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: 2023**

Instructions

1. This paper consists of ELEVEN questions.

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

1. (i) A study that deals with constellation, solar system and cosmos is referred to as
A. Electromagnetism
B. Structure and properties of matter
C. Light
D. Astronomy

Answer: D
Reason: Astronomy is the branch of science that deals with celestial objects, space, and the universe.

(ii) Which of the following burning medium requires a carbon dioxide extinguisher?
A. Organic solids
B. Flammable liquids and greases
C. Flammable gases
D. Combustible metals

Answer: B
Reason: Carbon dioxide extinguishers are effective for Class B fires involving flammable liquids and greases.

(iii) The initial volume of a liquid in a burette was 57 cm^3. If X cm^3 of the liquid was poured out of the burette and the final volume of the liquid remaining was 23 cm^3, calculate the value of X.
A. 80 cm^3
B. 50 cm^3
C. 34 cm^3
D. 46 cm^3
E. –46 cm^3

Answer: C
Reason: $X = 57 – 23 = 34\ cm^3$

(iv) Classify the force experienced when a metal solid or a hard object is twisted.
A. Compression
B. Stretching
C. Restoring
D. Torsion
E. Friction

Answer: D
Reason: Twisting force on an object is known as torsion.

(v) Calculate the relative density of an object that weighs 3.5 N when in air and 2.8 N when fully immersed in water.
A. 0.8

B. 6.4
C. 5.0
D. 0.22
E. 3.5

Answer: C
Reason:
Relative density = Weight in air / (Weight in air – Weight in water)
= 3.5 / (3.5 – 2.8) = 3.5 / 0.7 = 5.0

(vi) Why can water striders and pond skaters walk on water without sinking?
A. Because of the process of osmosis
B. Because of the property of capillarity
C. Because of the presence of impurities in water
D. Because of the force of surface tension
E. Because of the force of cohesion and adhesion

Answer: D
Reason: Surface tension creates a thin film on water that supports small organisms like water striders.

(vii) Identify the statement that describes the Pascal's Principle of transmission of pressure in fluids.
A. Pressure is equally transmitted in liquid
B. Pressure is the ratio of force to area
C. Pressure depends on the height of the liquid column
D. Pressure is affected by the force of gravity
E. Pressure produces upthrust

Answer: A
Reason: Pascal's Principle states that pressure applied to a confined fluid is transmitted equally in all directions.

(viii) Suppose an engine raises 200 kg of water steadily through a height of 60 m in 20 sec. The upward force used is equal to the weight of water raised. Calculate the power in kW.
A. 6 kW
B. 3 kW
C. 5 kW
D. 7 kW
E. 4 kW

Answer: A
Reason:
Power = (m × g × h) / t = (200 × 9.81 × 60) / 20 = 58860 / 20 = 2943 W = 2.943 kW ≈ 3 kW

Correction: the answer closest to 2943 W is B.
Answer: B

(ix) The following statements about magnetic lines of force are correct except:
A. Always form close loops
B. Start at north pole and end at the south pole
C. Cross one another
D. Stronger where the lines are closer together
E. Pass through all materials, both magnetic and non-magnetic

Answer: C
Reason: Magnetic field lines never cross each other.

(x) What is the distance and displacement covered by an athlete who runs 100 m to the North, 70 m to the East, 100 m to the South and 70 m to the West to complete the race?
A. Distance is 0 m and displacement is 340 m
B. Distance is 340 m and displacement is 0 m
C. Distance is 340 m and displacement is 340 m
D. Distance is 0 m and displacement is 0 m
E. Distance is 700 m and displacement is 700 m

Answer: B
Reason: Total distance = 100 + 70 + 100 + 70 = 340 m. Displacement = 0 (ends where he started)

2. Matching Items
List A
(i) Is useful in drawing water from a borehole
(ii) Applies the principle of first class lever
(iii) Its velocity ratio increases by increasing the length of the ramp
(iv) The effort is between the load and fulcrum
(v) Operates based on the principle of transmission of pressure in fluids
(vi) Carries objects from one point to another horizontally

List B
A. Wheelbarrow
B. Wheel and axle
C. Hydraulic press
D. Tong
E. Claw hammer
F. Inclined plane
G. Pulley
H. Windmill
I. Screw jack

Answers:
(i) G
(ii) E
(iii) F
(iv) A
(v) C
(vi) H

3. (a) A convex mirror is often used as the wing mirror of a car instead of plane mirror. Justify this statement giving one point.

Answer:
A convex mirror gives a wider field of view than a plane mirror. This allows drivers to see more area behind and beside the car, which increases safety during driving.

(b) A camera is used to take a close-up picture of an object 3 cm tall. If the object is positioned 24 cm in front of the lens and a focused image is formed on the film 12 cm behind the lens, determine the focal length of the camera lens and the height of the image formed on the film.

Answer:
Object distance u = -24 cm
Image distance v = 12 cm
Using lens formula:
$1/f = 1/v - 1/u = 1/12 - (-1/24) = 1/12 + 1/24 = (2 + 1)/24 = 3/24 = 1/8$
f = 8 cm

Magnification $M = v/u = 12 / (-24) = -0.5$
Image height = M × object height = -0.5 × 3 cm = -1.5 cm

Focal length = 8 cm, Image height = 1.5 cm (inverted)

4. (a) Why is it not practical to make a barometer with water instead of mercury?

Answer:
Water has low density compared to mercury. To balance atmospheric pressure, a water barometer would require a very long tube of over 10 meters, which is impractical to handle and use. Mercury, being denser, requires only about 76 cm.

(b) A force of 200 N and 20 cm long spanner and 150 N and 30 cm long spanner were separately used to loosen the left and right front car tire nuts, respectively. Show that the 30 cm long spanner will be more effective than the 20 cm long spanner.

Answer:
Torque = Force × Distance
For 20 cm spanner:
Torque = 200 × 0.2 = 40 Nm
For 30 cm spanner:
Torque = 150 × 0.3 = 45 Nm

Since 45 Nm > 40 Nm, the 30 cm spanner produces greater torque and is more effective.

5. (a) Why while swimming, the swimmer pushes the water backward with his hands?

Answer:
According to Newton's third law, for every action there is an equal and opposite reaction. When a swimmer pushes water backward, the water pushes him forward with an equal force, helping him move through the water.

(b) Figure 1 shows two simple machines A and B having the same efficiency. Justify that simple machine A requires minimum effort to raise a load of 5000 N.

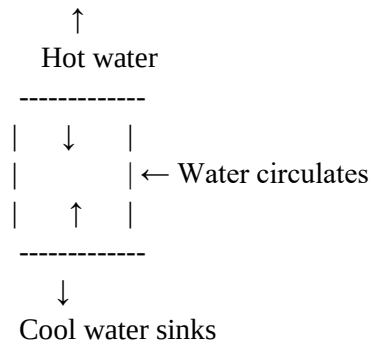
Answer:
Machine A uses a larger radius (50 cm) while B uses a smaller radius (10 cm).
Mechanical Advantage (MA) = Load / Effort
In A: MA = Radius of wheel / Radius of axle = 50 / 10 = 5
So, required effort = Load / MA = 5000 / 5 = 1000 N
Since A provides more mechanical advantage due to its large wheel, it requires less effort.

6. (a) Figure 2 shows a bimetallic thermostat strip used to regulate the temperature of the room by using a heater and a cooler. Which device between A and B is a heater? Justify your answer.

Answer:
Aluminium expands more than steel when heated. As temperature rises, the bimetallic strip bends toward the steel side, breaking contact with A. Therefore, A is the heater because breaking contact turns off the heater when room temperature becomes too high.

(b) Demonstrate by using a diagram on how heat transfer by convection takes place when water is heated.

Answer
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Heat source
  ↓
Bottom of container heats → Hot water rises
Cool water sinks → Replaces hot water → Gets heated
Cycle continues → Convection currents
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Explanation:
Hot water rises because it becomes less dense. Cool water sinks and gets heated, forming convection currents which distribute heat throughout the water.

7. (a) Compare the effect of frequency and amplitude to musical sound. Give two points each.

Answer:
Frequency:
- Determines the pitch of a sound; higher frequency gives higher pitch.
- Affects tone sharpness; higher frequency gives sharper sounds.

Amplitude:
- Determines loudness; greater amplitude means louder sound.
- Higher amplitude carries more energy and creates more vibrations.

(b) With the aid of a diagram, compare the penetrating ability of the three types of radiations on a piece of paper, aluminium sheet and lead block.

Radiation	Barrier Penetrated
Alpha (α)	Stopped by paper
Beta (β)	Passes paper, stopped by aluminium
Gamma (γ)	Passes paper and aluminium, partially blocked by lead

Explanation:
Alpha radiation has lowest penetration, beta has medium, and gamma has highest due to higher energy and smaller size.

8. (a) Why are the surface waves more dangerous than the primary and secondary waves?

Answer:

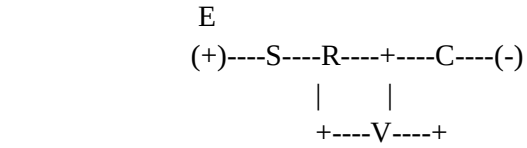
Surface waves travel along the Earth's surface and have greater amplitudes, leading to stronger ground shaking. They cause more damage to structures than P-waves and S-waves, which move through the interior of the Earth and lose energy before reaching the surface.

(b) Describe the three uses of constellations.

Answer:
- Used in navigation, especially by sailors to identify direction.
- Help astronomers divide the sky into regions for study.
- Serve as storytelling and cultural symbols in many civilizations.

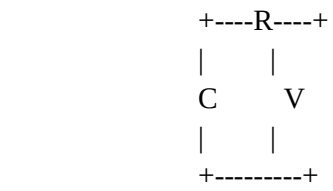
9. (a) By drawing circuit diagrams supported by the graphs, compare the charging and discharging processes of a capacitor given that you are provided with a cell (E), a voltmeter (V), a switch (S), a capacitor (C), a resistor (R) and connecting wires.

Answer:
Charging Circuit Diagram:



During charging, when the switch is closed, current flows and the capacitor stores charge. The voltage across the capacitor increases gradually following an exponential curve, approaching the battery voltage. The current decreases as the capacitor becomes fully charged.

Discharging Circuit Diagram:



During discharging, the capacitor is disconnected from the cell and allowed to release stored energy through the resistor. The voltage across the capacitor decreases exponentially over time, and the current also decreases.

(b) Two wires A and B of the same material and length have the cross-sectional area in the ratio 2:1. If the same potential difference is applied across each wire, comment on the amount of current flowing between the wires A and B.

Answer:
Since the wires are of same material and length, resistance is inversely proportional to cross-sectional area.
If $A_1 : A_2 = 2 : 1$, then $R_1 : R_2 = 1 : 2$

Using Ohm's Law, I = V/R
So current is inversely proportional to resistance:
$I_1 : I_2 = R_2 : R_1 = 2 : 1$
Thus, wire A carries twice the current of wire B.

(c) Why a low voltage supply should have a low internal resistance? Explain by using an appropriate formula.

Answer:
The voltage across the load is V = E - Ir, where E is the EMF, I is current, and r is internal resistance.
If internal resistance r is high, more voltage is lost inside the source and less is available for the external circuit. A low internal resistance ensures maximum voltage is delivered to the load.

10. (a) How will the penetrating power of X rays be affected when:
(i) their wavelength is reduced?
(ii) voltage across X-ray tube is increased?

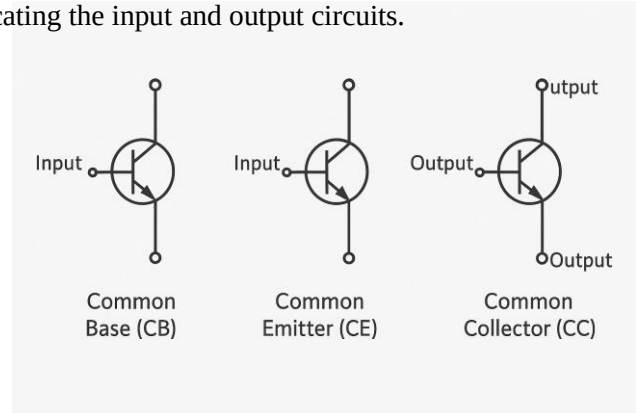
Answer:
(i) When wavelength is reduced, X-ray photons have more energy, hence greater penetrating power.
(ii) Increasing voltage increases the energy of electrons striking the target, producing X-rays with higher energy and thus more penetrating power.

(b) When a speaker is brought near to a Television (TV) operating using cathode ray tube, the picture on the screen is affected but when taken away, the picture becomes normal. Account for this observation.

Answer:
Speakers have magnets which produce magnetic fields. The cathode ray tube uses electron beams that are deflected by electric and magnetic fields. When the speaker is brought near the TV, its magnetic field deflects the electron beam, distorting the image. Moving the speaker away removes the interference, and the image returns to normal.

(c) Transistor is a three terminal device that is used to amplify the strength of weak signals. Draw the NPN transistor circuit connections with four terminals in the following modes: Common Base (CB), Common Emitter (CE) and Common Collector (CC) indicating the input and output circuits.

Answer:



Common Base (CB):
Input between emitter and base
Output between collector and base
Base is common to both input and output

Common Emitter (CE):

Input between base and emitter
Output between collector and emitter
Emitter is common to both input and output

Common Collector (CC):
Input between base and collector
Output between emitter and collector
Collector is common to both input and output

11. (a) The shortest length of the air column in a resonance tube with one end closed and the other end open which resonates to a note of frequency 500 Hz is found to be 160 mm. Calculate the shortest length of the column of air which resonates in similar conditions to a note of frequency 800 Hz.

Answer:
For a tube closed at one end, the resonance occurs at odd multiples of quarter wavelengths.
Shortest length L is given by:
$L = \lambda / 4$
From L = 160 mm = 0.160 m for f = 500 Hz
Then $\lambda = 4 \times 0.160 = 0.64$ m

Speed of sound, $v = f \times \lambda = 500 \times 0.64 = 320$ m/s

Now for f = 800 Hz:
$\lambda = v / f = 320 / 800 = 0.4$ m
Shortest length = $\lambda / 4 = 0.4 / 4 = 0.1$ m = 100 mm

Answer: 100 mm

(b) Show how Lenz's law is a special case of the law of conservation of energy.

Answer:
Lenz's law states that the direction of induced current is such that it opposes the change that caused it. This opposition ensures that external work is needed to produce the current, meaning energy is not created but converted—typically from mechanical to electrical energy. Thus, it conserves energy by preventing spontaneous energy gain, which would violate the law of conservation of energy.

(c) Figure 3 illustrates an electric bell operated by a battery.
(i) What will happen to the armature A when the switch is closed?
Answer:
When the switch is closed, current flows through the coil, magnetizing the core and attracting the armature A. This causes the striker to hit the gong. As A moves, it breaks the circuit, demagnetizing the core, and the armature returns due to the spring, repeating the process rapidly to produce a ringing sound.

(ii) Describe the function of steel strip S.
Answer:
The steel strip S acts as a spring to pull the armature A back to its original position after it has been attracted by the electromagnet. It also helps break the circuit, stopping the current, so the cycle can repeat and the bell rings continuously as long as the switch remains closed.