THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

031/1 **PHYSICS 1**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2022**

Instructions

1. This paper consists of ELEVEN questions.

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

I have extracted the questions and will now answer them as per your instructions:

(i) Which best represents fundamental quantities with their SI units?
A. Length (m), mass (kg), time (s), temperature (°C), amount of substance (mol), and electric current (A)
B. Length (m), mass (kg), force (N), temperature (K), time (s), amount of substance (mol), and energy (J)
C. Length (m), mass (kg), time (s), electric current (A), temperature (°C) and amount of substance (mol)
D. Length (m), mass (kg), time (s), temperature (K), electric current (A), amount of substance (mol), luminous intensity (cd)
E. Length (m), mass (kg), time (s), temperature (°C), electric current (A) and substance (mol)

Answer: D
Reason: The seven fundamental quantities and their SI units are: length (m), mass (kg), time (s), temperature (K), electric current (A), amount of substance (mol), and luminous intensity (cd).

(ii) Which one of the following conditions must be satisfied for a body to float?
A. An apparent weight is equal to the difference between real weight of the body and upthrust.
B. Upthrust is equal to weight of the fluid displaced.
C. Real weight of the body equals to upthrust.
D. Apparent weight is equal to the product of real weight of a body and its upthrust.
E. Density of a body is more than density of surrounding fluid.

Answer: C
Reason: For an object to float, the upthrust must equal the real weight of the object.

(iii) Which statement about the properties of gaseous state of matter is true?
A. Particles move in fixed positions.
B. Particles are closely packed with fixed volume.
C. Particles are orderly arranged.
D. Particles slide past one another in a definite arrangement.
E. Particles are widely spaced and in a disorderly motion.

Answer: E
Reason: In a gaseous state, particles are far apart and move randomly with high kinetic energy.

(iv) At which position will the object be placed for a concave mirror to form virtual, magnified and erect image?
A. Between the centre of curvature (C) and the pole (P) in front of the mirror
B. Between the principal focus (F) and the pole (P) in front of the mirror
C. Between the centre of curvature (C) and principal focus (F) in front of the mirror
D. Between the centre of curvature (C) and principal focus (F) behind the mirror
E. Between the centre of curvature (C) and the pole (P) in front of the mirror

Answer: B

Reason: A concave mirror forms a virtual, magnified, and erect image when the object is placed between the focus and the pole.

(v) Which of the following uniform motion graphs represents velocity?
A. (Graph showing curved displacement vs. time)
B. (Graph showing non-uniform displacement vs. time)
C. (Graph showing random displacement vs. time)
D. (Graph showing linear velocity vs. time)
E. (Graph showing linear displacement vs. time)

Answer: D
Reason: A velocity vs. time graph is labeled as velocity on y-axis and time on x-axis. Only D meets this criterion.

(vi) Two objects X and Y were supplied by equal quantities of thermal energy. It was observed that the temperature increase of object X is greater than the temperature increase of object Y. Which of the following statements explains the observation?
A. X has a lower melting point than Y.
B. X has a lower density than Y.
C. X has a lower thermal capacity than Y.
D. X is a better thermal conductor than Y.
E. X is heavier than Y.

Answer: C
Reason: Lower thermal capacity means that an object requires less heat to raise its temperature, hence X heats up more quickly.

(vii) What is state of a cup undergoing evaporation in an open air. What happens to the mass.
A. Both volume and mass do not change
B. Both mass and volume slightly decrease
C. Volume stays the same while weight stays the same
D. Volume stays the same while weight decreases
E. Mass stays the same while weight decreases

Answer: B
Reason: During evaporation, both mass and volume of liquid slightly decrease as molecules escape into the air.

(viii) Which beakers should a student use to check the fixed points?
The student has four beakers namely P, Q, R and S.
P contains a mixture of ice and salt
Q contains a mixture of ice and water
R contains a mixture of ice and lime water

S contains boiling water

A. Q and R
B. S and R
C. Q and S
D. P and R
E. S and P

Answer: C
Reason: The fixed points are the ice point (0°C) and steam point (100°C), which are represented by Q and S respectively.

(ix) Which one of the following is not a property of cathode rays?
A. They consist of fast moving protons.
B. They are emitted in straight lines.
C. They are deflected by electric fields.
D. They are deflected by magnetic fields.
E. They produce x-rays when stopped suddenly.

Answer: A
Reason: Cathode rays are composed of electrons, not protons.

(x) What does the term milky way mean?
A. A vast collection of asteroids.
B. One of the planets of the universe.
C. A group of stars that form a pattern in the sky.
D. Satellite of the earth.
E. One of the solar systems.

Answer: E
Reason: The Milky Way is a galaxy which includes our solar system.

Matching Items
List A
(i) Can be used to sterilize fruits and vegetables
(ii) Submarine communication in the Indian Ocean
(iii) Forms a shadow on the retina
(iv) Stimulate the sense cells in the retina
(v) Used for rapid cooking in an oven

List B
A. Visible light
B. X-rays

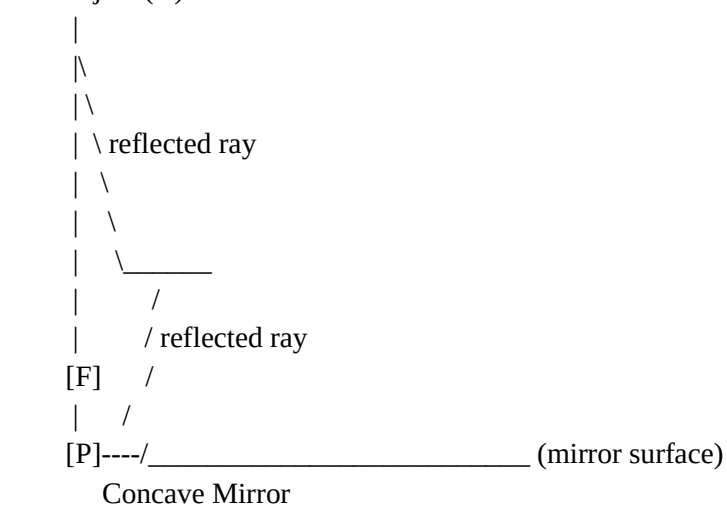
C. Gamma rays
D. Infrared radiation
E. Microwaves
F. Radio waves
G. Ultra-violet rays

Answers:
(i) G
(ii) F
(iii) B
(iv) A
(v) E

3. (a) A concave mirror is used to form an image of a pin object. By using a well labelled diagram; show how you can obtain an upright and enlarged image.

Answer:
To obtain an upright and enlarged image using a concave mirror, place the pin object between the focal point (F) and the pole (P) of the mirror. The rays diverge after reflection but appear to converge when extended behind the mirror, forming a virtual, erect, and magnified image.

Diagram



Concave Mirror
Image formed behind the mirror, upright and enlarged

(b) With the aid of diagrams, describe three ways in which a human eye can be compared to a photographic camera.

Answer:

i. Lens Function: In both the eye and camera, a convex lens focuses light. In the eye, the lens changes shape for accommodation. In a camera, the lens can be adjusted manually.

ii. Light-sensitive Surface: The retina of the eye is like the photographic film or image sensor in a camera, where the image is formed.

iii. Control of Light: The iris in the eye controls the amount of light entering just like the diaphragm in a camera adjusts light exposure.

Illustration (simplified comparison):
Eye:
Light ---> Cornea ---> Pupil/Iris ---> Lens ---> Retina (Image formed)

Camera:
Light ---> Lens ---> Diaphragm ---> Film/Image sensor (Image formed)

4. Carefully study the Figure 2 and then answer the question that follows:
Determine the pressure of the gas given that atmospheric pressure is 102000 Pa and density of mercury is 13.6 g/cm³.

Answer:
Height h = 20 cm = 0.2 m
Density of mercury $\rho = 13600$ kg/m³
$g = 9.81$ m/s²

Pressure due to mercury column = ρgh
$= 13600 \times 9.81 \times 0.2$
$= 26611.2$ Pa

Total pressure of the gas = Atmospheric pressure + pressure due to mercury
$= 102000 + 26611.2$
$= 128611.2$ Pa

5. (a) Why a ship cannot overturn when hit by a strong wave on one side?

Answer:
A ship cannot overturn easily due to its low center of gravity and wide base, which provides stability. When hit by a strong wave on one side, the ship's weight acts down through its center of gravity while buoyant force acts up through the center of buoyancy. This creates a restoring moment that resists overturning.

(b) Figure 3 shows a car moving to a farm. Identify four pairs of action/reaction forces taking place and describe their effects.

Answer:
i. Car pulls trailer (action), trailer pulls car (reaction): This interaction affects motion and acceleration of the car.
ii. Ground pushes up on car wheels (action), car wheels push down on ground (reaction): Maintains car support and balance.
iii. Air resistance on car (action), car pushes air forward (reaction): Affects speed and fuel consumption.
iv. Engine exerts force on wheels (action), wheels exert backward force on ground (reaction): This propels the car forward.

6. (a) Figure 4 shows a circuit diagram for controlling the temperature of a sitting room. Describe how the circuit controls the temperature when the switch is closed.

Answer:
When the switch is closed, current flows through the circuit and the heater element begins to warm the room. As temperature increases, the bimetallic strip bends due to different expansion rates of brass and iron. Eventually, the strip bends enough to break the contact, switching off the heater. As the room cools, the strip returns to its original position, reconnecting the circuit and restarting the heater. This cycle regulates room temperature.

(b) A pulley system with efficiency of 75% is made up of four pulleys. Sketch a well labelled diagram of this machine and then determine the effort required to raise two bags of maize each weighing 100 kg.

Answer:
Total load = 2 × 100 kg × 9.81 = 1962 N
Efficiency = 75% = 0.75
Velocity ratio (VR) = 4 (4 pulleys)

Effort = Load / (Efficiency × VR)
= 1962 / (0.75 × 4)
= 1962 / 3
= 654 N

7. (a) Why does it take less time to boil vegetables in a cooking pot with a lid on than one without a lid? Briefly explain.

Answer:
Using a lid reduces heat loss through evaporation and convection. It traps steam and heat inside, increasing the internal pressure and temperature, thus reducing the time needed to boil vegetables.

(b) An electric kettle containing two heating coils A and B is used to boil water. If it takes 10 minutes for coil A to boil water and 20 minutes for coil B to boil the same amount of water, how long does it take for the water to boil when the two coils are joined in series?

Answer:
Power is inversely proportional to time.
1/TA = 1/10, 1/TB = 1/20
When in series, total power decreases, so time increases.
Equivalent power = $(1/RA + 1/RB)^{-1}$ = RA + RB in series

Since times are 10 and 20 mins, relative resistances are RA and RB = 2RA
Total resistance = RA + 2RA = 3RA
New power = 1/3 of coil A
New time = 3 × 10 = 30 minutes

Answer: 30 minutes

(c) The half-life of a radioactive substance is 138 days. A sample of the substance has 1.6×10^{11} undecayed atoms at the beginning. How many undecayed atoms will be left after 690 days?

Answer:
Number of half-lives = 690 / 138 = 5
Remaining atoms = Initial × $(1/2)^5$
= $1.6 \times 10^{11} \times 1/32$
= 0.05×10^{11}
= 5.0×10^9 atoms

8. (a) Analyze five effects of volcanoes eruption on the Earth's surface.

Answer:
i. Formation of new landforms such as volcanic mountains and islands.
ii. Fertility of soil increases due to mineral-rich lava deposits.
iii. Destruction of vegetation and habitats due to lava flow and ash.
iv. Climate change caused by the release of gases like sulfur dioxide.
v. Loss of lives and displacement due to ash falls and pyroclastic flows.

(b) A turning fork produces resonances in a tube at 40 cm and 85 cm respectively. Calculate the wavelength of the turning fork.

Answer:
Distance between two resonances = 85 cm - 40 cm = 45 cm
This is half a wavelength
Wavelength = 2 × 45 cm = 90 cm = 0.90 m

9. (a) A stretched taut string of length 40 cm and mass 2×10^{-3} kg is pulled with a tension of 100 N. Determine the frequency of the first and second harmonics when it is plucked at its middle.

Answer:
Length L = 0.4 m, Tension T = 100 N, Mass m = 2×10^{-3} kg
Linear density $\mu = m/L = 2 \times 10^{-3} / 0.4 = 5 \times 10^{-3}$ kg/m
Speed $v = \sqrt{(T/\mu)} = \sqrt{(100 / 5 \times 10^{-3})} = \sqrt{20000} = 141.42$ m/s

First harmonic: $f_1 = v / 2L = 141.42 / (2 \times 0.4) = 176.78$ Hz
Second harmonic: $f_2 = 2f_1 = 353.56$ Hz

(b) When a potential difference of 60 V is applied across a primary circuit of a transformer, a current of 3.7 A flows. Find the potential difference across the secondary circuit if there is a current of 0.15 A flowing in it. Take the efficiency of the transformer to be 95%.

Answer:
Power in primary = Vp × Ip = 60 × 3.7 = 222 W
Efficiency = 95% = 0.95
Power in secondary = 0.95 × 222 = 210.9 W
Vs = Power / Is = 210.9 / 0.15 = 1406 V

10. (a) Explain four factors that affect the resistance of a conductor.

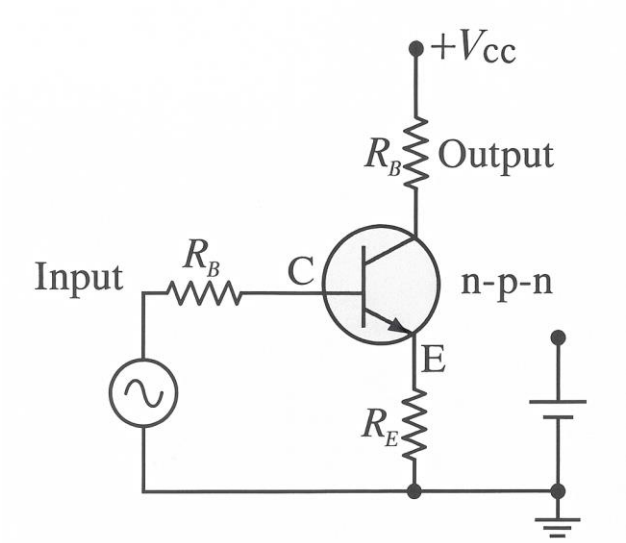
Answer:
i. Length: Resistance increases with length.
ii. Cross-sectional area: Resistance decreases with increasing area.
iii. Material: Different materials have different resistivities.
iv. Temperature: Resistance increases with temperature in metals.

(b) The parallel combination of 2 ohm and 5 ohm resistors are connected across the external resistor of 3 ohm through the supply of 4 V. Draw the circuit diagram and find the current flowing through a 5 ohm resistor.

Answer:
Parallel resistance:
1/R = 1/2 + 1/5 = 5/10 + 2/10 = 7/10
R = 10/7 ohm
Series with 3 ohm: Total R = 10/7 + 3 = 31/7 = 4.43 ohm
Total current I = V / R = 4 / 4.43 ≈ 0.902 A

Voltage across parallel part = I × 10/7 = 0.902 × 1.43 ≈ 1.29 V
Current through 5 ohm = V / R = 1.29 / 5 ≈ 0.258 A

(c) With the aid of a common-emitter amplifier circuit, explain why n-p-n transistor is used.



Common-emitter amplifier

Answer:
In a common-emitter amplifier, the n-p-n transistor allows easy flow of electrons which are majority carriers. It offers higher current gain, faster switching, and better performance in amplification. When a small input current is applied to the base, a much larger current flows from collector to emitter, making it ideal for amplifying weak signals.

11. (a) How does sound from the disco hall transmitted into your room? Briefly explain.
Answer:
Sound from the disco hall is transmitted into your room mainly through vibrations in walls, windows, and doors. When sound waves hit these structures, they cause them to vibrate and those vibrations transfer energy into your room, creating sound. Additionally, if there are openings like gaps or vents, sound can travel through air directly into your room. The energy of the sound waves decreases with distance, but high volume sounds still transmit due to their intensity and lower frequency components which penetrate barriers more easily.

(b) How are the microwaves used in cooking?

Answer:
Microwaves are used in cooking by penetrating food and causing water molecules inside it to vibrate rapidly. This vibration generates heat due to molecular friction, which cooks the food from the inside out. Microwave ovens use magnetrons to produce these waves, and the food absorbs this energy, especially where water content is high.

(c) How is the destructive interference used in noise reduction system? Briefly describe.
Answer:
Destructive interference in noise reduction systems is achieved by producing a sound wave that is exactly out of phase with the unwanted noise. When these two waves meet, their opposite amplitudes cancel each

other out, reducing the overall sound. This principle is used in noise-cancelling headphones, which detect ambient noise and emit an inverted wave to neutralize it, effectively reducing or eliminating the noise heard by the user.