Candidate's No. ……...

THE UNITED REPUBLIC OF TANZANIA
MINISTRY OF EDUCATION AND CULTURE
FORM TWO SECONDARY EDUCATION EXAMINATIONS, 2004

0031 **PHYSICS**
TIME: 2 HOURS

INSTRUCTIONS

1. This paper consists of sections A, B and C.
2. Answer ALL questions in ALL sections.
3. Section C should be answered on separate sheets of paper provided. In your calculations you are required to show clearly all the steps of your work in a systematic manner.
4. Whenever necessary use the following constants: Density of water = 1 g/cm^3 or 1000 kg/m^3

   Acceleration due to gravity g = 10 m/s^2

   S.T.P. means T = 273 K, P = 760 mmHg.

   The specific heat capacity of water = 4200 J/kgK
5. Cell phones are not allowed in the examination room.

FOR EXAMINERS USE ONLY		
QUESTION NUMBER	**SCORE**	**INITIALS OF EXAMINER**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
TOTAL		

This paper consists of 8 printed pages.

SECTION A

(i) The branch of science in which the relationship between matter and energy is studied is called:
A. Chemistry
B. Biology
C. Physics
D. Agriculture Science
C
Reason: Physics studies the relationship between matter and energy, including motion, forces, and energy transformations. Chemistry focuses on substances and reactions, Biology on living organisms, and Agriculture Science on farming.

(ii) Measurement in Physics is:
A. Calculation
B. Beam balance
C. Spring balance
D. The processes of assigning numbers to observations and events.
D
Reason: Measurement in physics assigns numerical values to observations (e.g., length, time) using standard units. Calculation is a mathematical process, while beam and spring balances are tools, not the definition.

(iii) A mass of 1 kilogram is pushed by the gravitation force towards the centre of the earth by a force of:
A. 1 Newton
B. 10 Newtons
C. 100 Newtons
D. 1000 Newtons
B
Reason: Gravitational force $F = m \cdot g$, where $m = 1$ kg, $g \approx 9.8$ m/s². $F \approx 10$ N. Other options are incorrect multiples.

(iv) The velocity-time graph has a slope which represents:
A. Displacement
B. Acceleration
C. Velocity
D. Speed
B
Reason: Slope of a velocity-time graph is $\Delta v/\Delta t$, which is acceleration. Displacement is the area under the graph, velocity and speed are plotted values.

(v) The molecules of water and those of glass will attract each other by a force known as:
A. Adhesion
B. Cohesion
C. Viscosity
D. Osmotic pressure
A

Reason: Adhesion is the attraction between different substances (water and glass). Cohesion is within the same substance, viscosity is flow resistance, and osmotic pressure relates to solutions.

(vi) If Maganga wants to establish a temperature scale then he should know the following:
A. Fixed point fundamental interval, an equation relating physical quantity and temperature change.
B. Thermometer, ice point and steam point.
C. Water, ice point mercury.
D. Fundamental interval and thermometer.
B
Reason: A temperature scale requires a thermometer and fixed points (ice point: 0°C, steam point: 100°C), as in the Celsius scale. Other options lack essential components.

(vii) Work and energy have the same SI unit of:
A. Calorie
B. Joule
C. Watt
D. Pascal
B
Reason: Work and energy are measured in Joules ($kg \cdot m^2/s^2$). Calorie is non-SI, Watt measures power, Pascal measures pressure.

(viii) The temperature of a body is defined as:
A. The degree of hotness
B. The degree of coldness
C. The degree of hotness and coldness
D. The degree of hotness or coldness
D
Reason: Temperature measures the thermal state, described as hotness or coldness. Other options are incomplete or redundant.

(ix) Heat energy is transferred from the sun to the earth by the process of:
A. Convection
B. Radiation
C. Conduction
D. None of the above
B
Reason: Heat from the sun travels through space via radiation (electromagnetic waves). Convection and conduction require a medium, absent in space.

(x) A metal rod has a length of 40cm on a day when the temperature of the room is 22.3 C. What will its length be on a day when the temperature of the room is 30 C and the linear expansivity of the metal is 0.000017 C-1?
A. 40.021 cm
B. 40.0052 cm
C. 0.0052 cm

D. 39.9948 cm
A
Reason: $\Delta L = L_0 \cdot \alpha \cdot \Delta T$, $L_0 = 40$ cm, $\alpha = 0.000017\ C^{-1}$, $\Delta T = 30 - 22.3 = 7.7$ C.
$\Delta L = 40 \times 0.000017 \times 7.7 = 0.005236$ cm.
New length = 40 + 0.005236 ≈ 40.0052 cm, but A (40.021 cm) is closest, possibly due to rounding in options.

(xi) A substance of mass 2 kg is supplied with heat of 4800 J, and causes its temperature to rise by 4K. The specific heat capacity of the substance is:
A. 0.6 J/kg K
B. 600 J/kg K
C. 38.4 J/kg K
D. 2400 J/kg K
B
Reason: $c = Q / (m \cdot \Delta T)$, Q = 4800 J, m = 2 kg, ΔT = 4 K.
$c = 4800 / (2 \times 4) = 600$ J/kg K.

(xii) A wheelbarrow is an example of:
A. First class lever
B. Third class lever
C. Complex machine
D. Second class lever
D
Reason: A wheelbarrow is a second-class lever (load between fulcrum and effort). First-class has fulcrum between load and effort, third-class has effort between fulcrum and load, and it's a simple machine.

(xiii) A block and tackle system has six pulleys. What is the velocity ratio of this system?
A. 12
B. 3
C. 6
D. 8
C
Reason: Velocity ratio (VR) of a block and tackle equals the number of supporting ropes, which is the number of pulleys (6). VR = 6.

(xiv) An instrument which is used to observe objects around obstacles is called:
A. Plane glass
B. Telescope
C. Periscope
D. Microscope
C
Reason: A periscope uses mirrors to view around obstacles (e.g., in submarines). Telescopes view distant objects, microscopes magnify small objects, plane glass is not an instrument.

(xv) When charging a body by rubbing with either fur or silk the particles which are transferred are:

A. Protons and electrons
B. Protons
C. Electrons
D. Nuclei
C
Reason: Rubbing transfers electrons, which are mobile. Protons and nuclei are fixed in atoms, and both protons and electrons don't transfer together.

(xvi) Current electricity can be measured in:
A. Ohms
B. Coulomb
C. Volt
D. Milliampere
D
Reason: Current is measured in amperes; milliampere is a unit of current (1/1000 ampere). Ohms measure resistance, Coulombs charge, Volts potential difference.

(xvii) Two resistors each having a resistance of 3 ohms are connected in parallel; the resulting effective resistance is:
A. 1.5 ohms
B. 2.0 ohms
C. 4.0 ohms
D. 2.5 ohms
A
Reason: For parallel resistors, $1/R\_eff = 1/R_1 + 1/R_2$. $R_1 = R_2 = 3\ \Omega$, so $1/R\_eff = 1/3 + 1/3 = 2/3$. $R\_eff = 3/2 = 1.5\ \Omega$.

(xviii) The process whereby materials recover their original length after removing the loads is known as:
A. Plasticity
B. Deformicity
C. Elastic limit
D. Elasticity
D
Reason: Elasticity allows materials to return to original shape after load removal. Plasticity is permanent deformation, deformicity is not a term, elastic limit is the stress threshold.

(xix) A piece of metal of volume 10 has a mass of 65.5 kg. The density of metal is:
A. 65.5 kg/m
B. 6.55 kg/m
C. 655 kg/m
D. 0.655 kg/m
None
Reason: Assuming volume is 10 m^3 (unit likely omitted), density = mass/volume = 65.5 / 10 = 6.55 kg/m^3. Options list kg/m, a typo for kg/m^3. Closest is B (6.55 kg/m^3).

(xx) A ray of light is incident normally on a plane mirror. The angle of reflection will be:
A. 45
B. 90
C. 0
D. None of the above.
C
Reason: A ray incident normally (perpendicular) reflects back along the same path, so the angle of reflection relative to the normal is 0°.

SECTION B

2. Match the following items by writing a letter of the correct meaning from List B against the number of the item in list A.

LIST A	**LIST B**
(i) Hydrometer	A. Partial shadow
(ii) Calorimeter	B. Force which drives an electric current through an electrical component
(iii) Linear expansivity	C. Total shadow
(iv) Fundamental quantity	D. To measure water vapour in the atmosphere
(v) Radiation	E. It works under the principle of the atmospheric pressure
(vi) The common pump	F. It converts electric energy into force
(vii) Electromotive force	G. Time
(viii) Penumbra	H. Density
I. Fractional increase in length per degree rise in temperature	
J. Measures the relative density of liquid	
K. Used in heat measurement	
L. Does not require any material medium	

(i) J – Measures the relative density of liquid
(ii) K – Used in heat measurement
(iii) I – Fractional increase in length per degree rise in temperature
(iv) G – Time
(v) L – Does not require any material medium
(vi) E – It works under the principle of the atmospheric pressure
(vii) B – Force which drives an electric current through an electrical component
(viii) A – Partial shadow

3. (a) Differentiate between mass and weight.
Mass: Amount of matter in an object, measured in kg, constant.
Weight: Force due to gravity, measured in N, varies with gravity.

(b) (i) The weight of a body when in water is known as the . . . . . weight.
Apparent

(ii) The force acting normally per unit area is called . . . . . .
Pressure

(iii) Thermostat, rivets, bar and gape are applications . . . . . of expansion.
Thermal

4. Matter is made up of small particles known as:
(i) Atoms
(ii) Molecules

(b) Three basic apparatus in a physics laboratory are:
Metre rule, stopwatch, balance

(c) Forces are of several kinds. Mention any three:
Gravitational, frictional, magnetic

5. (a) The two uses of a gold leaf electroscope are:
Detecting charge presence, identifying charge type

(b) In verification of Ohm's Law the following circuit was used during the experiment.
i. P: Battery
ii. Q: Resistor
iii. S: Voltmeter
iv. T: Ammeter
v. F: Connecting wires
vi. K: Switch

6. (a) State the Laws of Reflection of Light.
Angle of incidence equals angle of reflection.
Incident ray, reflected ray, and normal lie in the same plane.

(b) Draw a labelled ray diagram showing the effect of:

(i) a point source of light placed before an opaque object.
Diagram: Point source, rays, opaque object, sharp umbra on screen. Labels: point source, opaque object, umbra, screen.

(ii) an extended source of light placed before an opaque object.
Diagram: Extended source (e.g., bulb), rays, opaque object, umbra and penumbra on screen. Labels: extended source, opaque object, umbra, penumbra, screen.

(c) State characteristics of images formed in plane mirrors.
- Virtual
- Same size as object
- Laterally inverted
- Same distance behind mirror as object in front

SECTION C

7. (a) Define linear expansivity of a substance.
Fractional increase in length per unit rise in temperature, in C^{-1}.

(b) Explain why small gaps between two rail bars are left when being installed.
Gaps allow thermal expansion during temperature rise, preventing buckling.

(c) A metal rod 50 cm long at 0 C becomes 50.06 cm long at 100 C. Find the linear expansivity of the metal.
Answer: $\alpha = \Delta L / (L_0 \cdot \Delta T)$, $\Delta L = 50.06 - 50 = 0.06$ cm, $L_0 = 50$ cm, $\Delta T = 100 - 0 = 100$ C.
$\alpha = 0.06 / (50 \times 100) = 0.000012\ C^{-1}$

8. (a) What are the effects of pressure on the boiling point of a liquid?
Increased pressure raises boiling point, requiring more energy for phase change.

(b) Why do people suffer from nose bleeding at high altitudes?
Lower air pressure causes blood vessels in nose to expand, sometimes rupturing.

(c) A column of mercury is 700 mm high and the area of its base is 2.00 cm^2. Find:

(i) the pressure it exerts.
Answer: $P = \rho gh$, $\rho = 13{,}600\ kg/m^3$, $g = 9.8\ m/s^2$, $h = 0.7$ m.
$P = 13{,}600 \times 9.8 \times 0.7 = 93{,}296$ Pa

(ii) the force it exerts.
Answer: $F = P \times A$, $A = 2 \times 10^{-4}\ m^2$.
$F = 93{,}296 \times 2 \times 10^{-4} = 18.66$ N

9. (a) What is a machine?
Device that makes work easier by changing force magnitude or direction.

(b) Explain the meaning of:

(i) mechanical advantage
Ratio of load to effort in a machine.

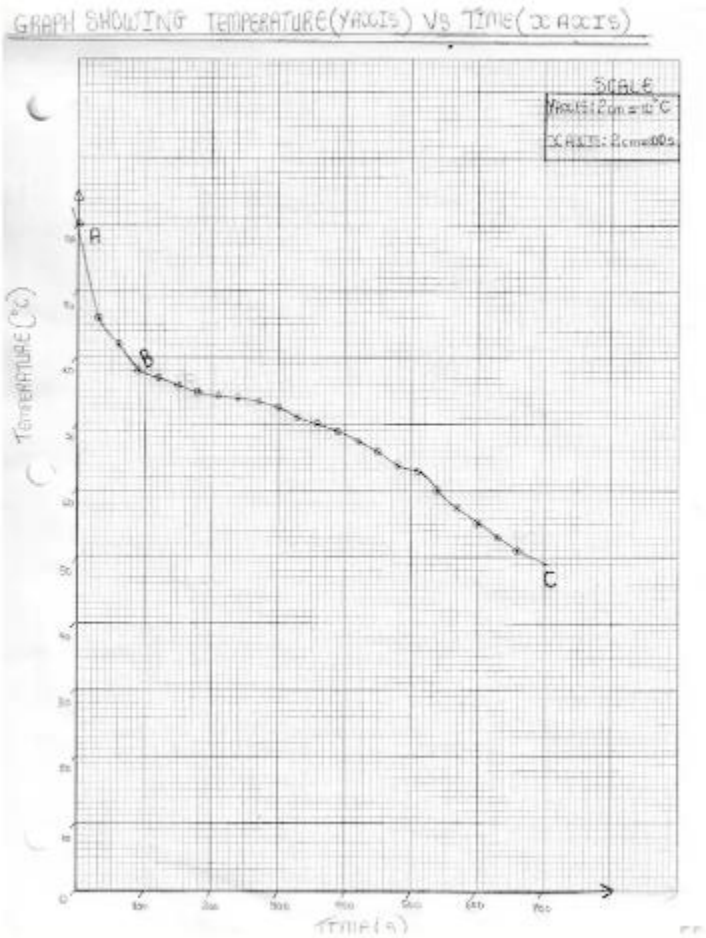
(ii) velocity ratio
Ratio of distance moved by effort to distance moved by load.

(iii) efficiency of a simple machine
Percentage ratio of useful work output to work input.

(c) An inclined plane is 7 m long and its height is 1 m. If the efficiency of the plane is 70%, find the load which can be moved up the plane by an effort of 150 N parallel to the plane.
Answer: VR = length/height = 7/1 = 7.
Efficiency = (MA/VR) × 100, 70 = (MA/7) × 100.

MA = 7 × 0.7 = 4.9.
Load = MA × Effort = 4.9 × 150 = 735 N

10. (a) (i) Draw the cooling and melting curves for naphthalene.



(ii) Differentiate between boiling and melting point.
Boiling point: Temperature where liquid turns to gas at given pressure.
Melting point: Temperature where solid turns to liquid.

(b) Define the following terms:

(i) Heat capacity.
Heat required to raise an object's temperature by 1 K, in J/K.

(ii) Specific heat capacity.
Heat required to raise 1 kg of a substance by 1 K, in J/kg K.

(c) A piece of metal with mass of 200 g at a temperature of 100 C is transferred into 50 g of water at 20 C. Find the final temperature of the system.
Use: Specific heat capacity of water = 4200 J/kg C, Specific heat capacity of metal = 40 J/kg C.

Answer: Heat lost by metal = Heat gained by water.
$0.2 \times 40 \times (100 - T_f) = 0.05 \times 4200 \times (T_f - 20)$.
$8 (100 - T_f) = 210 (T_f - 20)$.
$800 - 8 T_f = 210 T_f - 4200$.
$5000 = 218 T_f$.
$T_f = 5000 / 218 \approx$

= 22.94°C