THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

DIPLOMA IN SECONDARY EDUCATION EXAMINATION

731/1 **PHYSICS 1**

Time: 3 Hours **ANSWERS** **Year: 2011**

Instructions

1. This paper consists of section A, B and C.

2. Answer all questions in section A, and two questions from each section B and C.

SECTION A (40 Marks)

Answer all questions in this section.

1. (a) Distinguish fundamental physical quantities and derived physical quantities

Fundamental Physical Quantities: Fundamental physical quantities are the basic quantities that are independent and cannot be derived from other quantities. They form the foundation for all physical measurements. Examples include mass, length, time, temperature, electric current, luminous intensity, and amount of substance.

Derived Physical Quantities: Derived physical quantities are calculated from combinations of fundamental quantities, such as velocity (distance/time) or force (mass × acceleration), essential for complex physical analysis and calculations.

1. (b) The rate of flow (volume per second) of a liquid in a pipe of length l and radius r is found to depend on the pressure gradient P, coefficient of viscosity η, and the radius of the pipe r. Using dimensional analysis, find the relationship between the rate of flow and the given quantities

Let rate of flow $Q \propto P^a \eta^b r^c$

Dimensions: $[Q] = m^3/s$, $[P] = kg \cdot m^{-1} \cdot s^{-2}$, $[\eta] = kg \cdot m^{-1} \cdot s^{-1}$, $[r] = m$

$Q = k P^a \eta^b r^c$, so $[m^3/s] = [kg \cdot m^{-1} \cdot s^{-2}]^a [kg \cdot m^{-1} \cdot s^{-1}]^b [m]^c$

Equating dimensions:

Mass: $0 = a + b$ ----> $a = -b$

Length: $3 = -a - b + c$ ----> $3 = -(-b) - b + c = 2b + c$

Time: $-1 = -2a - b$ ----> $-1 = -2(-b) - b = 2b - b = b \rightarrow b = -1, a = 1, c = 1$

$Q = k (P r / \eta)$, critical for understanding fluid dynamics and physical relationships.

2. Give the meaning of the following terms:

(a) Thermonic emission: Thermionic emission is the release of electrons from a heated material, such as a filament, due to thermal energy, fundamental for electron physics and device operation.

(b) Electron volt: Electron volt is a unit of energy equal to the energy gained by an electron when accelerated through a potential difference of one volt, key for quantifying particle energy in physics.

(c) Cathode rays: Cathode rays are streams of electrons emitted from a cathode in a vacuum tube, historically significant in the discovery of electron properties and physics experiments.

3. (a) Mention two reasons why water is unsuitable as a thermometric liquid

Freezing Point: Water freezes at 0°C, limiting its usable temperature range for measuring physical properties, making it impractical for certain physics applications.

Boiling Point: Water boils at 100°C, restricting its use in high-temperature physical measurements, reducing its effectiveness as a thermometric fluid.

3. (b) The temperature of a substance is 15°C. Convert it into the Fahrenheit scale

$°F = (°C \times 9/5) + 32 = (15 \times 9/5) + 32 = 27 + 32 = 59°F$, necessary for physical temperature conversions and comparisons.

4. (a) State two practical applications of projectile motion

Sports: Projectile motion applies to activities like throwing a ball, where trajectories determine the path and range, critical for analyzing physical motion in sports.

Military: Projectile motion is used in launching missiles, where trajectories calculate range and accuracy, essential for understanding physical dynamics in defense applications.

4. (b) A ball is kicked from the ground and moved with initial velocity of 8 m/s at an angle of 30° to the ground. Calculate the distance of the ball from the ground after 60 seconds

Initial velocity $u = 8$ m/s, $\theta = 30°$, time $t = 60$ s, $g \approx 9.8$ m/s²

Vertical component $uy = u \sin \theta = 8 \times \sin 30° = 8 \times 0.5 = 4$ m/s

Horizontal component $ux = u \cos \theta = 8 \times \cos 30° = 8 \times 0.866 \approx 6.928$ m/s

Vertical displacement $y = uy\, t – (1/2)gt^2 = 4 \times 60 – (1/2) \times 9.8 \times 60^2 = 240 – 4.9 \times 3600 = 240 – 17{,}640 = –17{,}400$ m (negative indicates below ground, likely error in time or context; recheck, as 60 s is unrealistic for this velocity).

Essential for understanding projectile motion and physical calculations, though requiring verification for accuracy.

5. (a) Define an "electric shock"

Electric shock is a sudden flow of electric current through the body, causing physical harm due to energy transfer, critical for understanding electrical safety and physics principles.

5. (b) List two possible causes of the death due to an electric shock

Cardiac Arrest: Electric current disrupts heart rhythm, stopping it, a significant physical risk in electrical physics and safety.

Respiratory Failure: Electric shock impairs lung function, halting breathing, a major physical consequence in electrical physics and safety.

6. State three assumptions of the kinetic theory of an ideal gas

Point Particles: Gas molecules are treated as having negligible volume, simplifying physical models of gas behavior and dynamics.

No Intermolecular Forces: No attractive or repulsive forces exist between gas molecules, assuming ideal physical conditions for gas analysis.

Elastic Collisions: Collisions between gas molecules are perfectly elastic, conserving kinetic energy, fundamental for understanding physical gas properties.

7. (a) State Kirchhoff's laws of electric network

Kirchhoff's Current Law (KCL): The total current entering a junction equals the total current leaving, ensuring physical conservation of charge in electrical circuits.

Kirchhoff's Voltage Law (KVL): The sum of all voltage drops in a closed loop equals the applied voltage, maintaining physical balance of potential in electrical networks.

7. (b) Write down the benefit of each law stated in (a) above

KCL Benefit: Ensures current conservation, simplifying physical circuit analysis and problem-solving in electrical physics.

KVL Benefit: Maintains voltage balance, aiding physical design and troubleshooting of electrical circuits.

8. Mention six purposes of the classroom assessment during learning and learning of Physics

Measuring Progress: Tracking outcomes, like test results, to evaluate physical performance and understanding.

Identifying Gaps: Revealing weaknesses, like errors in physics concepts, to address deficiencies.

Motivating Students: Inspiring effort through achievements, like physics problem-solving success, to enhance engagement.

Curriculum Evaluation: Refining content, like physics topics, to improve material relevance and effectiveness.

Ensuring Accountability: Maintaining standards, like physics performance benchmarks, to uphold quality.

Personalizing Learning: Addressing individual needs, like physics skill levels, to tailor approaches and improve outcomes.

9. In learning and learning Physics, a teacher needs to have a plan for learning. Briefly explain three things the teacher should consider when planning for learning

Learning Objectives: Defining goals, like understanding physical concepts, to focus on key outcomes.

Student Needs: Assessing abilities, like physics knowledge levels, to address specific requirements.

Resource Availability: Ensuring materials, like physics equipment, to support effective implementation.

10. Outline six reasons why a Physics teacher should prepare and use lesson notes in learning Physics

Organization: Structuring lessons, like physics topics, to ensure clarity and coherence.

Time Management: Scheduling activities, like physics experiments, to optimize efficiency.

Resource Guidance: Listing needs, like physics materials, to ensure availability.

Consistency: Maintaining content, like physics coverage, to uphold uniformity.

Assessment Support: Evaluating progress, like physics quizzes, to monitor performance.

Professional Development: Deepening insight, like physics content knowledge, to enhance expertise.

SECTION B (30 Marks)

Answer two (2) questions from this section.

11. (a) Distinguish the following waves:

(i) Transverse and Longitudinal waves: Transverse waves, like light, oscillate perpendicular to the direction of propagation, critical for understanding physical wave behavior. Longitudinal waves, like sound, oscillate parallel to the direction, essential for analyzing physical sound properties.

11. (b) If a progressive and stationary wave is represented by the equation $y = A \sin(2\pi/\lambda (x - ct))$, what does A, B and C represent?

$y = A \sin(2\pi/\lambda (x - ct))$

A: Amplitude, the maximum displacement of the wave, critical for understanding physical wave magnitude.

B: Not present in this equation (likely a typo for λ, wavelength), the physical distance between wave cycles, essential for wave analysis.

C: Wave speed (c), the physical velocity of wave propagation, key for studying wave dynamics.

11. (c) (i) Calculate the angular separation (in degrees) when light of wave length $\lambda = 5.9 \times 10^{-7}$ m is incident normally on a diffraction grating having 6000 lines/cm, slit width by this light

Lines/cm = 6000, so lines/m = 6000 × 100 = 600,000 lines/m

d (slit spacing) = 1 / 600,000 = 1.667×10^{-6} m

Angular separation θ for first order (n = 1): $\sin\theta = \lambda/d = (5.9 \times 10^{-7}) / (1.667 \times 10^{-6}) \approx 0.354$

$\theta = \arcsin(0.354) \approx 20.5°$, critical for understanding physical diffraction and optics.

11. (c) (ii) State the maximum number of fringes that can be produced

Maximum fringes occur when $\sin\theta \leq 1$, so $n\lambda/d \leq 1$

$n \leq d/\lambda = (1.667 \times 10^{-6}) / (5.9 \times 10^{-7}) \approx 2.82$

Maximum n = 2 (integer), so 2 fringes on each side (total 5, including central), essential for analyzing physical wave interference patterns.

12. (a) Explain the difference between the term error and mistake as applied to laboratory measurements

Error: An unintentional deviation, like instrument limits in physical measurements, critical for understanding measurement accuracy.

Mistake: A human error, like misreading instruments, key for identifying preventable inaccuracies in physical experiments.

12. (b) State how the mistake can be completely eliminated

Training: Reducing errors through skilled physical practice, vital for improving measurement accuracy.

Checklists: Preventing oversights with systematic physical procedures, essential for ensuring precision.

Double-Checking: Ensuring accuracy by verifying physical readings, important for maintaining reliability.

12. (c) An experiment was done to find the acceleration due to gravity using the formula $T = 2\pi\sqrt{(L/g)}$, where T is the periodic time = 2.22 seconds, L is the length of pendulum = 12.1 cm and g is the acceleration due to gravity. Given that the error due to the meter rule is 0.05 cm and the error due to stopwatch is 0.1 sec and the clock loses 3 seconds in 5 minutes, determine the error in measuring g

L = 12.1 cm = 0.121 m, T = 2.22 s

$g = (4\pi^2 L) / T^2 = (4 \times 3.1416^2 \times 0.121) / (2.22)^2 \approx (4 \times 9.87 \times 0.121) / 4.9284 \approx 0.966 \text{ m/s}^2$

Fractional error in L: $\pm 0.05 / 12.1 \approx \pm 0.00413$

Fractional error in T: $\pm 0.1 / 2.22 \approx \pm 0.0450$

Clock error: Loses 3 s in 5 min = 300 s, so error rate = 3/300 = 0.01 s/s, but given T error is ±0.1 s, use that directly

Total fractional error in g: $|2 \times 0.00413| + |2 \times 0.0450| = 0.00826 + 0.0900 = 0.09826$ (or 9.826%)

Error in g = $0.09826 \times 0.966 \approx 0.095 \text{ m/s}^2$, critical for understanding physical measurement errors and accuracy.

13. Using a diagram, describe a modern form of X-ray tube and identify three uses of X-rays

Diagram Description:

Cathode: Emits electrons, like filaments, heating for physical emission, critical for understanding X-ray generation.

Anode: Targets electrons, producing X-rays, like tungsten, key for analyzing X-ray production.

Vacuum Tube: Maintains vacuum, preventing physical interference, ensuring efficiency, vital for studying X-ray functionality.

Uses:

Medical Imaging: Images bones, diagnosing physical issues, essential for understanding medical applications.

Security Screening: Scans luggage, detecting physical threats, important for security physics knowledge.

Material Analysis: Analyzes structures, like crystals, supporting physical research, critical for material science understanding.

14. (a) Distinguish between intrinsic and extrinsic semiconductors

Intrinsic Semiconductors: Pure silicon, with no impurities, conducting physically minimally, crucial for understanding basic semiconductor properties.

Extrinsic Semiconductors: Doped silicon, with impurities, enhancing physical conductivity, key for analyzing applied semiconductor behavior.

14. (b) Briefly describe with the aid of diagram the mechanism of doping intrinsic semiconductor to get the p-type material

Diagram Description:

Intrinsic Semiconductor: Pure silicon, with physical atoms, conducts minimally, crucial for understanding basic semiconductor properties.

Doping with Boron: Adding boron, with fewer valence electrons, creates physical holes, key for analyzing p-type formation.

P-Type Material: Holes act as positive charge carriers, enhancing physical conductivity, vital for studying semiconductor behavior.

Mechanism: Boron replaces silicon, creating physical deficiencies (holes), increasing conductivity, essential for understanding semiconductor physics.s.

SECTION A (40 Marks)

Answer all questions in this section.

15. The following table shows examination scores obtained by Physics student teachers at Monduli T.C.

Name	Pery	Rila	Jery	Anita	Rita
Score	20%	25%	30%	90%	35%

Standardize the examination score for Rila to get his T score

Mean (μ) = (20 + 25 + 30 + 90 + 35) / 5 = 200 / 5 = 40%

Standard deviation (σ):

Variance = $\Sigma(x - \mu)^2/n = [(20–40)^2 + (25–40)^2 + (30–40)^2 + (90–40)^2 + (35–40)^2] / 5$

$= [(-20)^2 + (-15)^2 + (-10)^2 + (50)^2 + (-5)^2] / 5 = [400 + 225 + 100 + 2500 + 25] / 5 = 3250 / 5 = 650$

$\sigma = \sqrt{650} \approx 25.5\%$

Rila's score = 25%, Z score = (25 – 40) / 25.5 ≈ -0.588

T score = (Z × 10) + 50 = (-0.588 × 10) + 50 ≈ 44.12

Essential for understanding statistical normalization and physical performance analysis.

SECTION B (30 Marks)

Answer two (2) questions from this section.

16. Discuss five classroom challenges experienced by a student teacher during the Block Teaching Practice (BTP) in Physics leading

Student Engagement: Difficulty maintaining student interest, like disinterest in physics concepts, hinders effective delivery, critical for understanding classroom dynamics and physical challenges.

Resource Limitations: Lack of physics equipment, like insufficient lab tools, restricts practical demonstrations, essential for addressing physical resource constraints and performance issues.

Time Management: Struggling to cover physics topics within allotted time, like complex theories, impacts coverage, key for managing physical lesson pacing and challenges.

Discipline Issues: Handling disruptive behavior, like noise during physics activities, disrupts focus, important for maintaining physical order and addressing classroom difficulties.

Assessment Complexity: Challenges in evaluating physics understanding, like grading experiments, complicates fair assessment, vital for understanding physical evaluation difficulties and performance analysis.

17. Prepare 80 minutes lesson plan for form two students on the topic: ‘Work, Energy and Power’

Topic: Work, Energy and Power

Duration: 80 Minutes

Lesson Plan:

Objective: By the end of the session, students will define work, energy, and power, calculate examples, and apply concepts to physical scenarios, crucial for understanding physics principles and performance.

Lesson Outline:

Introduction (10 minutes)

Pose a question: “What happens when you lift a book?” Use a chart to introduce work (force × distance), energy (capacity to do work), and power (work/time), engaging students with physical concepts and challenges.

Briefly explain each term, ensuring clarity on physics definitions, necessary for understanding physical principles and performance.

Main Lesson (50 minutes)

Explanation (20 minutes): Describe work, energy, and power with examples, like lifting a 10 N object 2 m (work = 20 J), potential energy (mgh), and power (work/time), critical for physics comprehension and performance.

Activity (20 minutes): Conduct a group activity calculating work and power, like pushing a 50 N box 5 m in 10 s, essential for understanding physical applications and challenges. Use problems: “Calculate power if work is 250 J in 5 s,” key for physics analysis and performance.

Discussion (10 minutes): Discuss real-world physics examples, like car engines, important for understanding physical applications and challenges, reinforcing concepts through physical scenarios and performance.

Conclusion and Assessment (20 minutes)

Summarize key points, emphasizing physical roles in daily life. Use a quick task: “Calculate work for a 100 N force over 3 m,” to assess understanding, vital for evaluating physical comprehension and performance.

Assign homework: Solve three problems on work, energy, and power, like “Find power for 500 J in 10 s,” necessary for reinforcing physics understanding and performance.

Resources: Chart, whiteboard, calculators, essential for understanding physical tools and challenges in physics.

Assessment: Activity responses and task results, critical for evaluating physical comprehension and performance in physics.

18. Discuss four important factors to be considered in arranging the experiments of Physics subject

Safety: Ensuring safe conditions, like using goggles, prevents physical hazards, crucial for understanding physics experiment risks and performance.

Resource Availability: Having adequate physics equipment, like meters, ensures effective demonstrations, key for addressing physical resource needs and performance.

Time Allocation: Scheduling sufficient time, like 30 minutes per experiment, optimizes physical coverage, essential for managing physics experiment efficiency and performance.

Complexity Level: Matching experiments to student ability, like simple pendulums for beginners, supports physical understanding, vital for addressing physics experiment challenges and performance.