**THE UNITED REPUBLIC OF TANZANIA**

**NATIONAL EXAMINATIONS COUNCIL OF TANZANIA**

**CERTIFICATE OF SECONDARY EDUCATION EXAMINATION**

**031/1** **PHYSICS 1**

(For Both School and Private Candidates)

**Duration: 3 Hours** **SOLUTIONS** **Year: 2025**

## Instructions

1. This paper consists of sections A, B and C with a total of **eleven (11)** questions.
2. Answer **all** questions in section A and B and **two (2)** questions from section C.
3. Section A carries **sixteen (16)** marks, section B **fifty four (54)** marks and section C **thirty (30)** marks.
4. All writing must be in **blue** or **black** pen.
5. All answers must be written in the answer booklet(s) provided.
6. Communication devices and any unauthorised materials are **not** allowed in the examination room.
7. Write your **Examination Number** on every page of your answer booklet(s)

SECTION A (16 Marks)

Answer all questions in this section.

1. For each of the items (i) - (x) choose the correct answer from among the given alternatives and write its letter beside the item number in the answer booklet provided.

(i) Which of the following ways as applied in Physics can be used by one person to convey the message to another person who is in the nearby village in the form of writings?

A Electronic mails

B Fiber optics

C Headphones

D Radio waves

E Cables

Correct answer: A Electronic mails.

Reason: Electronic mails allow written messages to be sent from one person to another over long distances, including to nearby villages, which fits the requirement of conveying information in the form of writing. Other options like radio waves or headphones transmit audio signals, not written messages.

(ii) Carefully study logical steps 1 to 8 and then answer the question that follows:

1 Formulating a testable hypothesis

2 Data interpretation

3 Performing an experiment

4 Problem identification

5 Drawing conclusion

6 Asking questions

7 Data presentation

8 Data collection and analysis

Which steps show the best logical sequence for scientific investigation?

A 8,7,6,5,4,3, 2, 1

B 8,6,4,2,7,5,3,1

C 4,6,1,3,7,8,2,5

D 4,6,1,3,8,2,7,5

E 6,4,1,3,8,2,7,5

Correct answer: D 4,6,1,3,8,2,7,5.

Reason: Scientific investigation begins with problem identification (4), then asking questions (6), formulating a hypothesis (1), performing experiment (3), collecting data (8), interpreting data (2), presenting data (7), and finally drawing conclusion (5). This sequence reflects proper logical steps.

(iii) Which precaution should be taken to avoid false reading before using a micrometer screw gauge in measuring lengths?

A The thimble and ratchet should be correctly handled to get rid of mismatch.

B The faces of anvil and spindle should be wiped clean to remove any dirty particles.

C The sleeve and thimble should be wiped clean to remove any dirty particles.

D The anvil and ratchet should be adjusted correctly to get rid of zero error.

E The sleeve and thimble should be held tight on their frame to get rid of parallax error.

Correct answer: B The faces of anvil and spindle should be wiped clean to remove any dirty particles.

Reason: Any particles on the anvil or spindle affect the contact points and lead to inaccurate measurements. Cleaning these surfaces ensures accurate readings.

(iv) Why a person cannot push a car from inside when it is stuck in the mud or sand?

A Outside the car the friction force between the legs and ground produces backward force.

B Inside the car the friction force between the legs and car produces less forward force.

C Inside the car the friction force between the legs and car produces backward force.
D Outside the car the friction force between the legs and ground produces forward force.
E Outside the car the friction force between the legs and the car produces forward force.

Correct answer: B Inside the car the friction force between the legs and car produces less forward force.
Reason: To move a car, a person needs to exert force against a stationary surface. Inside the car, legs push against the car itself, so no external forward reaction occurs, hence less forward force is generated.

(v) Which action will increase the density of a substance?
A Increasing the mass of the substance while increasing its volume.
B Increasing the volume of the substance while its mass kept constant.
C Decreasing the mass of the substance while decreasing its volume.
D Increasing the mass of the substance while fixing its volume.
E Increasing the mass of the substance while decreasing its volume.

Correct answer: E Increasing the mass of the substance while decreasing its volume.
Reason: Density is mass divided by volume ($\rho = m/V$). Increasing mass and decreasing volume increases density because both changes enhance the mass-to-volume ratio.

(vi) A drop of water spreads on the surface of a smooth tiles while an equal sized drop of honey refuses spreading. Why are these wonders taking place?
A Water has more cohesive force than honey
B Water has more adhesive force than honey
C Honey has more cohesive force than water
D Honey has more adhesive force than water
E Water has less adhesive force than honey

Correct answer: B Water has more adhesive force than honey.
Reason: Adhesive force causes attraction between the liquid and surface. Water spreads because its adhesive force with tiles is stronger than honey, which has high cohesion and resists spreading.

(vii) When a sharp pencil of 5 g is placed on your hand on its tip it will exert pressure on the hand. Calculate the maximum pressure the pencil will exert to you if it has dimensions shown in Figure 1.
A $1.59 \times 10^6$ 6 Pa
B $1.59 \times 10^3$ Pa
C $2.55 \times 10^{-3}$ Pa
D $2.55 \times 10^9$ Pa
E $2.55 \times 10^3$ Pa

Correct answer: A 1.59 × 10^6 Pa.
Reason: Pressure is force divided by area (P = F/A). The weight of the pencil provides force, and the tiny tip area generates a high pressure. Using the given mass and dimensions yields P ≈ 1.59 × 10^6 Pa.

(viii) An object of 5 cm is placed 25 cm away from the concave mirror of radius of curvature 24 cm. Deduce the position and characteristics of the image formed.
A 23.1 cm real inverted and diminished
B 23.1 cm real inverted and magnified
C 25.0 cm real upright and diminished
D 25.0 cm real upright and magnified
E 23.1 cm virtual inverted and diminished

Correct answer: B 23.1 cm real inverted and magnified.
Reason: Using mirror formula 1/f = 2/R, f = 12 cm. Image distance 1/v = 1/f – 1/u =

1/12 – 1/25 ≈ 0.0427, so v ≈ 23.4 cm. Since v > f, the image is real, inverted, and larger than object (magnified).

(ix) Suppose an engine raises 200 kg of water steadily through a height of 60 m in 20s. If the upward force used is equal to the weight of water raised, calculate the power in kW.

A 4 kW

B 5.88 kW

C 3 kW

D 5 kW

E 7 kW

Correct answer: B 5.88 kW.

Reason: Power P = Work done / time = mgh / t = 200 × 9.8 × 60 / 20 ≈ 5880 W ≈ 5.88 kW.

(x) Which one of the following alternatives will decrease the capacitance of the variable parallel capacitor in a radio receiver if the dielectric materials remain constant?

A Decrease the separation and increase the area of the plates of the capacitor

B Increase the separation and increase the area of the plates of the capacitor

C Increase the separation and decrease the area of the plates of the capacitor

D Decrease the separation and decrease the area of the plates of the capacitor

E Decrease the separation and maintain the area of the plates of the capacitor

Correct answer: C Increase the separation and decrease the area of the plates of the capacitor.

Reason: Capacitance of a parallel plate capacitor $C = \varepsilon_0 A/d$. Increasing separation (d) and decreasing area (A) both reduce capacitance.

2. Match the descriptions of temperature terms in List A with their corresponding terms in List B by writing the letter of the correct response beside the corresponding item number in the answer booklet provided.

| **List A** | **List B** |
|---|---|
| (i) The temperature of melting ice. | A Upper fixed point |
| (ii) The temperature scale that is used in the SI systems of units. | B Thermodynamic scale |
| (iii) A measure of the average kinetic energy of the particles in a substance. | C Fundamental interval |
| (iv) The temperature of boiling water. | D Thermoelectric thermometer |
| (v) A temperature scale based on absolute scale. | E Absolute zero |
| (vi) The point in which all molecular motion stops at -273.15°C. | F Lower fixed point |
| | G Temperature |
| | H Kelvin scale |
| | I Celsius scale |

**Answer**

| (i) | (ii) | (iii) | (iv) | (v) | (vi) |
|---|---|---|---|---|---|
| I | H | G | A | B | E |

SECTION B (54 Marks)

Answer all questions in this section.

3. (a) Identify the type of lens which fits a person with:

(i) Short-sighted defect

A person with short-sightedness (myopia) cannot see distant objects clearly. A concave lens is used to diverge light rays before they enter the eye, allowing the person to focus distant objects on the retina.

(ii) Long-sighted defect

A person with long-sightedness (hypermetropia) cannot see nearby objects clearly. A convex lens is used to converge light rays so that the image forms correctly on the retina.

(b) Why concave mirrors used as shaving mirrors? Explain with the aid of a well-labelled diagram.

Concave mirrors are used as shaving mirrors because they produce magnified, upright images when the object is within the focal length. This allows a person to see facial details more clearly.

A diagram would show a concave mirror with the face placed between the focal point and the mirror, showing the upright, magnified virtual image reflected.

4. (a) Draw a diagram of simple mercury barometer showing clearly:

(i) The Torricellian vacuum.

The Torricellian vacuum is the empty space above the mercury column in the barometer tube. It represents the absence of air pressure in that region.

(ii) The atmospheric pressure and height of the mercury.

The atmospheric pressure is shown as the height of the mercury column, which balances the external air pressure. A typical height is 76 cm at sea level.

(b) Figure 2 shows rulers balanced at their centers of gravity in Case I and II. Determine the difference in weight between A and B.

By using the principle of moments,
CASEI, clockwise moments = 20 x A Ncm
Ant-clockwise moments = 25 x 4 Ncm
Then, from principle of moments, 20A = 100; A = 5 N
CASE II.
Clockwise moments = 25 B
Anticlockwise moments = (20 x 1) + (2 x 40) = 100
Then from principle of moments; 25B = 100; B = 4N
**Difference in weight = 5 N – 4N = 1N**

5. (a) (i) Why a person jumping from a high ground to the floor bends knees upon making contact?

Bending the knees increases the time over which the momentum change occurs, reducing the force experienced by the body on impact, according to impulse-momentum principle.

(ii) State the law or principle that supports your answer in (a)(i).

This is supported by the impulse-momentum principle, which states that impulse equals the change in momentum. Increasing the contact time reduces the force.

(b) A wooden plank is used to raise a heavy load from point A to point B as shown in Figure 3. Use Figure 3 to show that velocity ratio = 1/sin θ

The velocity ratio is given by the ratio of the distance moved by effort to the distance moved by load.

For an inclined plane of angle θ,

VR = length of slope / vertical height

= 1 / sin θ.

6. (a) (i) How can a bimetallic strip be made? Briefly explain.

A bimetallic strip is made by firmly joining two metals with different coefficients of thermal expansion, such as iron and brass. When heated, the metals expand differently, causing the strip to bend.

(ii) By using a simple diagram show how a bimetallic strip made of iron and brass is formed when heated with the same temperature.

The diagram would show a flat bimetallic strip with brass on one side and iron on the other. Upon heating, the strip bends towards the metal with smaller expansion coefficient (iron), showing differential expansion.

(b) Suppose 105 g of water at 75°C is added to 215 g of cold water at 15°C and the mixture is well stirred. Determine the final temperature of the mixture if the heat absorbed by the container is neglected.

Using the principle of conservation of energy: heat lost by hot water = heat gained by cold water.
Let final temperature be T.

$105 \times (75 - T) = 215 \times (T - 15)$

$7875 - 105T = 215T - 3225$

$7875 + 3225 = 215T + 105T$

$11100 = 320T$

**$T = 34.69°C \approx 35°C$**

7. (a) Briefly explain the three factors that determine the quantity of heat generated by an electric current.

The three factors are:

Current (I): Higher current produces more heat due to increased electron flow.

Resistance (R): Higher resistance causes more energy dissipation as heat according to Joule's law.

Time (t): Heat generated is proportional to the duration the current flows through the conductor.

(b) In a certain experiment the p.d across the terminals of the cell was 1.1 V when a current of 0.20 A was being drawn from the cell and the p.d across the terminals of the same cell was 1.30 V when the current drawn from the cell was 0.10 A. Calculate the:

(i) Internal resistance of the cell.

Let E = emf, r = internal resistance, V = terminal voltage, I = current.

$V = E - Ir$

From first measurement: $1.1 = E - 0.20r$

From second measurement: $1.3 = E - 0.10r$

Subtract second from first: $1.1 - 1.3 = (E - 0.2r) - (E - 0.1r)$

$-0.2 = -0.2r + 0.1r = -0.1r$

$r = 0.2 / 0.1 = 2\ \Omega$

(ii) Electromotive force of the cell. (2 marks)

Using first equation: $1.1 = E - 0.2 \times 2 \rightarrow 1.1 = E - 0.4 \rightarrow E = 1.5$ V

8. (a) Why is Venus nicknamed as twin planet of the Earth?

Venus is nicknamed Earth's twin because it is similar in size, mass, density, and composition. Both planets have similar radius and surface gravity.

(b) Briefly explain:

(i) Two negative effects of volcanic activity on the earth's surface.

Volcanic eruptions can destroy vegetation and human settlements through lava flows. They can also release poisonous gases and ash, causing air pollution and health hazards.

(ii) Two positive effects of volcanic activity on the earth's surface.

Volcanic ash enriches soil with minerals, enhancing agricultural productivity. Lava flows can also form new land and geothermal energy sources can be harnessed.

## SECTION C (30 Marks)

Answer two (2) questions from this section.

9. (a) The cloud chamber is used for detecting ionized nuclear radiation. Explain how you can use it to detect the alpha and beta particles.

Alpha particles leave thick, short, straight tracks in the cloud chamber because they are heavy and highly charged. Beta particles leave thin, long, and often curved tracks because they are light and deflected by magnetic fields.

(b) One of the nuclear laboratory scientists recorded the information such that the mass of received sample X was 20 g and after 150 days was 0.652 g.

(i) How many half-lives had elapsed for sample X to decay to 0.652 g? (3 marks)

$N = N_0 \times (1/2)^n \rightarrow 0.652 = 20 \times (1/2)^n$

$(1/2)^n = 0.652 / 20 \approx 0.0326$

$n \log(1/2) = \log(0.0326) \rightarrow n \times (-0.3010) = -1.487$

$n \approx 4.94 \approx 5$ half-lives

(ii) Using information obtained in (b)(i) determine the half-life of sample X.

$t_{½}$ = total time / number of half-lives = 150 / 5 = 30 days

(c) Draw a well labelled diagram to show the components of a cathode ray tube.

The diagram would include: cathode, anode, fluorescent screen, electron beam, deflection plates. Labels indicate electron source, acceleration, and beam direction.

10.(a) Briefly explain three applications of diffraction of waves.

Diffraction is used in:

Spectroscopy: Separating light into wavelengths using diffraction gratings.

Sound propagation: Explains why sound can bend around obstacles.

Radio signals: Diffraction allows radio waves to reach receivers not in direct line-of-sight.

(b) One scientist was investigating the impact of tension on the frequency of vibrating wire. The following data were recorded: Length of a stretched wire was 30 cm, tension

of wire was 900 N, and slotted masses of 3 g and 12 g. Use these data to show how the masses on the vibrating wire affect its frequency.

The frequency f of vibrating wire is

Frequency, $f = (1/2L)\sqrt{(T/\mu)}$, where $\mu$ = mass per unit length.

Increasing the mass increases $\mu$, reducing the frequency.

The higher mass (12 g) produces a lower frequency compared to the lower mass (3 g).

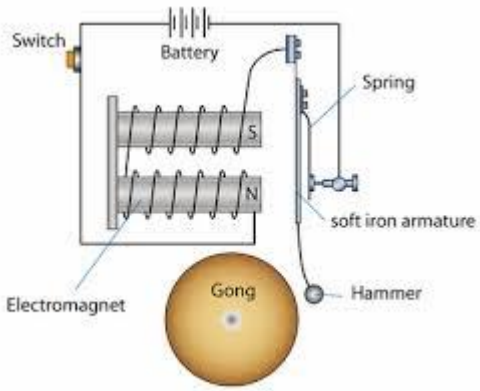
(c) Draw the PNP and NPN transistor circuit symbols and indicate their three layers of the transistors and the direction of conventional current.

11.(a) Draw a well labelled electric bell circuit and explain how it works.

The electric bell consists of a battery, switch, electromagnet, hammer, and gong.

When the switch is pressed, current flows through the electromagnet, attracting the hammer to strike the gong.

The break in the circuit allows the hammer to return, producing continuous ringing.



(b) Use Fleming's left-hand rule to explain the direction of the force in a current carrying wire.

Fleming’s left-hand rule: Thumb = force, first finger = magnetic field, second finger = current. Orient the left hand to find the direction of the force on the conductor in the magnetic field.

(c) (i) What makes the efficiency of a transformer less than 100%? Briefly explain.

Losses such as copper loss ($I^2R$), core loss (hysteresis and eddy currents), and leakage flux reduce transformer efficiency below 100%.

(ii) With reference to Faraday's law of electromagnetic induction determine two factors which affect the magnitude of the induced e.m.f of the conductor.

The induced e.m.f depends on the

rate of change of magnetic flux and the number of turns in the coil.

Faster flux change or more turns increases the induced e.m.f.