THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

DIPLOMA IN SECONDARY EDUCATION EXAMINATION

731/1 **PHYSICS 1**

Time: 3 Hours **ANSWERS** **Year: 2009**

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.

1. (a) What is meant by the term random error?

A random error is an error that occurs due to unpredictable variations in measurement conditions, affecting the accuracy and precision of results. These errors arise due to factors such as slight changes in experimental conditions, limitations in instruments, and human perception errors.

(b) Using two relevant examples, explain the cause of random errors.

One example of a random error is measuring the length of an object using a ruler multiple times and obtaining slightly different values each time due to inconsistent eye positioning. Another example is measuring the time of a falling object with a stopwatch, where reaction time variation causes small differences in recorded values.

2. The resistance force F opposing a small sphere of radius r moving with uniform velocity V through a fluid of viscosity η is given by $F = 6\pi\eta rV$. Show that this equation is dimensionally correct.

To check the dimensional correctness of the equation, we analyze the dimensions of each term:

The left-hand side, force F, has dimensions:
$F = \text{mass} \times \text{acceleration} = MLT^{-2}$

The right-hand side:
Viscosity η has dimensions $ML^{-1}T^{-1}$
Radius r has dimensions L
Velocity V has dimensions LT^{-1}

Multiplying these:
$(ML^{-1}T^{-1}) \times (L) \times (LT^{-1}) = MLT^{-2}$

Since both sides have the same dimensions, the equation is dimensionally correct.

3. (a) Explain the following terms as applied to fluid mechanics.

(i) Viscous fluid

A viscous fluid is a type of fluid that resists motion due to internal friction between its layers. The resistance is due to intermolecular forces, which make the fluid flow more slowly when subjected to an external force.

(ii) Turbulent flow

Turbulent flow is a type of fluid motion characterized by chaotic changes in pressure and velocity. Unlike laminar flow, where fluid moves in parallel layers, turbulent flow involves irregular eddies, swirls, and rapid variations in velocity.

(b) What is meant by the term incompressible fluid as applied to fluid flow?

An incompressible fluid is a fluid whose density remains constant regardless of pressure changes. This assumption is often used in fluid dynamics to simplify calculations, particularly for liquids, which have very low compressibility.

4. (a) Define simple harmonic motion.

Simple harmonic motion (SHM) is a type of periodic motion in which a particle moves back and forth along a straight path under the influence of a restoring force proportional to its displacement from the equilibrium position.

(b) A particle is moving with simple harmonic motion. Write the relation between:

(i) Force and displacement of the particle

The force acting on a particle in simple harmonic motion is given by $F = -kx$, where k is the force constant and x is the displacement. The negative sign indicates that the force always acts toward the equilibrium position.

(ii) Velocity and time

The velocity of a particle in simple harmonic motion is given by $v = A\omega \cos(\omega t + \varphi)$, where A is the amplitude, ω is the angular frequency, t is time, and φ is the phase constant. The velocity varies sinusoidally over time.

5. Assume that the human body has a total surface area of 1.18 m^2 and the surface temperature of 30°C. Find the total rate of radiation of energy from the body if the emissive power of the body is 30%.

Using Stefan-Boltzmann's law:
$P = e\sigma AT^4$
where $e = 0.30$ (emissivity), $\sigma = 5.67 \times 10^{-8}$ W/m^2K^4 (Stefan's constant), $A = 1.18$ m^2, and $T = (30 + 273)K = 303$ K.

$P = 0.30 \times (5.67 \times 10^{-8}) \times (1.18) \times (303)^4$
$= 0.30 \times (5.67 \times 10^{-8}) \times (1.18) \times (8.4 \times 10^9)$
$= 0.30 \times 5.67 \times 1.18 \times 8.4 \times 10^{-8} \times 10^9$
$= 0.30 \times 56.2 \times 10^{-8+9}$
$= 0.30 \times 56.2 \times 10^1$
$= 16.86$ W

The total rate of radiation of energy from the body is 16.86 W.

6. (a) Give the meaning of

(i) Atomic number

The atomic number is the number of protons in the nucleus of an atom. It determines the element's identity and its position in the periodic table.

(ii) Mass number

The mass number is the total number of protons and neutrons in the nucleus of an atom. It represents the atom's overall mass.

(b) A radioactive element of mass 218 and atomic number 84 disintegrates with the emission of an α-particle. What might be the atomic number and mass number of the new element?

An alpha particle has 2 protons and 2 neutrons. When emitted, the atomic number decreases by 2 and the mass number decreases by 4.

New atomic number = 84 - 2 = 82
New mass number = 218 - 4 = 214

The new element is lead (Pb) with atomic number 82 and mass number 214.

7. (a) What is meant by the term half-life?

Half-life is the time required for half of the radioactive atoms in a sample to decay into stable products. It is a constant property of each radioactive isotope.

(b) Show that the half-life of a given substance is given by $T = 0.693/\lambda$.

The decay law is $N = N_0e^{-\lambda t}$, where λ is the decay constant. When $t = T$ (half-life), $N = N_0/2$. Substituting,

$N_0/2 = N_0e^{-\lambda T}$
Dividing both sides by N_0,

$1/2 = e^{-\lambda T}$
Taking the natural logarithm,

$\ln(1/2) = -\lambda T$
Since $\ln(1/2) = -0.693$,

$-0.693 = -\lambda T$

$T = 0.693/\lambda$

8. (a) What are cathode rays?

Cathode rays are streams of high-speed electrons emitted from the negative electrode (cathode) of a vacuum tube when a high voltage is applied.

(b) Mention three properties of cathode rays.

Cathode rays travel in straight lines in the absence of an electric or magnetic field.
They carry negative charge and are deflected by electric and magnetic fields.
They can cause fluorescence when they strike certain materials.

9. (a) State Ohm's law.

Ohm's law states that the current passing through a conductor is directly proportional to the voltage across it, provided that the temperature remains constant. Mathematically, V = IR.

(b) Differentiate ohmic conductors from non-ohmic conductors.

Ohmic conductors obey Ohm's law, meaning their resistance remains constant as voltage and current change, e.g., metallic wires. Non-ohmic conductors do not obey Ohm's law, meaning their resistance varies with applied voltage or temperature, e.g., diodes and thermistors.

10. It is believed that the interior part of the earth (the core) is in molten form. What seismic evidence supports this belief?

Seismic evidence supporting the belief that the Earth's core is molten includes the behavior of seismic waves. Primary waves (P-waves) can travel through both solid and liquid, while secondary waves (S-waves) can only travel through solids. When an earthquake occurs, S-waves do not pass through the Earth's outer core, creating an S-wave shadow zone. This indicates that the outer core is liquid. Additionally, P-waves slow down and bend when passing through the outer core, further confirming its molten nature.

11. (a) Describe five principles of teaching and learning Physics.

The principle of activity-based learning states that students learn Physics better through hands-on activities such as experiments and demonstrations rather than passive listening.

The principle of linking theory with practice emphasizes that Physics concepts should be connected to real-life applications to enhance understanding and interest in the subject.

The principle of gradual progression suggests that complex Physics topics should be introduced progressively, starting from simple concepts before advancing to more difficult ones.

The principle of student-centered learning promotes engaging students in problem-solving and discussions rather than relying solely on teacher-centered instruction.

The principle of clarity and precision in teaching stresses that explanations and demonstrations should be clear, concise, and logically structured to avoid confusion.

(b) Explain the significance of the principles in (a) above.

Activity-based learning helps students develop critical thinking skills and a deeper understanding of Physics concepts through experimentation.

Linking theory with practice makes learning more meaningful and motivates students by showing the real-world relevance of Physics.

Gradual progression helps students build a strong foundation, reducing the difficulty of grasping advanced concepts.

Student-centered learning increases engagement and encourages independent thinking, fostering a better understanding of Physics.

Clarity and precision in teaching ensure that students grasp concepts correctly, reducing misconceptions and enhancing retention of knowledge.

12. Any Physics teacher needs to know Physics laboratory rules before conducting experiments in the laboratory.

(a) Explain four laboratory rules that are supposed to be known by a Physics teacher.

A teacher must ensure that students wear appropriate safety gear, such as lab coats and goggles, to protect against potential hazards.

A teacher should instruct students to handle electrical equipment properly to prevent electric shocks and short circuits.

A teacher must ensure that chemicals and experimental materials are labeled correctly and used safely to avoid accidents.

A teacher should emphasize the importance of maintaining cleanliness in the laboratory by keeping workstations organized and disposing of waste materials properly.

(b) Mention five sources of accidents in a Physics laboratory.

Spillage of liquids, especially chemicals, can cause slipping hazards and chemical burns.

Faulty or improperly connected electrical equipment can lead to electric shocks or short circuits.

Improper handling of glassware, such as test tubes and beakers, can result in breakage and injuries.

Failure to follow safety procedures, such as neglecting protective gear, can lead to burns or exposure to harmful substances.

Poor ventilation in the laboratory can cause inhalation of toxic fumes, leading to respiratory problems.

13. In test construction, moderation is crucial. Give four reasons for the moderation of Physics tests.

Moderation ensures that test questions are clear, unambiguous, and free from errors, improving the reliability of assessment results.

It helps maintain fairness by ensuring that the test aligns with the syllabus and does not favor or disadvantage any group of students.

Moderation enhances the validity of the test by confirming that the questions effectively measure the intended Physics knowledge and skills.

It prevents excessive difficulty or simplicity in questions, ensuring that the test accurately assesses students' abilities without being too challenging or too easy.

14(a) Explain briefly the importance of assessment in the teaching and learning of Physics.

Assessment is important in Physics as it helps evaluate students' understanding of concepts and their ability to apply knowledge. It enables teachers to identify learning gaps and adjust their teaching methods accordingly. Assessment also motivates students to study and improve their problem-solving skills. Additionally, it provides feedback to both students and educators, ensuring continuous improvement in learning outcomes.

14(b) In setting standard questions in Physics, we normally consider the Table of Specification by which levels of abilities and skills tested are indicated.

The Table of Specification ensures that questions assess different cognitive levels, such as knowledge, comprehension, and application. It helps in designing balanced examinations that fairly test students' understanding of various topics. This approach prevents bias and ensures that assessments measure a range of skills, from basic recall to critical thinking and problem-solving.

14(c) An essay question on the following:

(i) III, 5

Explain the phenomenon of dispersion and how it contributes to the formation of colors in different situations. Provide examples from daily life where dispersion is observed and describe the role of different wavelengths in color separation.

(ii) III, 4

Discuss the applications of lenses in optical instruments. Explain how different types of lenses work in devices such as microscopes, cameras, and telescopes. Use diagrams where necessary to support your explanation.

14(d) A multiple-choice item with four suggested answers on each of the following:

(i) I, 1

Which of the following best describes the nature of light?

A. Light travels in a straight line only in a vacuum.
B. Light exhibits both wave and particle properties.
C. Light cannot be refracted or reflected.
D. Light is a purely mechanical wave.

Correct answer: B. Light exhibits both wave and particle properties.

(ii) I, 4

Which optical instrument uses a convex lens to magnify small objects?

A. Telescope
B. Periscope
C. Microscope
D. Plane mirror

Correct answer: C. Microscope.

14(e) A structural (completion or fill-in-the-blanks) question on each of the following:

(i) I, 6

The production of sound waves involves the vibration of _____ through a medium.

(ii) II, 7

Waves can be classified based on their direction of vibration as either _____ or _____ waves.

(iii) III, 2

A concave mirror can be used to produce a real, inverted image when an object is placed _____.

15. Explain the procedures of helping a student who has suffered an electric shock.

First, turn off the power source to stop the flow of electricity. If it is not possible to switch off the power, use a non-conductive object, such as a wooden stick, to separate the student from the electric source.

Next, check if the student is conscious by talking to them and observing their response. If they are unconscious, immediately call for emergency medical assistance.

If the student is not breathing, begin CPR (cardiopulmonary resuscitation) by performing chest compressions and rescue breaths. Keep monitoring their pulse and breathing while waiting for help.

If the student has suffered burns, cover the affected area with a sterile cloth or bandage. Avoid applying ointments or ice to the burn.

Finally, keep the student calm and in a comfortable position. Continue observing their condition and reassure them while awaiting professional medical assistance.

16. Mr. Chapakazi has taught a topic called "work" to his Form II students. Prepare five (5) questions from that topic he might use to assess the learning achievement of his students.

1. Define the term "work" in Physics and state the SI unit used to measure it.
2. A person lifts a box of mass 10 kg to a height of 2 meters. Calculate the work done against gravity.
3. Explain the factors that affect the amount of work done on an object.
4. Differentiate between positive work, negative work, and zero work with examples.
5. Describe how the concept of work applies to simple machines such as pulleys and levers.

17. "On a rainy day during the school sports day, Rashid, the 100-metre runner, took 10 seconds to run the 100-metre race. Find his average speed."

(a) Moderate the above question.

Rashid participated in a 100-meter race during a school sports day. Due to the rainy conditions, he completed the race in 10 seconds. Calculate his average speed and express your answer in meters per second.

(b) Why do you think moderation is very important in test construction?

Moderation is important in test construction to ensure that questions are clear, fair, and appropriate for the students' level of understanding. It helps to eliminate ambiguity and ensures that the question measures the intended learning objective. Additionally, moderation prevents bias and maintains consistency in difficulty levels across different assessments.

18. Pressure depends on the area of contact. The larger the area, the lower the pressure for the same thrust. This is the conclusion of a lesson. Refer to your past experience of teaching the topic and answer the following questions.

(a) How would you introduce the lesson to your students?

I would introduce the lesson by demonstrating an experiment using a sharp knife and a blunt knife. I would ask students to compare the effort required to cut an object with each knife. This would help them observe how pressure is affected by the area of contact, making the concept easier to understand.

(b) What ideas do you think the students would give from the activities of the lesson?

Students might conclude that pressure increases when the force is applied over a smaller area and decreases when the force is distributed over a larger area. They may also relate the concept to real-life situations such as walking on sand with flat shoes versus high heels, or how a needle easily pierces fabric compared to a blunt object.