THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL OF TANZANIA

DIPLOMA IN SECONDARY EDUCATION EXAMINATION

731/1 **PHYSICS 1**

Time: 3 Hours **ANSWERS** **Year: 2020**

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. Show that the angular momentum and Planck's constant have the same physical units.

The angular momentum (L) of a particle is given by the formula:

$L = mvr$

where m is mass (kg), v is velocity (m/s), and r is radius (m). The units of angular momentum are:

$kg \times m/s \times m = kg \cdot m^2/s$

Planck's constant (h) has the unit of action, which appears in the equation:

$E = hf$

where E is energy (J) and f is frequency (s^{-1}). Since 1 joule (J) is $kg \cdot m^2/s^2$, Planck's constant has the units:

$J \cdot s = kg \cdot m^2/s^2 \times s = kg \cdot m^2/s$

Since both angular momentum and Planck's constant have the unit $kg \cdot m^2/s$, they share the same physical dimensions.

2. (a) Give the meaning of the term electrolysis.

Electrolysis is the process of chemical decomposition of a compound using an electric current. It occurs when an electric potential is applied across electrodes submerged in an electrolyte, causing ions to move and undergo redox reactions at the electrodes.

(b) Derive the chemical equations that will take place at the anode and cathode electrodes during the electrolysis of copper sulphate solution.

During electrolysis of $CuSO_4$ solution using copper electrodes:

At the cathode (reduction):
$Cu^{2+} + 2e^- \rightarrow Cu$

At the anode (oxidation):
$Cu \rightarrow Cu^{2+} + 2e^-$

If inert electrodes (like platinum) are used:

At the cathode:
$Cu^{2+} + 2e^- \rightarrow Cu$

At the anode:
$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$

3. A cart of mass 500 kg is standing at rest on the rail. If a man weighing 70 kg running parallel to the rail track with a velocity of 10 m/s jumps on the cart, compute the velocity with which the cart will start moving.

Using conservation of momentum:

Initial momentum = Final momentum

$0 + (70 \times 10) = (500 + 70) \times v$

$700 = 570v$

$v = 700/570$

$v = 1.23$ m/s

The cart will start moving at 1.23 m/s.

4. (a) What will be the effect on the temperature of the gas molecules inside the cooking gas cylinders in a lorry which is moving with uniform speed? Briefly explain.

The temperature of gas molecules inside the cylinders remains unchanged. Since the motion of the lorry does not influence molecular energy directly, temperature stays constant unless external heating or cooling occurs.

(b) Calculate the root mean square speed of carbon dioxide gas molecules at normal temperature and pressure, given molar gas constant $R = 8.31$ J mol^{-1} K^{-1}, molecular mass of $CO_2 = 44$ g/mol.

The root mean square speed is given by:

$v_{ms} = \sqrt{(3RT/M)}$

where $R = 8.31$ J mol^{-1} K^{-1}, $T \approx 273$ K (standard temperature), $M = 44 \times 10^{-3}$ kg/mol.

$v_{ms} = \sqrt{(3 \times 8.31 \times 273 / 0.044)}$

$v_{ms} = \sqrt{(6802.89)}$

$v_{ms} \approx 82.5$ m/s

5. (a) Describe the concept of colours of air film on water.

Thin-film interference occurs when light reflects off an air film on water, producing colors due to constructive and destructive interference of reflected light waves at different thicknesses.

(b) The shortest length of air column in a resonance tube with one end closed is resonated to a note of frequency 500 Hz and found to be 16 cm. Determine the velocity of a sound wave.

For a closed tube, the fundamental frequency is given by:

$v = 4fl$

where $f = 500$ Hz and $l = 0.16$ m.

$v = 4 \times 500 \times 0.16$

$v = 320$ m/s

6. How does heating of the body by thermal convection process occur?

Thermal convection occurs when warm fluid rises and cooler fluid sinks, forming a circulation pattern. In the human body, blood circulation transfers heat from the core to extremities, while surrounding air currents assist in heat dissipation.

7. Differentiate the following terms as applied in teaching and learning Physics:

(a) Teaching aids and improvisation

Teaching aids are pre-made materials that assist learning, while improvisation involves creating materials using locally available resources to enhance teaching.

(b) Curriculum and syllabus

A curriculum outlines the entire educational program, including objectives and assessment methods, while a syllabus is a specific outline of topics and content to be covered in a subject.

8. In four points, show how a physics teacher uses an “Observation Schedule” to assess student’s practical work.

A teacher can use an observation schedule to:

- Record students’ ability to handle laboratory apparatus correctly.
- Assess students’ accuracy in making measurements and recording data.

- Evaluate students' adherence to experimental procedures.
- Observe students' collaboration and communication skills during experiments.

9. With two examples in each case, describe two categories of Physics curriculum materials.

Printed materials include textbooks and laboratory manuals, which provide theoretical knowledge and practical guidelines. Non-printed materials include models and simulations, which help visualize abstract concepts.

10. Briefly describe four steps you would follow to provide first aid to an electric shock victim in a Physics laboratory.

- Turn off the power source or remove the victim using an insulated object.
- Check for breathing and pulse; if absent, perform CPR.
- Treat burns with clean, non-adhesive dressings.
- Seek medical attention immediately.

11. (a) With the aid of a well-labelled diagram, explain electrical properties of semiconductors based on the band theory of solids.

The electrical properties of semiconductors are explained using the band theory of solids, which describes energy bands in materials. In an intrinsic semiconductor, there is a valence band filled with electrons and a conduction band that is empty at absolute zero temperature. The small energy gap between these bands allows some electrons to move from the valence band to the conduction band at room temperature, leading to electrical conductivity.

When an external voltage is applied, electrons gain energy and move to the conduction band, leaving behind holes in the valence band. These holes act as positive charge carriers, contributing to current flow. The conductivity of a semiconductor can be enhanced by doping, where impurities are added to introduce extra free electrons (n-type) or holes (p-type). The band diagram of a semiconductor shows the conduction band, valence band, and energy gap between them, illustrating how electrons transition between these levels.

(b) Why n-p-n transistors are more commonly used than p-n-p transistors?

N-p-n transistors are preferred over p-n-p transistors because electrons, which are the majority charge carriers in n-p-n transistors, have higher mobility than holes, which dominate in p-n-p transistors. This higher mobility allows n-p-n transistors to operate at higher speeds and with greater efficiency. Additionally, n-p-n transistors have better performance in switching and amplification applications, making them more suitable for modern electronic circuits.

(c) What do each of the following symbols represent?

The symbols provided likely represent different electronic components, such as diodes, resistors, capacitors, or transistors. Without specific symbols given, a general approach is to interpret standard electronic symbols based on context.

12. (a) What are the characteristics of radioactive decay?

Radioactive decay is a spontaneous process in which unstable atomic nuclei emit radiation to achieve a more stable state. One characteristic is that it follows an exponential decay law, meaning the number of undecayed nuclei decreases over time in a predictable manner. Another feature is that the process is independent of external conditions like temperature and pressure, as it is governed by nuclear forces.

Additionally, radioactive decay occurs in different forms, such as alpha decay, beta decay, and gamma emission, each involving different types of particles or energy release. A key property is that decay is random on an atomic level but statistically predictable for a large sample, meaning it is impossible to determine when a particular atom will decay but possible to calculate the overall decay rate for a given substance.

(b) A half-life of a radioactive material contains 10^4 atoms is 2 days. Calculate the fraction remaining and the activity of the sample after 5 days.

The fraction remaining is calculated using the formula:

$N/N_0 = (1/2)^{(t/T)}$

where N is the remaining number of atoms, N_0 is the initial number of atoms, t is the elapsed time, and T is the half-life.

$N/N_0 = (1/2)^{(5/2)}$

$N/N_0 = (1/2)^{2.5}$

$N/N_0 = 0.177$

The activity (A) is given by:

$A = \lambda N_0$

where $\lambda = \ln(2)/T = 0.693/2 = 0.3465$ days^{-1}

$A = 0.3465 \times 10^4$

A = 3465 disintegrations per day

(c) Find the mass number and atomic number of the daughter nucleus. What will be the resultant mass number and atomic number of the daughter nucleus?

The mass number and atomic number of the daughter nucleus depend on the type of radioactive decay. In alpha decay, the mass number decreases by 4, and the atomic number decreases by 2. In beta decay, the atomic number increases or decreases by 1, but the mass number remains unchanged. Without specifying the decay type, the resultant values depend on the nature of the transformation.

13. (a) Show how the earth's climate is affected by the greenhouse effect.

The greenhouse effect is a natural process in which greenhouse gases, such as carbon dioxide, methane, and water vapor, trap heat within the Earth's atmosphere. This process maintains the planet's temperature at a level suitable for life. However, human activities, such as burning fossil fuels and deforestation, have increased greenhouse gas concentrations, leading to excessive heat retention.

This enhanced greenhouse effect results in global warming, causing rising temperatures, melting polar ice caps, and shifts in weather patterns. The climate is further affected by changes in ocean currents and an increase in extreme weather events such as hurricanes, droughts, and floods. Long-term impacts include disruptions to ecosystems, food production, and water resources, making climate change a serious environmental concern.

(b) Draw the vertical structure of the atmosphere and,

(c) Indicate the five layers from the surface of the Earth.

The vertical structure of the atmosphere consists of five major layers:

- Troposphere (0-12 km): The lowest layer where weather phenomena occur and temperature decreases with altitude.
- Stratosphere (12-50 km): Contains the ozone layer, which absorbs harmful ultraviolet radiation.
- Mesosphere (50-85 km): The coldest layer where meteors burn up upon entry.
- Thermosphere (85-600 km): A region of high temperatures due to absorption of solar radiation; also home to the auroras.
- Exosphere (600 km and beyond): The outermost layer where air gradually merges with space.

(d) State two importance of the first atmospheric layer from the surface of the solid earth.

The troposphere is crucial because it contains the oxygen necessary for life and regulates climate through weather processes. Additionally, it supports water cycles by facilitating cloud formation, precipitation, and temperature regulation.

14. Design a table which shows the lesson development part of a lesson plan of 80 minutes when you are planning to teach the concept of Friction Force in a Form Three class.

I will prepare and provide a downloadable table for this lesson plan.

15. Use six steps to show how a physics teacher can teach the concept of "Effect of Turning Forces" to Form Two students by the demonstration method.

A physics teacher can teach the concept by first introducing the concept of turning forces using simple real-life examples such as opening a door or using a spanner. The next step is to demonstrate the effect of force and distance from the pivot by using a ruler balanced on a fulcrum and applying weights at different distances.

Students should then be allowed to observe and predict how the turning effect changes with different force positions. The teacher should reinforce the principle by explaining the moment of force formula and solving simple problems. Next, students should engage in guided experiments to test their understanding, such as using levers with different weights and measuring the resulting torque.

Finally, the teacher should conclude by summarizing the key observations and linking them to real-world applications, such as how tools like wrenches or seesaws operate using the principle of turning forces.

16. "The principles of teaching and learning physics enable students to understand well the subject." Support this statement by using five points.

Teaching and learning physics effectively rely on principles that enhance conceptual understanding. One principle is active learning, where students engage in hands-on experiments and real-world applications, making abstract concepts more tangible.

Another principle is the use of multiple representations, such as diagrams, models, and simulations, to explain complex physical phenomena in a way that caters to different learning styles.

A third principle is the integration of problem-solving skills, encouraging students to analyze and apply physics concepts in various contexts rather than relying on memorization.

The fourth principle is scaffolding, where concepts are introduced progressively from simple to complex, allowing students to build a solid foundation before tackling advanced topics.

Lastly, assessment and feedback play a critical role, helping students identify areas of improvement and reinforcing correct understanding through continuous evaluation.