P510/1

PHYSICS

Paper 1

APRIL-2024

$2\frac{1}{2}$ Hours

ST. BRIDGET GIRLS' HIGH SCHOOL

Uganda Advanced Certificate of Education

TEST 2 2024

S.6 PHYSICS

Paper 1

2 hours: 30 minutes

INSTRUCTIONS TO CANDIDATES

*Answer **five** questions*

Assume where necessary:

Acceleration due to gravity	*g*	=	$9.81 ms^{-2}$
Electronic charge	*e*	=	$1.6 \times 10^{-19} C$
Electron mass		=	$9.11 \times 10^{-31} kg$
Radius of earth		=	$6.4 \times 10^{6} m$
Planck's constant	*h*	=	$6.6 \times 10^{-34} Js$
Speed of light in vacuum	*c*	=	$3.0 \times 10^{8} ms\text{-}1$
Stefan's – Boltzmann's constant	σ	=	$5.67 \times 10^{-8} Wm^{-2}K^{-4}$
Wien's displacement constant		=	$2.90 \times 10^{-3} m\ K$
Specific heat capacity of water		=	$4.2 \times 10^{3}\ J\ kg^{-1}\ K^{-1}$
Gas constant	*R*	=	$8.31\ j\ Mol^{-1}\ k^{-1}$
Universal gravitational constant	*G*	=	$6.67 \times 10^{-11}\ N\ m^{2}kg^{-2}$
Charge to mass ratio	*e/m*	=	$1.8 \times 10^{11}\ Ckg^{-1}$
Avogadro's number	N_A	=	$6.02\ X\ 10^{23}\ mol^{-1}$
One electron volt	*(eV)*	=	$1.6 \times 10^{-19}\ J$

Turn Over

1.

a. Define the term dimension of physical quantities ***(01mark)***

b.

i. Assume that the period (***T***) depends on the following

Mass ***(m)*** of the bob

Length ***(l)*** of the pendulum

Acceleration due to gravity ***(g)***

Use dimension analysis to show that $T = K\sqrt{\frac{l}{g}}$, where K is a constant ***(03marks)***

ii. Distinguish between fundamental and derived quantities ***(02marks)***

iii. Show that ***V= u+at*** is dimensionally consistent ***(02marks)***

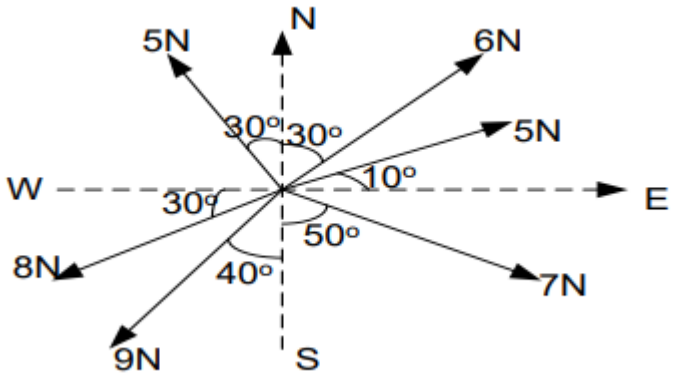
c. Define the following terms

i. Vector quantities ***(01mark)***

ii. scalar quantities ***(01mark)***

iii. give one example of each of the above quantities. ***(02marks)***

d. Forces of 6N, 5N, 7N, 8N, 5N, and 9N act on a particle of mass 0.5kg as shown in the figure below



Turn Over

Calculate

i. the resultant force on the body ***(03marks)***

ii. Acceleration of the body ***(02marks)***

e. A boat crosses a river 3km wide flowing at 4m/s to reach a point on the opposite bank 5km upstream. The boat's speed in still water is 12m/s. Find the direction in which the boat must be headed

2.

a. Define the elastic and inelastic collisions. ***(02marks)***

b. In an experiment to measures its velocity, a bullet of mass 10g is fired at short range from a gun of mass 0.8kg into a block of wood of mass 390g suspended from a vertical string. On striking the block, the bullet is embedded and the block rises to a vertical height of 6.0cm above its rest position. Calculate the;

i. speed of the bullet ***(03marks)***

ii. the recoil velocity of the gun ***(02marks)***

c.

i. Distinguish between conservative and non-conservative forces and state an example of each ***(03marks)***

ii. Show that in a system where the only forces acting are conservative forces, mechanical energy is conserved. ***(03marks)***

iii. A car of mass 1.0×10^3 moves with uniform velocity of $36kmh^{-1}$ up a straight track inclined at an angle of 20^o to the horizontal. The total frictional resistance to the motion of the car is 248N. Calculate the power developed in the engine. ***(03marks)***

Turn Over

d.

i. State the principle of conservation of linear momentum

(01mark)

ii. Using newton's law of motion, prove the principle of conservation of linear momentum ***(03marks)***

3.

a.

i. Define the term thermometric property giving two examples

(03mark)

ii. Describe how a Celsius scale can be establish ***(02marks)***

b.

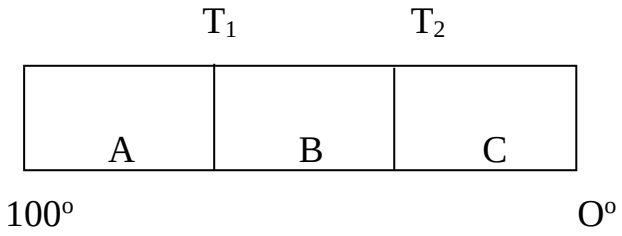
i. Using a well labeled diagram, describe an experiment to determine the specific latent heat of vapourisation of water electrical method

(03marks)

ii. Describe with the aid of a diagram how a thermocouple thermometer works ***(03marks)***

c.

i. Three metallic conductors A, B and C of equal lengths and cross section area are joined to form an insulated composite rod as shown in the figure below.



Turn Over

The exposed end of A and C are maintained at 100^{o}C and ^{o}C respectively. If the ratio of the thermal conductivities A, B and C is 1.5: 2: 2.5 respectively, find the steady temperature of the interfaces T_1 and T_2. ***(04marks)***

ii. Draw a sketch graph of temperature against length of the composite rod. ***(02marks)***

d. Explain why;

i. one feels cool after sweating. ***(02marks)***

ii. green house effect causes global warming ***(02marks)***

4.

a. Define binding energy of a nuclide. ***(01mark)***

b.

i. Sketch a graph showing how binding energy per nucleon varies with mass number. ***(01mark)***

ii. describe the main features of the graph in b(i) above. ***(03marks)***

c.

i. Distinguish between nuclear fission and nuclear fusion and account for energy released in each case. ***(03marks)***

ii. With the aid of a labeled diagram, describe the working of an ionization chamber. ***(02marks)***

iii. With aid of a diagram describe the structure and mode of operation of an x ray tube ***(02marks)***

Turn Over

d.

i. What is meant by half-life and decay constant as applied to radioactivity. ***(02marks)***

ii. Show that the number of atoms N at any time t is given by the expression $N = N_0 e^{-\lambda t}$ where N_0 is the initial number of atoms and λ is the decay constant ***(02marks)***

iii. Using the expression above, show that the half life $t_{\frac{1}{2}}$ is given by the expression $t_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$ ***(01marks)***

iv. A Gerger Muller (GM) tube placed 20cm from a 2.0g of Randon $^{222}_{86}Rn$ gives a count rate of 85 counts per second. If the entrance window of the GM tube has an area of 10cm^2, calculate the half-life of radon. ***(03marks)***

5.

a.

i. Describe an experiment which justifies the existence of a small nucleus at the centre of an atom. ***(03marks)***

ii. What are failures of Rutherford model of an atom ***(02marks)***

b.

i. State Bohr's postulates of a hydrogen atom. ***(02marks)***

ii. State the limitations of Bohr's model of the atom. ***(02marks)***

c.

i. Use Bohr's model to show that the total, E, of an electron in an atom is given by $\boldsymbol{E = -\frac{me^4}{8\varepsilon_0{}^2 n^2 h^2}}$ where **m** is the mass of the electron, $\boldsymbol{\varepsilon_o}$ is permittivity of free space, **n** is principal quantum number and **h** is Planck's constant. ***(05marks)***

Turn Over

ii. Explain why the energy is negative ***(01mark)***

d. The ionization energy of helium is 24.6eV. An electron from an excitation level of helium of energy -21.4eV falls to the ground state.

i. Define ionization energy. ***(01mark)***

ii. Calculate the wave length of the radiation emitted in the above transition to the ground state. ***(03marks)***

iii. In what region of the spectrum does the radiation emitted lie? ***(01mark)***

END