fluid changes its density significantly under pressure, like gases, while an incompressible fluid maintains a constant density regardless of pressure changes, typically liquids.

6. State: (a) Two differences between progressive and stationary waves.

   - Progressive waves transfer energy from one point to another, while stationary waves do not transfer energy but instead form fixed nodes and antinodes.
   - In progressive waves, all points have different phases except at a specific distance, while in stationary waves points between two nodes oscillate in phase.

   (b) Four methods used to form interference patterns.

   - By using two coherent light sources.
   - By using thin films such as soap bubbles.
   - By using diffraction gratings.
   - By using division of wavefront or division of amplitude techniques.

7. Outline four importance of teacher's guide book in teaching Physics subject.

   - It provides a clear sequence and scope of topics to be taught.
   - It suggests appropriate teaching aids and experiments.
   - It outlines expected learning outcomes for each lesson.
   - It offers standard assessment techniques and sample questions.

8. Give four measures to be considered in ensuring safety in a Physics laboratory.

   - Use of appropriate safety equipment like goggles and gloves.
   - Proper labeling and storage of chemicals and apparatus.
   - Supervising students closely during practicals.
   - Clear marking of emergency exits and provision of fire extinguishers.

9. Argue using four points the statement, "before conducting any physics lesson a teacher must prepare a lesson plan".

   - A lesson plan organizes content and teaching procedures, ensuring logical and effective delivery.
   - It helps in selecting appropriate resources and experiments for clear demonstrations.
   - It ensures all necessary safety precautions and setups are considered in advance.
   - It provides a basis for assessing learner progress through clearly stated objectives.

10. Show the four basic rules under the principle "students learn better when they approach materials from simple ideas to complex" when teaching and learning physics.

    - Begin with concrete, observable phenomena before introducing abstract concepts.
    - Introduce basic terms and principles before applying them in complex problem-solving.
    - Start with familiar, real-life examples before tackling theoretical explanations.
    - Proceed gradually from simple measurements and setups to detailed, multi-step experiments.

SECTION B (30 Marks)

Answer two questions from this section. Each question carries 15 marks.

11. (a) Explain why Ohm's law cannot be verified using a filament lamp.

Ohm's law states that the current through a conductor is directly proportional to the potential difference across it, provided temperature remains constant. In a filament lamp, as the current increases, the temperature of the filament rises significantly, increasing its resistance. This causes the current-voltage relationship to become non-linear, making it impossible to verify Ohm's law.

(b) Explain why the electrical conductivity of electrolytes is less than that of metals.

In metals, electrical conductivity is due to the free movement of electrons, which are lighter and move faster. In electrolytes, conductivity relies on the movement of positive and negative ions, which are heavier than electrons and move slower, causing a lower rate of charge transfer and hence lower conductivity.

(c) Find the time used to deposit 0.254 kg of copper on the cathode of a copper voltammeter when a steady current of 100 A is maintained.

Using:
$m = (M \times I \times t) / (n \times F)$

Where:
$m = 0.254$ kg $= 254$ g
$M = 63.5$ g/mol
$I = 100$ A
$n = 2$
$F = 96500$ C/mol

$t = (m \times n \times F) / (M \times I)$
$= (254 \times 2 \times 96500) / (63.5 \times 100)$
$= (49068000) / 6350$
$= 7726.3$ seconds

Time $= 7726.3$ s ≈ 2.15 hours

12. (a) Estimate the steady temperature of the filament when the tungsten filament of an electric lamp has a length of 0.5 m and a diameter of 6×10^{-5} m and the power rating of the lamp is 60 W. Assuming that the radiation from the filament lamp is equivalent to 80% of a perfect black body radiator at the same temperature.

Using:
$P = e \sigma A T^4$

Where:
$P = 60$ W
$e = 0.8$
$\sigma = 5.67 \times 10^{-8}$ W/m²K⁴
$A = \pi d L = 3.142 \times 6 \times 10^{-5} \times 0.5 = 9.426 \times 10^{-5}$ m²

$T^4 = P / (e \sigma A)$
$= 60 / (0.8 \times 5.67 \times 10^{-8} \times 9.426 \times 10^{-5})$
$= 60 / (4.278 \times 10^{-12})$
$= 1.402 \times 10^{13}$

$T = (1.402 \times 10^{13})^{1/4}$
$= 3187$ K

Steady temperature ≈ 3187 K

(b) Determine the thickness of brick which conduct the same quantity of heat per second per unit area as 0.1 m of air given that a cavity wall is made of a 0.1 m thick bricks with an air space of 0.1 m thick between them. Assuming the thermal conductivity of brick is 20 times that of air.

Let k_a = thermal conductivity of air
Then, $k_\beta = 20\ k_a$

Equal heat transfer means:
$(k_a / 0.1) = (20\ k_a / d)$

$d = 20 \times 0.1$
$d = 2$ m

Thickness of brick = 2 m

13. (a) Explain the basic condition for proper functioning of transistor as an amplifier.

For a transistor to function as an amplifier, the emitter-base junction must be forward-biased while the collector-base junction must be reverse-biased. This allows the transistor to control a large collector current using a small base current.

(b) Use the circuit shown in Figure 1 to calculate the load resistor RL, base current IB and the base resistor RB, given beta = 100.

values:
Vcc = 12 V
Vbe = 0.7 V
Ic = 2 mA

RL = (Vcc - Vce) / Ic
Assume Vce = 6 V
RL = (12 - 6) / 0.002
= 6 / 0.002
= 3000 Ω

IB = Ic / β
= 0.002 / 100
= 20 μA

RB = (Vcc - Vbe) / IB
= (12 - 0.7) / 20 × 10^{-6}
= 11.3 / 20 × 10^{-6}
= 565 kΩ

(c) Required the candidates to derive a truth table for the circuit shown in Figure 2.

Figure 2 is a two-input AND gate.

A	B	Output
0	0	0
0	1	0
1	0	0
1	1	1

SECTION C (30 Marks)

Answer two questions from this section. Each question carries 15 marks.

14. (a) Differentiate between general instructional objectives and specific instructional objectives as used in a lesson plan.

General instructional objectives are broad statements indicating what the teacher aims to achieve by the end of a lesson or course. Specific instructional objectives are precise, measurable actions that students should be able to perform by the end of a particular lesson.

(b) Candidates were required to explain by giving three reasons why the "instructional objectives" and "reinforcement stage of a lesson plan" are important in teaching Physics.

Instructional objectives guide the teacher in selecting appropriate content, resources, and teaching methods.

They help in assessing whether learning goals have been achieved by matching outcomes with the objectives.

They assist learners in focusing on key points during the lesson.

The reinforcement stage consolidates knowledge, ensures learners grasp key concepts, and corrects misconceptions before proceeding.

15. (a) Give five advantages of using multiple choice items in Physics test.

They allow objective marking since each question has only one correct answer.

They can test a wide range of content areas in a relatively short period.

They are easy to administer and quick to score, whether manually or by machine.

They minimize the influence of writing skills on the assessment of subject knowledge.

They are suitable for assessing different levels of cognition, including application and analysis, when well-constructed.

(b) Study a table of specification and to answer the questions that follow:

(i) Which learning objectives were given equal emphasis in the test.

Remembering, Understanding, and Applying were given equal emphasis since each appears five times across the content areas.

(ii) Which content were least emphasized in the test.

Sustainable energy sources was least emphasized since it had the fewest total items allocated to it.

(iii) How many test items were set on Forces in equilibrium and Temperature?

Forces in equilibrium had a total of 5 items (1+1+1+0+1+1 = 5)
Temperature had a total of 7 items (2+1+1+2+0+1 = 7)

(iv) How many test items were set for the summative test?

Summing all the items:
Forces in equilibrium = 5
Simple machines = 7
Motion in a straight line = 4
Temperature = 7
Sustainable energy sources = 3

Total = 5 + 7 + 4 + 7 + 3 = 26 items

(v) What percentage of the test items was devoted to simple machines?

(7 / 26) × 100 = 26.92%

(vi) What percentage of the test items was devoted to analyzing?

Analyzing items appear in:
Simple machines = 2
Temperature = 2

Total analyzing items = 4
Percentage = (4 / 26) × 100 = 15.38%

(vii) Explain three criteria that have been considered to determine the relative weight of each learning objective and area content.

The significance of the topic in achieving the overall Physics syllabus objectives, giving more weight to essential content.

The difficulty level of the content, ensuring a balance of simple, moderate, and complex questions across objectives.

The allocated teaching time for each topic, with topics requiring more classroom hours receiving more test items.

16. As prospective Physics teachers, show six steps to be followed when teaching the topic of "global warming" using cooperative and participatory methods to Form Four students.

Begin by stating clear lesson objectives related to global warming, such as identifying causes, effects, and control measures.

Introduce the topic through a brainstorming session or a short video presentation to activate prior knowledge and interest.

Divide students into small groups, assigning each group a specific aspect of global warming such as causes, effects, or mitigation strategies for research and discussion.

Facilitate group presentations where each team shares their findings while the teacher moderates and supplements information.

Conduct a class-wide discussion or debate on possible solutions and responsibilities at individual, national, and global levels.

Conclude with a summary of key points, reinforcing knowledge through a brief quiz, reflective questions, or written notes.