ARISON A'LEVEL PHYSICS PROBLEMS.

FOR FORM FIVE.

Prep: Sir: ALPHONCE JACKSON RICHARD.
Physics Teacher at LION OF JUDAH ACADEMY.
Contact: 0762-510757

INSTRUCTIONS..

The following information may be used.

a) **Acceleration due to gravity, g = 9.8ms^{-2}**
b) **Radius of the earth, Re = 6.4 x 10^{6} m**
c) **Electronic charge, e = 1.6 x 10^{-19} C**
d) **Universal Gravitational constant, G = 6.67 x 10^{-11} Nm^{2} kg^{-2}**
e) **Boltzmann constant, K = 8.6 x 10^{-5} eVK^{-1}**
f) **Thermal conductivity of cork Kc=0.063Wm^{-1} K^{-1}**
g) **Universal moral gas constant R=8.31 Jmol^{-1} K^{-1}**
h) **Thermal conductivity of glass ,kg=0.72Wm^{-1} K^{-1}**
i) **Speed of light in vacuum, C = 3 x 10^{8} m/s**
j) **Normal atmospheric pressure, 10^{5}Pa**
k) **Mass of the earth = 6.0 x 10^{24} kg**
l) **Stefan Boltzmann constant = 5.67 x 10^{-8} Wm^{-2}K^{-4}**
m) **The temperature at triple point of water = 273.16K**
n) **Mass of electron = 9.11 x 10^{-31} kg**
o) **1.0 g of water = 1.0 cm^{3}**
p) **For air,γ = 1.4**
q) **Pie,π = 3.14**
r) **Solar constant = 1400Wm^{-1}K^{-1}**
s) **Specific heat capacity of water = 4200JKg^{-1}K^{-1}**
t) **Latent heat of vaporization = 2.256 x 10^{6}JKg^{-1}**
u) **Thermal conductivity of copper = 380Wm^{-1}K^{-1}**
v) **Thermal conductivity of iron = 80Wm^{-1}K^{-1}**
w) **Mass of the moon =7.35x 10^{22} Kg**
x) **Density of a metal sphere=800Kgm^{3}**
y) **Radius of the sun = 7.5 x 10^{8} m**
z) **Distance of the sun-earth = 1.5 x 10^{11} m**
aa) **Specific heat capacity of a metal sphere =400JKg^{-1}K^{-1}**
bb) **Thermodynamics temperature T = 273K**
cc) **Young's modulus of copper = 110 x 10^{9}Nm^{-2}**
dd) **Young's modulus of iron = 190 x 10^{9}Nm^{-2}**
ee) **Permittivity of free space μ_o = 8.85 x 10^{-12} C^{2}/Nm^{2}**
ff) **Speed of sound in air = 340 m/s**
gg) **Surface tension of soap film = 0.08Nm^{-1}**
hh) **Viscosity of air = 1.8 x 10^{-5} Nsm^{-2}**
ii) **Density of oil = 900Kgm^{-3}**

1. MEASUREMENT

Qn1.(a)(i) What do you understand by the dimensions and dimensional formula of a physical quantity?

(ii) When you hear the term dimension, what massage do you get about the physical quantity?

(b)(i) Why do we use square brackets round M, L, and T?

(ii) Can we tell the unit of a physical quantity from its dimensions?

(iii) What is the basic requirement for a physical relation to be correct?

(iv) While deriving the relationship between physical quantities by dimensional analysis, dimensionless constant enters into the relationship. Can you find its magnitude by the method of dimensions?

(v) Should an equation describe a physical situation?

Qn2.(a) With example explain the following about dimension analysis

i. Can we add quantities having the same dimension but different units?
ii. Can we add quantities having the same dimensions and the same units?
iii. Can two quantities may have the same dimensions but different units?

(b) (i)The dimensional formula for velocity is given as $[M^0 LT^{-1}]$.Outline two (2) important information obtained from the dimensional formula above.

(ii) A dimensional consistency is necessary condition for a physical relation to be correct. Why is not sufficient?

(iii) Explain why, we can always add two physical quantities of the same unit but we cannot always add two physical quantities of the same dimension?

Qn 3(a) (i) The force F is given in terms of time t and displacement X by the equation.

$$F=A\cos(HX) + C\sin\left(\frac{1}{Dt}\right)$$

What are the dimensions of HD?

(ii) Pressure depend on distance as,

$$P = \frac{\alpha}{\beta}\exp\left(\frac{-\alpha Z}{K\theta}\right)$$

Where and are constants, Z is distance, K is Boltzmann constant, it's unit is Joule per Kelvin, and $\theta$is temperature. Find the dimension and unit of β.

(b)The frequency in the note given by an organ pipe depends on the length, the air pressure and air density.

i. Using dimensional analysis obtain the formula for the frequency.
ii. What will be new frequency of a pipe whose original frequency was 256HZ if the air density falls of 2% and the pressure increased by 1%.

(c) The velocity of transverse wave along a string can be fully expressed in term of tension T in the string, the mass per unit length M of the string and a dimensional constant K. Use dimensional analysis to derive an expression for V in term of K, T and M.

Qn4(a) (i) Explain the difference between systematic error and random errors using particular operation such as the use of a clock to illustrate your answer.
(ii) Which type of error is likely to be more misleading?

(b) Two forces have magnitude F1= (60±3) N and F2= (45±2) N calculate the absolute percentage maximum uncertainty in:-

i. Sum of the forces.
ii. Product of the forces.

(c) Theoretical formula for a period of oscillations T of a certain system is:-

$$T = 2\pi \sqrt{\frac{b^2 + 3a^2}{2ag}}$$

Where of is the acceleration due to gravity. Find the accuracy of "g" obtained given that the measured value a, b and T are

a = (10.27±0.005) cm
b = (12.54±0.005) cm
T = (0.964± 0.002) Seconds

Qn5 (a) (i) How can random and systematic errors be minimized during an experiment?
(ii) In an experiment to determine the value of Young‟s Modulus of elasticity of steel wire of length 325 cm (measured by a metric scale of least count 0.1 cm) is loaded by a mass of 2 kg and it is found that it stretched by 0.227 cm (measured by a micrometer having a least count of 0.001 cm). The diameter of the wire as measured by screw gauge (least count is 0.001 cm)is found to be 0.043 cm. Calculate the maximum percentage error in Young‟s Modulus of elasticity of steel.

(b)A rectangular block has a mass of (1.5± 0.1) Kg, and a volume that can be calculated from the following dimensions; (80±2) mm, (50±1) mm and (30±3)mm. Assuming that all the errors are independent, calculate the maximum uncertainty in the measured values of;

i. The volume of the block.
ii. The density of the block.

(c) Use the following results to plot points on a graph to show how the P.d across on ohmic device varies with the current flowing through it.

V (Volts)	3.0	4.6	6.2	6.6	7.0	8.4	9.4	10.0	10.4	12.4
I (Amperes)	0.5	1.3	2.0	2.3	2.7	3.0	3.5	4.0	4.6	4.8

i. Draw the best straight line through the points and deduce the resistance of the device from the slope of the graph.
ii. Join point 1-5, 2-6, 3-7, 4-8, 5-9, 6-10 and measure these six slopes. Calculate the mean value of the slopes, and again deduce the resistance of the device.
iii. Why is result (ii) more liable?

Qn6 (a)(i) Define the term least count and discrepancy as applied in error analysis.
(ii) If the error in X is denoted by dx, determine the formula for $d(x^2 y^3)$ and hence find the error in (x^2y^3) when X=(5±0.05)cm and y=(10±0.1)cm.
(b)(i) Consider S=Xcosθ for X=(2±0.2)cm and =(53±2)^o =(0.9250±0.0035)rad. Find S and its maximum uncertainty Δs or (S±Δs) . NOTE: The uncertainty in angle must be in radians for a function t =f(W_1 ,X_1,Y…..) its total differential is:-

$$Z=(\frac{df}{dw})dw + (\frac{df}{dx})dw + (\frac{df}{dy})dy+\ldots\ldots\ldots$$

(ii) In an experiment to measure the angles of spectrometer read up to 6 of an arc. Estimate the percentage error in refractive index of material of glass prism μ, where:-

$$\mu = \frac{\sin(\frac{A+B}{2})}{\sin(\frac{A}{2})}$$

A= angle of prism, B=angle of minimum deviation. Where A=60^0 and B= 48^o 36'.

(c) (i) Differentiate an accurate experiment from precise experiment.
(ii) A stop watch used in a simple pendulum experiment can read up to 0.2s. What is the precision of Measurement of a periodic time of 50s?

Qn7. (a) (i) What is the advantage of expressing physical quantities in terms of Dimensional equations?
(ii) Will the measure of a physical quantity depend upon the system of units used?

(b) A calorie is a unit of heat or energy and it is equal to 4.2J, where 15 = 1Kgm^2 s^{-2} Suppose we employ a system of units in which the unit of mass is α Kg, the unit of length is β m, and the unit of time is γ s. What will be magnitude of calorie in terms of this new system?

(c) (i) Define the term Percentage error and fractional error.
(ii) The magnification M of a prism is given by:-

$$M = \frac{\sin(A/2 + D_m)}{\sin(A/2)}$$

Where A is apex angle = 250
Dm is the minimum deviation = 10034' .Calculate the Percentage error in magnification 10 error in spectrometer used to measure angles is 5.

Qn8. (a) (i) The diameter of a constant wire is (0.375 0.001) mm. What does this mean?
(ii) Differentiate between an error and a blunder

(iii) The formula for calculating Young‟s modulus Y from the extension e of a loaded wire of length l and diameter d when the applied tension is F is.

$$Y = \frac{4Fl}{\pi d^2 e}$$

If F is of order of 500N and known to 1 part in 1000, L is of the order 3m and measured to within 2mm, e is of the order 5mm measured to 0.1mm and d is of the order 1mm measured to 0.01mm, determine the Young‟s modulus and its error.

(b) (i) What is meant by the statement that an equation is homogeneous with respect to its unit.

(ii) The power output P of a windmill depends on the area A, swept by the windmill bladed, the density p of air, and the speed v of wind. Use the method of dimension to derive the formula of P in terms of A, p and v.

Qn9.(a) (i) What is meant by dimensional variables? Give two examples.

(ii) Give one fact on which the principle of homogeneity of dimensions is based.

(b) (i) What is the basic requirement for a physical relation to be correct?

(ii) If the velocity of light, acceleration due to gravity and normal atmospheric pressure are chosen as the fundamental units, find the values of length, mass and time.

(c) (i) Suggest the dimensions consistency of the expression below , where all symbols carry their usual meaning.

$$y = a\sin\omega\left(\frac{x}{v} - k\pi\right).$$

(ii) From the given expression in 1 (c) (i), show that is a dimensional constant. k

Qn10 .(a)(i) Mention and define four categories of dimensional physical quantities and give two examples on each.

(ii) State the principle of Homogeneity of dimensional analysis

(iii) Check the correctness of the equation τ = Iα, where τ is torque, I is moment of inertia and α is angular acceleration.

(b) Give the meaning of the following terms as used in error analysis

i. Absolute error.
ii. Relative error.

(c) The force F acting on an object of mass M, travelling at velocity v in a circle of radius r is given by:-

$$F = \frac{MV^2}{r}$$

If the measurements are recorded as M=(3.5±0.1)Kg, V=(20±1)m/s, r=(12.5±0.5)m, find the maximum possible:-

i. Fractional error.
ii. Percentage error in the measurement of force.

(c) Show how you will record the reading of force F in part (b**).**

Qn11. (a) (i) Define the term dimensions of a physical quantity**.**
(ii) Identify two uses of dimensional equations.

(b) (i) What is the basic requirement for a physical relation to be correct?
(ii) List two quantities whose dimension is $[ML^2 T^{-1}]$.

(c) (i) The frequency f of vibration of stretched string depends on the tension F, the length L ,and the mass per unit length μ of the string. Derive the formula relating the physical quantities by method of dimensions.
(ii) Use dimensional analysis to prove the correctness of the relation.

$$\rho = \frac{3g}{4\pi RG}$$

Where by ρ=density of the earth, g= acceleration due to gravity, R=radius of the earth and G= gravitational constant.

Qn12(a) Define the following terms as used in error analysis
i. Systematic error.
ii. Random error.
iii. Absolute error.
iv. Relative error.

(b) The force acting on an object of mass travelling at velocity on a circle of radius is given as:-

$$F = mv^2/r$$

The measurements are recorded as:
$m = 3.5kg \pm 0.1kg; \quad v = 20m/s \pm 1m/s; \quad r = 12.5m \pm 0.5m.$
Find the maximum possible:-
i. Fraction error.
ii. Absolute error.

(c) A physical quantity P is given by $P = ab^2c^3d^4$The percentage error in measurement of $a, b, c$and d are 0.5% each. What is the percentage in P?

Qn13 (a) (i) State two limitations of Dimensional analysis
(ii) Mention three uses of dimensional analysis
(b) The density of earth is given by:-

$$\rho = \left(3g/4\pi RG\right)$$

Where R is the radius of earth and G is gravitational constant. Check the dimensional consistency of this relation.

(c) The velocity V of water waves may depend on their wavelength λ, the density of water $\rho$and the acceleration due to gravity$g$. Find the relation between these quantities by the method of dimensions.

Qn14.(a) (i) Speed and velocity are dimensionally equivalent. Explain briefly the meaning of this statement.

(ii) The wavelength of a wave associated with a particle moving with momentum P is given by the equation $\lambda = \frac{h}{p}$where h is a constant.

- Determine the dimensions of h.
- Suggests two possible units of the constant h.

(b) (i) A student wish to determine the integer value of the exponent n in the equation $\mathbf{y=c^n\ at^2}$. The dimensions of y, a, and t are known. It is known that c has no dimensions. Can dimensional analysis be used to determine n? Account for your answer

(ii) Two quantities A and B have different dimension. With reason, which mathematical operations should be used to give a physical meaning?

(c) A hypothetical experiment is conducted to determine young's formula:-

$$Y = \frac{COS\theta\ T^X\ \tau}{L^3}$$

If Y=young modulus, T=time period, τ=Torque and, L=length, then find the dimensional formula for X.

(d) (i) The following observations were actually made during an experiment to find the radius of curvature of a concave mirror using a spherometer: l= 4.4 cm; h=0.085cm.The distance l between the legs of the spherometer was measured with a metre rod and the least count of spherometer was 0.001 cm. Calculate the maximum possible error in the radius of curvature.

Given that, the Radius of curvature;

$$R = \frac{l^2}{6h} + \frac{h}{2}$$

(ii) Given the following experimental results of different quantities. Specify the type of the error presented in the experimental value.

- P= (90±0.01)Nm^{-2}
- L= (67.8±0.15)cm
- V= (10.3±0.2)m^3

Where P=Pressure, V= volume and L= length

(iii) In an experiment to determine the age of a deed wood, it is known that in carbon of living wood there is a total of 18.5±0.322 counts per minute per gram of carbon 14. The count rate recorded by the counter was 12.43±0.728 counts per minute per gram for a particular specimen. If the half life of the radioactive carbon is 5730±28.65 years, determine the age of the specimen and its error. Given that, $A=A_o e^{-\lambda t}$

Where A= Count rate recorded by the counter, A_o=Total count rate, t=age of the specimen, $\lambda = \frac{0.693}{T}$. Where T is the half life.

Qn15.(a) State all applications and all limitations of dimension analysis

(b) A book with many printing errors contains four different formulas for the displacement y of a particle undergoing a certain periodic motion:

i. $y = a\sin 2\pi/T$
ii. $y = a \sin vt$
iii. $y = (a/T) \sin t/a$
iv. $y = (a/\sqrt{2})(\sin 2\pi t/T + \cos 2\pi t/T)$

(a= maximum displacement of the particle, v =speed of the particle, T= time period of motion). Rule out the wrong formulas on dimensional grounds.

(c) (i)The dimensions of energy, and also of those of moment of a force are found to be 1 in mass, 2 in length and -2 in time. Explain and justify this statement.

(ii) A sphere of radius R moving through a fluid of density D with high velocity V experiences a retarding force F given by $F= K.R^x. D^y.V^z$, where K is a non-dimensional coefficient. Use the method of dimensions to find the values of x, y and z.

(d) (i) State two advantages of dimensional analysis.

(ii) Justify that L+L=L and L-L=L, where L is length

(iii) A famous relation in physics relates moving mass M to rest mass M0 of a particle in terms of its speed V and the speed of light C. A girl of form one , recalls the relationship almost correctly but forgets where to put the constant C. She writes:

$$M = \frac{M_0}{\sqrt{1 - V^2}}$$

Guess where to put the missing C.

Qn16, (a) (i) What is meant by dimensional of physical quantity?

(ii) The velocity of transverse wave along a string can be fully expressed in term of tension T in the string, the mass per unit length M of the string and a dimensional constant K use dimensional analysis to derive an expression for V in term of K, T and M.

(b) (i) Explain the difference between systematic error and random errors using particular operation such as the use of a clock to illustrate your answer

(ii) Which type of error is likely to be more misleading?

(c) Two forces have magnitude F1= (66±3)N and F2=(45±2) N. Calculate the absolute percentage maximum uncertainty in:-

i. The sum of the forces.
ii. The product of the forces.
iii. The division/quotient of the forces.

Qn17 (a) (i) Distinguish random error from systematic error.

(ii) Give a practical example of each term in 1(a) (i) and briefly explain how they can be reduced or eliminated.

(b) (i) Define the terms error and mistake.

(ii) An experiment was done to find the acceleration due to gravity by using the formula T=2 $\sqrt{\frac{l}{g}}$, where all symbols carry their usual meaning. If the clock losses 3 seconds in 5 minutes, determine the error in measuring ,g, given that T=2.22sec, l=121.6cm, ΔT=0.1sec and Δl = ±0.05m.

(c) (i) Mention two (2) importance of dimensional analysis in spite of its drawbacks?

(ii) The following measurements were taken by a student for the length of a Piece of rod: 21.02, 20.99, 20.92, 21.11 and 20.69cm. Basing on error analysis, find the true value of the length of a piece of rod and its associated error.

Qn18 (a) (i) What is dimensional constant?

(ii) In the formula ,$X - 3\,y\,Z^2$ Where X and Z and are the dimension of capacitance and magnetic induction respectively. Find the dimension of y in MKSQ system (where MKSQ stand for metre, kilogram, second and charge.)

(b) (i) The specific resistance of a thin circular wire of radius r(cm), resistance, R(Ohms) and length L(cm) is given by ,

$$\rho = \frac{\pi r^2 R}{L}$$

If r= (0.26±0.02)cm, R= (32±1)Ohms and L= (78±0.01)cm. Find the percentage error in ρ.

(ii) What is relative error and absolute error in ρ.

Qn19. (a)(i) State the theory of dimensional analysis

(ii) Dimensional analysis can be used to derive an expression of a physical quantity provided the terms upon which the given physical quantity depends are known. Outline all the steps involved in this method.

(iii) A jet of water of cross sectional area A and velocity V strikes normally on a stationary flat plate. The mass per unit volume of water is Q. By dimensional analysis, show that an expression for the force F exerted by the jet against the plate is given by **KAV^2Q**

(b)The actual length of the playing field is 500m. A measuring instrument shows the length to be 508m.Find:

i. Absolute error in the measured length of the field.
ii. Relative error in the measured length of the field; and
iii. Percentage error in the measured length of the field

(c) Suppose the slope of a best fit line is 1.0 and slopes of maximum and minimum worst lines are 1.16 and 0.81 respectively. Estimate the value of slope of the graph.

Qn20. (a) (i) Distinguish between fundamental and derived quantities and give one example for each.

(ii) The frequency „f‟ of a note given by an organ pipe depends on the length „ ‟ the air pressure „P‟ and density‟s‟. Use the method of dimensions analysis to find the formula for the frequency.

(b) (i) State principles of dimension analysis.

(ii) Prove that Pressure and kinetic energy per unit volume are dimensionally equivalent.

(c) The pressure P, volume V and temperature T of a gas are related as;

$$\left(P + \frac{a}{V^2}\right)(V - b) = cT$$

Where a, b and c are constants. Find the dimensions of $\frac{a}{b}$.

2. NEWTON'S LAWS OF MOTION AND PROJECTILE MOTION.

Qn1. (a) A child is in a flat track moving along a level round with a constant velocity. He throws a tomato vertically upward.

i. Will the child be able to catch the tomato?

ii. Describe the motion of the tomato as seen by the children and by the observer standing alongside the road.

(b) Two guns H and D are mounted 6m apart and rigged to fire simultaneously. The bullets are fired towards each other and collide at a height 1m above the muzzles of the guns. Gun H is fired at a 75^o with speed of $9ms^{-1}$. Find the launch speed and angle and angle Q_D for gun D. Given Q_D¿45^o

(c) (i) Explain why a particle moving in circular path with constant speed has acceleration.

(ii) Centripetal force and centrifugal force are equal in magnitude, but opposite in direction. Do they balance each other?

(iii) Is any work done by centripetal force? Explain.

Qn2. (a) State the Newton‟s Law of motion that define a force;

i. Qualitatively.

ii. Quantitatively.

(b) If the force acting on the body of mass 10kg is given by $F(t) = (2t + 3t^2)N$ where t is time in seconds. Find the impulses of the force at the time interval 1 second to 3 second.

(c) (i) Define the term Collision as applied in Newton
(ii) A perfectly elastic oblique Collision takes place between a moving particle and a stationary particle of equal masses. Show that after the collision, the two particles move at right angles to each other.

Qn3(a) Define the following terms;

i. Projectile motion.
ii. Angle of projection.
iii. Trajectory.
iv. Maximum height.
v. Time of ascent

(b)(i) Explain why the horizontal velocity in projectile motion is a constant.
(ii) State the principle of physical independence of motions.

(c)(i) What assumptions are made in the treatment of projetile motions?
(ii) What are the limitation of projectile motion.
(iii) G ive three examples of projectile motion.

Qn4 (a)(i) Show tha the trajectory of an oblique projectile is a parabola
(ii) The equation of trajectory of an oblique projectile is:-

$$y = \sqrt{3}\,X - \frac{gX^2}{2}$$

What is the initial velocity and the angle of projection of the projectile?

(b) A child is in a fl track moving along a level road with a constant velocity. He throws a mango verticaly upward.

i. Will the child be able to catch the mango?.Explain.
ii. Describe the motion of the mango as seen by the children and by the observer standing alongside the road.

(c) A hunter is aiming straight at a monkey hanging on a tree branch. What should a wise monkey do so that it is not hurt by the firing?.Why?

Qn5(a) In a football match, a player stands 20m away from a goalkeeper. The player kicks the ball towards the goalkeeper at an angle of elevation of 40^o with a speed of 20m/s. The keeper has a time reaction of 0.3seconds.Find

i. In which direction should the keeper run to catch the ball?

ii. The keeper minimum average speed in running to catch the ball just before reaching the ground.

(b) A projectile is aimed at a mark A. When its angle of projection is 30^0 it falls 30m behind point A and when its angle of projection is 45^o it falls far the mark by 50m. Find

i. The horizontal distance from point of projection to point A.
ii. The correct angle of elevation.

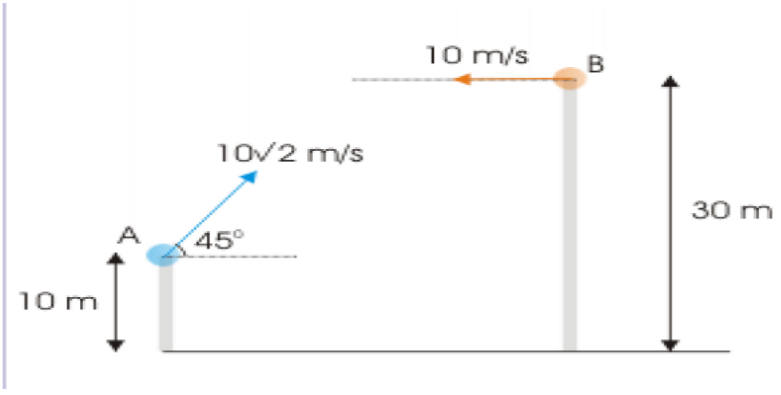
(c)(i) Two bodies initially travelling horizontally in space with velocities of -4m/s and +6m/s are then let to fall under gravity , thus describing a projectile motion. Find when their velocities will be perpendicular to each other.

(ii) A ball is projected at a point A above the cliff of height H, with velocity U making angle to the horizontal. Show that , the horizontal distance covered by the ball just before it strikes a point on a horizontal plane is given by:-

$$X = \frac{U\cos\theta}{g}(U\sin\theta + \sqrt{U^2Sin^2\theta + 2gH})$$

Qn6(a)Two particles are projected at the same instant from two points A and B on the same horizontal plane where AB=30m. The motions take place in a vertical plane containing AB. The initial velocities for the particles from A and B are 40m/s and 25m/s respectively, and their angles of projection are $\sin^{-1}(\frac{7}{20})$ with respect to AB and $\cos^{-1}(\frac{4}{5})$ with respect to BA, respectively. Find out when and where they will collide with each other.

(b)Two projectiles are projected simultaneously from two towers as shown in the figure. If the projectiles collide in the air, then find the distance between the towers.



(c)Two particles A and B are projected to the same point in the same vertical plane ,A is projected at a height of 5m above the ground making an angle of 30^o with the

horizontal ,B is projected with a velocity of 30m/s at the ground below making an angle of 60^{o} with the horizontal if they collide determine:

i. Initial velocity of A.
ii. The horizontal distance moved at the point of collision.
iii. Time taken for collision to occur.

(d)A hawk is flying horizontally at 10.0m/s in a straight line 700m above the ground. A mouse it was carrying is released from its grasp. The hawk continues on its path at the same speed for 3seconds before attempting to retrieve its prey. To accomplish the retrieval, it dives in a straight line at constant speed and recaptures the mouse 10.0m above the ground.

i. Find the diving speed of the hawk.
ii. What angle did the hawk make with the horizontal during its descent?

Qn7 (a)(i) State the Newton‟s law of motion that define

- The qualitative meaning of force.
- The quantitative meaning of force.

(ii) Sand falls vertically at the rate of 0.15kg/s on to a horizontal conveyor belt moving with a velocity of 0.05m/s. What force has to be applied to the conveyor belt to maintain its constant velocity?

(b) (i) Define coefficient of restitution for a pair of colliding bodies.
(ii) A billiard ball of radius 1.5cm moving with 1m/s hits an identical ball at rest. If the impact parameter of the collision is 1.5cm, find the speed and direction of each ball after the collision, assuming it to be elastic.

Qn8. a) i) What is meant by the range of a projectile?
ii) Show that the maximum range of a projectile having an initial speed u is obtained when projectile at an angle of 45^{o} to horizontal.
iii) Give two practical application of projectile at your locality.

b) A stone of mass 2kg is thrown at 5m/s upward at a 30 angle from a cliff 20m high. Calculate;

i. The time it takes to reach the ground.
ii. Its distance from the foot of the cliff.
iii. The speed of the stone on striking the ground.

Qn9(a) (i) What is meant by the term vertex as used in projectile motion?
(ii) Give two factors which determine the span of jump in long jumping.

(b)An aero plane travelling horizontally at 80m/s and at a height of 196m drops a bomb to hit the target.

i. What horizontal distance from the target should the bomb be dropped?
ii. Calculate the velocity of the bomb as it reaches the ground.

Qn10 (a) (i) State Newton‟s law which qualitatively define force.

(ii) The coefficient of restitution of a pair of colliding bodies is zero. What does this Statement means?

(iii)A body of mass 2kg makes elastic collision with another body at rest and turns back along the same line with a speed equal to one half of its original speed. What is the mass of the second body.

(b) (i) State Newton‟s law of experimental impact

(ii) A jet of water of cross section area and velocity 12m/s impinges normally on a plane inelastic wall so that the velocity of water is destroyed on reaching the wall. Calculate the thrust on the wall.

Qn11 (a) (i) Distinguish between a projectile and projectile motion.

(ii.) State four (04) assumptions that were put forward with regards to projectile motion.

(b) The trajectory of a projectile is represented by:-

$$y = x\sqrt{3} - \frac{1}{4}x^2$$

Where x and y are in m.

i. Find the angle of projection.
ii. Find the initial velocity of projectile

(c) A grasshopper can jump maximum distance 1.6m. if spends negligible time on the ground. How far can it go in 10 seconds?

Qn12. (a) A 75Kg hunter fires a bullet of mass 10g with a velocity of 400m/s from a gun of mass 5Kg. Calculate the:

i. Recoil velocity of the gun.
ii. Velocity acquired by the hunter during firing**.**

(b) A jumbo jet travelling horizontally at 50m/s at a height of 500m from sea level drops a luggage of food to a disaster area.

i. At what horizontal distance from the target should the luggage be dropped?
ii. Find the velocity of the luggage as it hit the ground.

Qn13.(a)(i) Mention two characteristics of projectile motion

(ii) A ball is thrown with an initial velocity U of 48m/s directed at an angle of 37^o with the vertical.Find:-

- The X and Y components of U.
- The position of the ball, the magnitude and direction of its velocity when t=2seconds.
- The highest point of the ball and the time taken to reach there**.**
- The range of the ball.

(iii) Why projectile motion is a two dimensional motion?

(iv) Mention two (2) uses of projectile motion in daily life

(b)(i) A person sitting in a moving train throws a ball vertically upwards. How does the ball appear to move to an observer?

- Inside the train?
- Outside the train?

(ii) From the top of a tower 156.8m high, a projectile is thrown up with a velocity of 39.2m/s making an angle 30^o with the horizontal direction. Find the distance from the foot of tower, where it strikes the ground and the time taken by it to do so.

(iiii)If the horizontal range of a projectile is R and the maximum height attained by it is H, then prove that the velocity of projection is:-

$$U= \sqrt{\left[2g\left(H + \frac{R^2}{16H}\right)\right]}$$

(c) Draw the trajectory of the following equations of projectile motion

- $y= x\tan\theta - \frac{gx^2}{2V_0^2\cos^2\theta}$
- $y= \frac{gx^2}{2V_0^2}$
- $y= -x\tan\theta + \frac{gx^2}{2V_0^2\cos^2\theta}$
- $y= x\tan\theta + \frac{gx^2}{2V_0^2\cos^2\theta}$

Where all symbol carry their usual meaning.

(d) (i) A missile fired from a point **O**, with velocity **40 m/s** at an angle to the horizontal, passes through a point distant **32m** horizontally and 45m vertically from **O**. Show that there are two possible angles of projection (give their values to the nearest degree).Illustrate your answers on a diagram**.**

(ii) Prove that the velocity at the end of an oblique projectile is the same in magnitude as at the beginning but the angle that it makes with the horizontal is negative of the angle of projection

(iii) Prove that the motion of one projectile as viewed from another projectile will be a straight line motion.

Qn14.(a)(i) State Newton's first law of motion and Newton's second law of motion

(ii) Show that the Newton's first law of motion gives the qualitative definition of force and the second law gives the measure (or quantitative definition) of force.

(b) A mass less rope is passed over a frictionless pulley. LISA holds on to one end of the rope and a mirror having the same weight as that of LISA, is attached to the other end of the rope at the LISA'S level. Can LISA get away from his image seen in the mirror?

- By climbing up the rope.
- By climbing down the rope.
- By releasing the rope.

(c) An aircraft has 8 machine guns directed straight ahead. Each gun fires bullet of mass 25g at the rate of 1200per minute with a muzzle velocity, measured when the gun is stationary, of 730m/s.

i. By how much is the speed of the aircraft reduced in 5 seconds, when all the guns are firing, if the total mass of the machine and the pilot is 2720kg.
ii. Find the backward force exerted on the aircraft by the firing.

(d) (i) Define coefficient of restitution and show that in a collision in which kinetic energy is conserved, momentum is also conserved.

(ii) Explain how the LIFT OFF of a rocket is achieved.

Qn15.(a)(i) State the general assumptions in studying projectile motion.

(ii) At which point of projectile motion:-

- Kinetic energy is maximum.
- Potential energy is maximum.
- Kinetic energy is minimum
- Velocity is minimum.
- Velocity is maximum.

(b)A body A is thrown from a point 40m from a cliff 90m high, at an angle of elevation of 70^{o} .At the same instant, another body B is thrown from the top of the cliff at an angle of elevation of 30^{o} with a speed of 20m/s. If the two bodies collide, calculate

i. The speed of projection of body A.
ii. The time at which collision occurs.
iii. The horizontal distance from the cliff at which collision occurs.
iv. The vertical distance above the ground at which collision occur.

(c)Two particles are projected at the same time instant from a point 32m from the foot of the post in directions making angles 600 and 450 with the horizontal, so that the former strikes the top of the post at the same moment the latter strikes the bottom of the post. Determine the height of a post.

Qn16. (a) Explain the following

i. It is difficult to move a cycle along a road with its brakes on**.**
ii. Proper inflation of tyres of vehicles saves fuel**.**
iii. Give one argument in favor of the fact that frictional force is a non-conservative force

(b) (i) Define coefficient of restitution for a pair of colliding bodies.

(ii) A 10g bullet is fired from a rifle horizontally into a 5Kg block of wood suspended by a string and the bullet gets embedded in the block. The impact causes the block to swing to a height of 5cm above its initial level. Calculate the initial velocity of the bullet.

Qn17.(a) State the principle of conservation of linear momentum and show how it follows from Newton‟s laws of motions.

(b) A wooden block of mass 5kg is pulled along a rough horizontal table by means of string parallel to the surface of a table which passes over a light frictionless pulley at the edge of the table and carries a mass of 3kg the resistance offered by the surface of the table to the motion of the block is 20N calculate the acceleration with which the block moves.

(c) (i) A body of mass M_1 moving with a velocity u collide inelastically with M_2 at rest. Show that the kinetic energy lost due to this impact is given by:-

$$K.E_{lost} = \frac{1}{2}\frac{m_1u^2}{\left[1+\frac{m_1}{m_2}\right]}$$

(ii) What factor determines the energy loss in this case? How is the energy loss compare when the factor you have mentioned is very large or very small?

Qn18.(a) Explain why the velocity of a body undergoing projectile motion is minimum at maximum height.

(b) A particle is projected from ground level with an initial speed u at an angle θ to the horizontal.

- Derive an expression for the time T elapsed when its velocity change signs.
- Derive expression for maximum height reached.

(c) A missile is projected from a ground level to a target at horizontal distance of 120m if it took 4seconds for a missile to hit the target , determine;

i. The speed and direction of projection of the missile.
ii. The maximum height reached by the missile.

Qn19. (a) Outline the motions that add up to make projectile motion

(b) In the first second of its flight a rocket ejects of $\frac{1}{60}$ its mass with a relative velocity of $2400ms^{-1}$.

i. Find its acceleration.
ii. What is the final velocity if the ratio of initial to final mass of the rocket is 4 at a time of 60seconds?

(c) A package of medical supplies is released from a small plane flying over an isolated single settlement. The plane flies horizontally with a speed of $25ms^{-1}$ at an altitude of 20m. Where will the package strike the ground?

Qn20. (a) (i) State the Principle of conservation of linear momentum.
(ii) Give two (2) examples of the Principle stated in 3 (a) (i) above.

(b) A cannon of mass 1300kg fire a 72kg ball in a horizontal direction with a nuzzle seed of 55ms-1. If the cannon are mounted so that it can recoil freely, Calculate:-

i. Recoil velocity of the cannon relative to the earth.
ii. Horizontal velocity of the ball relative to the earth.

(c) A particle of mass 3.0kg is attached to a point O on a smooth horizontal table by means of a light in extensible string of length 0.5m. The string is fully extended and the particle moves on the table in a circular path about O with a constant angular velocity of 8.0 radians per second. Calculate the tension in the string.

Qn21.(a) (i) What factors determine the span of jump?

(ii) The velocity of the maximum height of a projectile is half its initial velocity of projection, . What is the horizontal distance of the projectile?

(b) A ball falling freely from a given height H hits an inclined plane in its path at a height h as a result of this impact, the direction of velocity of the ball becomes horizontal, for what value of the ball will take maximum time to reach the ground?

(c) (i) State the condition for maximum horizontal range.

(ii) Give one similarity and one difference between projectile and circular motion.

(d) (i) An aeroplane moving horizontally at 150m/s releases a bomb at a height of 500m, the bomb hits the ground intended. What was the horizontal distance of the aeroplane from the tangent when the bomb was released?

(ii) A boy throws a ball horizontally with a velocity of 8m/s from the top of a building. The ball falls to the ground 12m away from the building. What is the height of the building?

Qn22.(a) (i) State Newton's laws of motion.

(ii) A 0.1kg ball moving at a speed of 5m/s in the positive x-direction collide head on with 0.3kg ball that is at rest, assuming that collision is elastic; determine the final velocity of two balls.

(b) A full fuelled rocket of mass 5000kg is set to be fired vertically. If the rocket ejects its gases at a speed of 3×10^3m/s w.r.t the rocket and burns fuel at the rate of 50kg/s. what is the rocket initial upward acceleration? Include the effect of gravity.

Qn23.(a) (i) Outline the motions that add up to make projectile motion

(ii) If R is the horizontal range for θ inclination and h_{max} is the maximum height reached by the projectile. Show that the maximum range is given by:-

$$\mathbf{R_{max} = R^2/[8h_{max} + 2h_{max}]}$$

(b) In the first second of its flight a rocket ejects of its mass with a relative velocity of 6400ms-1.

i. Find its acceleration.
ii. What is the final velocity if the ratio of initial to final mass of the rocket is 3 at a time of 40seconds?

(c) A package of medical supplies is released from a small plane flying over an isolated single settlement. The plane flies horizontally with a speed of $25ms^{-1}$ at an altitude of 20m. Where will the package strike the ground?

Qn24 (a) A lighter object and heavier object have the same momentum. Which one has greater kinetic energy? Show how you obtain your answer.

(b) (i) Define the term impulse and impulsive force.
(ii) A 2Kg ball moving horizontally at a speed of 30m/s is kicked backward and moves with a speed of 10m/s at an angle of 30^o above the horizontal. Determine the impulse imparted on the ball.

(c) A block of mass $m = 1\,Kg$ is pulled by a force of 10N at an angle $\theta = 60^o$ with horizontal surface. Find the acceleration of the block if:-
i. The surface is frictionless.
ii. The coefficient of friction between the surface and block is $\mu = 0.2$.

Qn25. **Mrs.ARISON** sitting on the ground see an aero plane travelling horizontally with a velocity of 200m/s at a height of 650m dropping a luggage of medicine to the victims of **COVID-19**. If the luggage lands on a platform fixed on the ground and that its horizontal distance covered is 51.9 times the height of the platform, Determine,
a) The time taken by the luggage to land on a platform.
b) The height of the platform from the ground.

Qn26.A boy standing at the top of a tall building kicks a ball with a velocity of 56m/s which lands to the ground after 10seconds at a distance of 789m from the foot of a building.
a) Find the angle of inclination to the horizontal at which the ball was kicked.
b) Determine the height of the building.
c) Calculate the landing velocity of a ball and the angle it makes to the horizontal at this instant.

Qn27. (a) A ball is thrown with velocity whose horizontal component is from a point 1.3m above the ground and 6m away from a vertical wall 4.9m high in such a way as just to clear the wall. At what time will it reaches the ground.

(b) A body is projected at an angle such that the horizontal range is three times the greatest height.
i. Find the angle of projection

ii. If with this angle the range is 400m, find the necessary velocity of projection and the time of flight.

3. CIRCULAR MOTION, SIMPLE HARMONIC MOTION, AND GRAVITATION.

Qn1. (a) (i) Define simple harmonic motion.

(ii) Show that the equation $y = A\sin(wt + \varphi)$ represents S.H.M and explain the meaning of the symbols y, $w$and φ.

(b) A body of mass 200g is executing S.H.M with amplitude of 20mm. The maximum force which an act up on it is 0.064N; calculate:-

i. Its maximum velocity.
ii. Its periodic time of oscillation.

(c) The displacement in from the equilibrium position of a particle moving with S.H.M is x in m given by:-

$$x = 0.05\sin 6t$$

Where t is time in second measured from an instant when, x=0.

i. Calculate the time period of the oscillations and maximum acceleration of the particle.
ii. State the amplitude of the oscillation.

Qn2.(a) State Newton's law of gravitational and derive the dimensions of the gravitational constant.

(b) The time taken by the satellite to complete one revolution around the earth's is called time Period of the satellite. It is denoted by T, then show that:-

$$T = \sqrt{3\pi / G\rho}$$

Where is the mean density of the earth.

(c) Assuming the orbit of the earth about the sun to the circular (it is actually slightly elliptical) with Radius 1.5 x 10^{11}m. Find the mass of the sun, the earth revolves around the sun in 3.15 x 10^{7}seconds.

Qn3. (a) What is the angular velocity?

(b) A stone of mass 0.6kg attached to a string of length 0.5m is whirled in a horizontal circle at a Constant speed. If the maximum tension (force) in the string is 30N before it breaks, calculate:-

i. The maximum speed of the stone.
ii. The maximum revolution per second it can make.

(c) A small mass of 5g is attached to one end of a light in extensible string of length 20cm and the other end of the string is fixed. The string is held tout and horizontal

and the mass is released. When the string reaches the vertical position, what are the magnitudes of:-

i. The Kinetic energy (K.E) of the mass.
ii. The Velocity of the mass.
iii. The acceleration of the mass.

Qn4.(a) (i) What is the difference between Geostationary satellite and polar satellite?
(ii) Why space rockets are usually launched from west to east?

(b) (i) A satellite goes round the earth in 90minutes in a circular orbit. Calculate the height of the satellite above the earth taking earth to be a sphere of radius 6370 Km. The value of g at the orbit of the satellite is 9.8 m/s^2
(ii) What is gravitational potential? and hence write down its expression.

(c) (i) What is banking of road?
(ii) A car whose wheels are 1.5m apart laterally and whose centre of gravity is 1.5m above the ground round, a curve of radius 250m. Find the maximum speed at which the car can travel without toppling.

Qn5.(a) (i) Differentiate between forced oscillation and free oscillation.
(ii) Will a simple pendulum vibrate at the centre of the earth? Explain.
(b) (i) Show that the total energy of a body executing S.H.M of $y = ASinwt$ is independent of time.
(ii) The simple harmonic motions are represented by the two equations.

$$y_2 = 5\sin\left(2\pi t + \pi/4\right),\ y_2 = 5\sqrt{2}(\sin 2\pi t + \cos 2\pi t)$$

What is the ratio of their amplitude?

Qn6. (a) (i) What is the criterion for an object to execute simple harmonic motion?
(ii) A body executing simple harmonic motion is associated with the accelerating force acting on it, its velocity and its acceleration. Which of the three physical quantities are in phase?
(b) What do you understand by the following terms:-

i. Damped oscillations.
ii. Undamped oscillations

(c) (i) Sketch the wave form diagrams to represent the terms in 6 (b) above
(ii) A simple pendulum has a period of 1second in city A, where the acceleration due to gravity is 9.66m/s^2. When it is taken to city B it has a period of 1.005seconds. Calculate the value of acceleration due to gravity in city B.

Qn7. (a) (i) Mention one application of parking orbit.
(ii) Briefly explain how the parking orbit of a satellite is achieved?

(b) The Earth satellite revolves in a circular orbit at a height of 600km above the Earth's surface. Find:-

i. The velocity of the satellite.
ii. The period of the satellite.

(c) A man can jump 1.5m high on the Earth. Calculate the approximate height he might able to jump on the planet whose density is ¼ that of the Earth and radius is 1/3 of the Earth.

Qn8. (a) (i) Differentiate between perfect banking and imperfect banking.
(ii) A curve on a road forms an arc whose radius of curvature is 200m. if the width of the road is 10m and its outer edge is 0.49m higher than the inner edge, for what speed it is ideally banked?

(b) (i) Give two practical examples of oscillatory motion which approximate to simple harmonic motion.
(ii) What conditions must be satisfied if the approximations are to be good ones?

(c)A Point mass moves with simple harmonic motion. Draw on the same axes sketch graphs to show the variation with position of:-
i. The potential energy.
ii. The kinetic energy.
iii. The total energy of the particle.

(d) A particle rests on horizontal platform which is moving vertically in simple harmonic motion with an amplitude of 10cm. Above a certain frequency, the thrust between the particle and the platform becomes zero at some point in the motion.
i. What is frequency?
ii. At what point in the motion does the thrust become zero at this frequency?

Qn9. (a) (i) Define the term gravitational field strength.
(ii) Show that the gravitational field strength at a place is equal to the acceleration due to gravity at that place.
(iii) Assuming that the earth were a hollow sphere. Sketch a graph showing how the gravitational field strength would vary from the centre of the earth. Explain the shape of your graph.

(b) A geostationary satellite of mass 2000kg is in its orbit, how much energy is needed to take it out of the gravitational influence of the earth?

Qn10. (a) (i) Why does the kinetic energy of an earth satellite change in the elliptical orbit?
(ii) Give two factors which determine whether a planet has an atmosphere or not.

(b) A space craft is launched from the earth to the moon .If the mass of the earth is 81 times that of the moon and the distance from the centre of the earth to that of the moon is about 4.0×10^5 Km.
i. Draw a sketch showing how the gravitational force on the spacecraft varies during its journey.

ii. Calculate the distance from the centre of the earth where the resultant gravitational force becomes zero**.**

Qn11.(a)The equation of simple harmonic motion is given as,

$$x=6\sin 10\pi t + 8\cos 10\pi t$$

Where x is in centimeter and t in second. Determine the:-

i. Amplitude.
ii. Initial phase of motion.

(b) (i) Show that the total energy of a body executing simple harmonic motion is independent of time**.**

(ii) Find the periodic time of a cubical body of side 0.2m and mass 0.004Kg floating in water then pressed and released such that it oscillates vertically**.**

Qn12. (a) Explain the following:-

i. It is difficult to move a cycle along a road with its brakes on.
ii. Proper inflation of tyres of vehicles saves fuel**.**
iii. Give one argument in favor of the fact that frictional force is a non-conservative force.

(b)(i) Define coefficient of restitution for a pair of colliding bodies.

(ii) A 10g bullet is fired from a rifle horizontally into a 5Kg block of wood suspended by a string and the bullet gets embedded in the block. The impact causes the block to swing to a height of 5cm above its initial level. Calculate the initial velocity of the bullet.

(c)(i) Explain the following observations

- A particle moving in circular path with a constant speed has acceleration
- A motorbike rider bends while going around a corner.

(ii) A racing car goes around a circular curve as fast as it can without skidding. The radius of the curve is 50m and the road is banked at 20^{o} to allow faster speed. If the coefficient of static friction between the road and the tyres is 0.8, determine the maximum speed of the car.

Qn13.(a) (i) State the keplers laws of planetary motion

(ii) Derive the Newton's law of gravitation from kepler's law.

(b) At a certain instant, the earth ,the moon and a stationary spacecraft of mass 1250kg lies at the vertices of an equilateral triangle whose sides are 3.84×10^{3} Km in length.

i. Find the magnitude and direction of the net gravitational force exerted on the spacecraft by the earth and the moon.
ii. What is the minimum amount of work required to move the spacecraft far from the earth and the moon. Ignore any gravitational effects due to other planets and the sun**.**

(c) (i) Show that the gravitational field strength at a place is equal to the acceleration due to gravity at that place.
(ii) Assuming that the earth is a hollow sphere, Sketch a graph showing how the gravitational field strength would vary from the centre of the earth. Explain the shape of your graph.

Qn14 (a)(i) Define the terms amplitude and period as used in simple harmonic motion.
(ii) An object is moving with simple harmonic motion along x-axis with a period of 0.3seconds and amplitude of 6.0cm.At t=0, the object is instantaneously at rest at x=6.0cm. Calculate the time it takes the object to go from 6.0cm to -1.5cm.
(iii) In what circumstances will a particle execute simple harmonic motion?

(b) A block with mass 2kg attached to a horizontal spring of force constant 200N/m is moving with simple harmonic motion having amplitude of 5cm,at the instant when the block passes through its equilibrium position, a lump of putty of mass 200g is dropped vertically on to the block from a very small height and stick to it.
i. Find the new amplitude and period.
ii. Calculate the energy loss in the process.
iii. Comment on the energy loss in (b) (i) above.

(c)A cylindrical test tube has an area of cross-section of 2.0×10^{-4} m^2 ,and is weighed with lead to have a total mass of 50g.It is then set floating in air with a depth h immersed.
i. Why is it necessary to weigh it with lead?
ii. What is the frequency of oscillation when it is set into oscillation**?**

Qn15.(a) Describe the path of a moving body in the event that its acceleration is a constant in magnitudes at all times and:-
i. Perpendicular to the velocity.
ii. Parallel to the velocity.

(b)(i) Explain why a bicycle rider leans inward while taking a turn.
(ii) A pail of water is rotated in a vertical circle of radius 1m. What is the pail's minimum speed at the top of the circle if no water is to spill out?

(c) A body of mass 1kg is attached to the end of a string of length 1m, the other end of which is fixed. The body is allowed to make a conical pendulum with the string inclined at 30^o to the horizontal, Calculate:-

i. The period of oscillation of the body.
ii. The tension in the string.

(d) A small block of mass M is placed in a hemi-spherical bowl of radius r and the bowl is set rotating about its axis of symmetry. The radius vector of the bowl through the block makes an angle with the vertical. Find the angular speed and frequency of the bowl. If may be assumed that there is no friction between the block and the bowl.

(e)(i) What is binding energy of an earth-satellite system?
(ii) A satellite of mass 4000kg moves round the earth in circular orbit of radius 7.5×10^6 m. What is the binding energy of the earth-satellite system?

Qn16.(a)(i) Differentiate between perfect banking and imperfect banking
(ii) A curve on a road forms an arc whose radius of curvature is 200m.If the width of
the road is 10m and its outer edge is 0.49m higher than the inner edge, for what speed it is ideally banked?

Qn17.(a) Define simple harmonic motion.
(b) A point mass move with simple harmonic motion. Draw on the same axes, sketch the graph to show the variation with position of:-
i. Potential energy.
ii. Kinetic energy.
iii. Total energy of the particle.

(c)Two point masses describes simple harmonic motion along the same straight line with an amplitude of 120mm.0ne leads the other by a phase angle of $\frac{\pi}{2}$ radian.
i. At what position from the central position do they cross?
ii. What is their greatest separation?

Qn18.(a) (i) State the law of orbit.
(ii.) Sketch the graph of variation of gravitational field strength with distance from the centre of the earth.

(b) (i) Define intensity of gravitational field.
(ii) Does escape velocity depend upon the mass of the object to be projected? Explain.

(c.) (i) Why the space rockets are generally launched West to East?
(ii) In a two stage launch of a satellite, the first stage brings the satellite to a Height of 150km and the second stage gives if the necessary critical speed to put it in a circular orbit. Which stage requires more expenditure of fuel?

Qn19 (a) State the conditions for a oscillatory motion to be considered simple harmonic.

(b) A block with mass 2Kg attached to a horizontal spring of force constant $200Nm^{-1}$ is moving with simple harmonic motion having amplitude of 5cm. At the instant when the block passes through its equilibrium position, a lump of putty of mass 200g is dropped vertically on to the block from a very small height and stick to it.

i. Find the new amplitude and period.
ii. Calculate the energy loss in the process.
iii. Comment on the energy loss in (b) (i) above

Qn20. (a) (i) What is meant by gravitational constants, G?

(ii) Briefly explain why Newton's equation of universal gravitation does not hold for bodies falling near the surface of the earth

(b) Show that the total energy of a satellite in its orbit equals half it potential energy.

(c) A rocket is fired vertically upward with a speed of 5km/s from the surface of the earth. How far from the earth does the rocket go before returning to the earth?

Qn21.(a) (i) Give an expression for the restoring force acting on the body executing simple harmonic motion (S.H.M).

(ii) How would the period of a simple harmonic oscillator be affected if the amplitude of oscillation is doubled?

(b)Two particles of masses 0.8Kg and 0.3Kg are suspended by a weightless spring of a force constant of 12.5N/m. If the first particle is gently removed at equilibrium, calculate the:-

i. Amplitude of the second particle.
ii. Angular frequency of the second particle.

Qn22. (a) (i) What is meant by escape velocity?

(ii) Why the escape velocity in 22 (a) (i) does not depend on the direction of projection.

(b) (i) How much would the gravitational potential energy of a body of mass increase if it was moved from the earth surface to infinity?

(ii) A body of mass 5.0×10^3 Kg is at a height of 6.4×10^6m above the earth's surface. Determine the kinetic energy acquired by the body in order to escape the earth's field.

Qn23.(a) what provide the centripetal force for:-

i. A space capsule circling the earth.
ii. An electron orbiting the nucleus.
iii. A train traveling round a horizontal circular arc.

(b) A motorcycle has a constant speed of 25m/s as it passes over the top of a hill whose radius of curvature is 130m. The mass of the motorcycle and the driver is 350kg. Find:-

i. The normal force that acts on the cycle.
ii. The speed with which the cycle enters the hill.

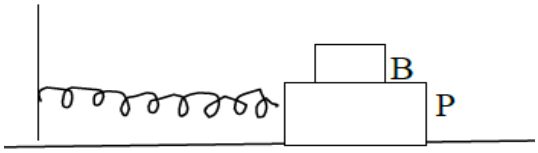
(c) A satellite of mass 800kg is to be put into orbit 500km above the top earth's surface. How much energy is needed to place the satellite into the orbit from the earth's surface?

Qn24. (a) (i) Define simple harmonic motion (s.h.m).

(ii) Give three examples of systems which vibrate with approximate simple harmonic motion.

(b) State the relationship between the force on a body and the distance of the body from a fixed position when the body is executing is k will execute s.h.m when given a small vertical displacement from its equilibrium position and find the period of oscillation.

(c) A flat plate P executes horizontal simple harmonic motion by sliding across a frictionless surface with a frequency of 1.5 Hz. A block B rests on the plate, as shown in figure below and the coefficient of static friction between the block and the plate is 0.6. What maximum amplitude of oscillation can the plate block system have if the block is not to slip on the plate?



Qn25(a) (i) What is a centripetal force?

(ii)A string 0.5m long is used to whirl a 1kg in a vertical circle at uniform speed of 5m/s. Determine the tension in the string when the stone is at:

i. The top of the circle.
ii. The bottom of the circle.

(b) (i) What is the criterion for an object to execute simple harmonic motion?

(ii) A body executing simple harmonic motion is associated with the accelerating force acting on it, its velocity and its acceleration. Which of the three physical quantities are in phase?

(ii) A simple pendulum has a period of 1second in city A, where the acceleration due to gravity is 9.66m/s^2. When it is taken to city B it has a period of 1.005seconds. Calculate the value of acceleration due to gravity in city B.

(c) The Earth satellite revolves in a circular orbit at a height of 600km above the earth's surface. Find:-

i. The velocity of the satellite.
ii. The period of the satellite.

Qn26. (a) Define the following terms as used in simple harmonic motion.

i. Amplitude.
ii. Period.

(b) A simple pendulum of length 1.5m has a bob of mass 2.0kg.

i. State the formula for the period of small oscillation and evaluate it in this case.
ii. If with a string taut a bob is pulled aside a horizontal distance of 0.15m from the mean position and then released from rest, find the kinetic energy and the speed with which it passes through the mean position.
iii. After 50 complete swings, the maximum horizontal displacement of the bob has become only 0.10 m . What fraction of the initial energy has been lost.

(c) A cubical body (0.1m and mass 0.002kg) floats in water. It is pressed and then released so that it oscillates vertically. Find the time period.

Qn27.(a) A bucket of water is swung in a vertical circle of radius r in such a way that the bucket is upside down when it is at the top of the circle. What is the minimum speed that the bucket may have at this point if the water is to remain in it.

(b) Use Newton's laws of motion to explain why a body moving with uniform speed in a circle must experience a force towards the centre of the circle.

(c) A particle is attached by means of inextensible string to a point 0.4m above a smooth, horizontal table. The particle moves on horizontal table in a circle of radius 0.3m with angular velocity ω. Find the reaction on the particle in terms ω

Qn28. (a) Explain why an artificial satellite will revolve with high speed for an orbit of small radius than for that of large radius

(b) Consider a circle that represents a planet of radius r = 4.8 x 10^6m with gravitation field strength at the surface of 16N/Kg .

(i) Draw on the diagram a set of solid lines to represent the gravitation field of the planet.

(ii) Calculate the difference in height of point P and Q above the surface of the planet given that $V_P = -5.5\,x\,10^7\ J/Kg$ and $V_Q = -6.9\,x\,10^7\ J/Kg$.

4 . ROTATION OF RIGID BODIES.

Qn1. (a) (i) Define torque and give its SI unit

(ii) A disc of moment of inertia of 2.5 x 10^{-4} kgm^2 is rotating freely about an axis through its centre at 20rev/min. If some wax of mass 0.04kg is dropped gently onto the disc 0.05m from its axis, what will be the new revolution per minute of the disc?

(b) Explain briefly why:-

i. Higher diver can turn more somersaults before striking the water?
ii. Dancer on skates can spin faster by folding her arms?

(c) A heavy flywheel of moment of inertia 0.4kgm^2 is mounted on a horizontal axle of radius 0.01m. If a force of 60N is applied tangentially to the axle:-

i. Calculate the angular velocity of the flywheel after 5seconds from rest.
ii. List down two (2) assumptions taken to arrive at your answer in 1 (c) (i) above.

(d) A constant force of 40N is applied tangentially to the rim of a wheel of radius 10cm mounted on a fixed axle which is initially at rest. If the wheel has a moment of inertia of0.2Kgm^{-2} , calculate the:-

i. Torque acting on the wheel.
ii. Work done on the wheel after 5 revolutions.

Qn2. (a) Briefly explain the meaning of radius of gyration.

(b) Explain the following observations:-

i. Flywheels are often large diameter wheels with heavy rims rather than disc type wheels of constant thickness.
ii. An ice skater rotates faster is she draws her arms closer to her body

(c) A constant torque of 200Nm twists a wheel about its axis is 100Kgm^{-2}. Find

i. The angular velocity gained in 4 seconds.
ii. The kinetic energy gained after 20 revolutions.

(d) (i) Explain what is meant by moment of inertia and angular momentum.

(ii) A constant force of 30N is applied tangentially to the rim of wheel mounted on a fixed axle and which is initially at rest. The wheel has moment of inertia of 0.2Kgm^{-2} and radius of 15cm. Find the work done on the wheel in 10 revolutions.

Qn3.(a) Define the following terms as applied in rotation dynamics:

i. Torque Ꞇ .

ii. Angular acceleration.

(b) (i) Write down relation connecting the terms in (a) above.
(ii) Represent graphically the variation of Ꞇ and ⍺ on a rigid body.

(c)A fly wheel rotates on a bearing which exerts a constant friction torque of 12Nm. An external torque of 36Nm acts on the flywheel for 15 seconds, and then removed. If the angular velocity of the flywheel increased from zero to 60rad/s in 15seconds period;

i. Calculate movement of material of the flywheel.
ii. Find at what further time the flywheel will come to rest.

(d)(i) Define moment of inertia qualitatively
(ii) A platform is rotating at an angular speed of 2.2rad/sec. A block is resting in this platform at a distance of 0.30m from the axis. The coefficient of static friction between the block and the platform is 0.75.Without any external torque acting on the system, the block is moved towards the axis. Ignore the moment of inertia of the platform, determine the smallest distance from the axis at which the block can be relocated and still remain in place as the platform rotates.

(e) Justify the statement that If no external torque acts on a body, its angular velocity will not be conserved.

Qn4.(a) (i) Define the Parallel axes theorem and perpendicular axes theorem.
(ii) Define the term torque and give its SI unit.
(iii) If you stop a spinning raw egg for a shortest possible instant and the released, the egg will start spinning again. If you do the same for a hard –boiled egg, it will remain stopped. Explain this.

(b) Prove the result that velocity V of translation of a rolling body (like a ring, disc, cylinder or sphere) at the bottom of an inclined plane of a height h is given by:-

$$V^2 = \frac{2gh}{1+\frac{k^2}{R^2}}$$

Using dynamical consideration (i.e., by consideration of forces and torques).Note k is the radius of gyration of the body about its symmetry axis, and R is the radius of the body. The body starts from rest at the top of the plane.

(c) A rigid body rotates about an axis with an angular velocity ω. If the relevant moment of inertia of the body is I, show that its rotational kinetic energy is $\frac{1}{2} I \omega^2$.

(d) A metal cylinder of moment of inertia 1.8 x 10^{-3} Kg and radius 3cm, can rotate about its axis of symmetry which is horizontal. A string is wrapped round the cylinder and a 800g mass is attached to the end of string. When the mass is released it causes the cylinder to rotate. Find:-

i. The linear acceleration of the mass.

ii. The tension in the string.

Qn5. (a) (i) Define torque and give its SI unit

(ii) A disc of moment of inertia of 2.5×10^{-4} kgm^{-2} is rotating freely about an axis through its centre at 20rev/min. If some wax of mass 0.04kg is dropped gently onto the disc 0.05m from its axis, what will be the new revolution per minute of the disc?

(b) Explain briefly why:-

i. Higher diver can turn more somersaults before striking the water?
ii. Dancer on skates can spin faster by folding her arms?

(c) A heavy flywheel of moment of inertia 0.87 Kgm^{-2} is mounted on a horizontal axle of radius 0.089m. If a force of 166N is applied tangentially to the axle:-

i. Calculate the angular velocity of the flywheel after 5seconds from rest.
ii. List down two (2) assumptions taken to arrive at your answer in 4 (c) (i) above.

5. FLUID DYNAMICS

Qn1.(a) Define the following terms with respect to the fluid flow.

i. Critical velocity
ii. Reynolds's number.
iii. Turbulent flow.
iv. Irrotational flow.

(b) Explain the following observations:-

i. Why you cannot remove the filter paper from the funnel by blowing into the narrow end.
ii. A table tennis ball may be supported in a narrow jet of air.
iii. Why fire fighters have a jet attached to the head of their water pipes?
iv. People living in a houses far removed from a municipal water tank often, find it difficult to get water on the top floor even if it is situated lower than the level of water tank. Why?
v. Why the wings of an aero plane are rounded outwards while flattened inwards?

(c)(i) State the Poiseuille's theorem

(ii) The level of liquid in a cylindrical vessel is kept constant at 35cm. It has three identical horizontal tubes of length 39cm each coming out at heights 0 cm, 5 cm and 9 cm respectively. Calculate the length of a single overflow tube of the

same radius as that of the three identical tubes which can replace them, when placed horizontally protruding at the bottom of the cylinder.

(d) A garden hose has an inside cross-sectional area of 3.60cm2 and the opening in the nozzle is 0.25cm^2. The water velocity is 50m/s in a segment of the hose that lies on the ground

i. With what velocity does the water leave the nozzle when it is held 1.50m from the ground?
ii. What is the water pressure in the hose on the ground? Given: Pressure at the nozzle is 1atm and density of water is 1000kg/m^3.

Qn 2.(a)(i) State the Bernoulli's principle

(ii) Briefly explain three application of Bernoulli's principle.

(iii) Mention three important features of an ideal liquid.

(b) (i) Water flows steadily along a horizontal pipe at a volume rate of 8 x 10^{-3} m^3s^{-1}. If the area of cross-section of the pipe is 40cm^2, calculate the flow velocity of the water.

(ii) Find the total pressure in the pipe if static pressure in the horizontal pipe is 3.0 x 10^4 Pa, assuming the water is incompressible, non-viscous and its density is 1g/cm^3

(iii) What is the new flow velocity if the total pressure is 3.6 x10^4 Pa?

(c) Give reason for the following observations as applied in viscosity.

i. Why the viscosity of gases increases with the rise of temperature?
ii. High viscosity liquids are used as buffers in trains.
iii. Machine parts are jammed in winter.

(d) (i) Show that if three capillaries of radii r_1, r_2 and r_3 and having L_1, L_2 and L_3 respectively are connected in series across head of pressure P, the rate of flow of the liquid is given by:-

$$Q = \frac{\pi P}{8\eta\left(\frac{L_1}{r_1^4}+\frac{L_2}{r_2^4}+\frac{L_3}{r_3^4}\right)}$$

(ii) A fully loaded Boeing aircraft has a mass of 3.3 x 105Kg. Its total wing area is 500 m^2 .It is in level flight with a speed of 960Km/hr.

- Estimate the pressure difference between the lower and upper surfaces of the wings.
- Estimate the fraction increase in the speed of the air on the upper surface of the wing relative to the lower surface.

Qn3.(a) (i) The oils used as lubricants should have greater value of viscosity. Why**?**

(ii) State the equation of continuity.

(iii) Give any two differences between streamline flow and turbulent flow.

(b) (i) What does critical velocity and Reynolds`s number signify in a fluid flow?

(ii) Explain why when temperature increases, the viscosity of liquids decreases while the viscosity of gases increases?

(c) Calculate the critical velocity for air flowing through a tube of 1x10-2 m radius. Given that density of air p=1.3 kgm^{-3} and η=181x10 Nsm^{-2} and N_R=2000.

(d) (i) What is terminal velocity?

(ii) In an experiment to determine the coefficient of viscosity of motor oil the following measurements were made; mass of glass sphere, m=0.12g, diameter of sphere, d=4mm, terminal velocity of sphere, V=5.4cm/s, density of oil, p=860kg/m^3. Calculate the coefficient of viscosity of the oil.

Qn4. (a) State Bernoulli`s principle and give all the limitations.

(b) Derive the Bernoulli's equation from,

i. Work-Energy theorem.
ii. Newton's second law of motion

Give all the assumptions used.

(c) What is an aero foil and explain how is it made to lift up?

(d) (i) State Torricelli`s theorem.

(ii) A drum of 30 cm radius has a capacity of 220dm^3 of water. It contains 198dm^3 of water and is placed on a solid block of exactly the same size as drum. If a small hole is made at lower end of the drum perpendicular to its length, find the horizontal range of water on the ground in the beginning.

(e) The flow of blood in a large artery of an anaesthetized dog is diverted through a venturimeter. The wider part of the meter has a cross-section area equal to that of the artery, A=8mm^2.The narrower part has an area a=4mm^2. The pressure drop in the artery is 24Pa. what is the speed of the blood in the artery? Assume density of blood ρ=1.0 x10^3 kgm^{-3}.

Qn 5.(a) Write short notes on the following terms as applied in fluid dynamics

i. Laminar flow.
ii. Turbulent flow.
iii. Critical velocity.
iv. Reynolds number.
v. Irrotational flow.
vi. Rotational flow,
vii. Compressible fluid.
viii. Incompressible fluid

(b) Twelve spherical raindrops of equal size are falling vertically through air with a terminal velocity of 56m/s .What would be the terminal velocity if these two drops were to coalesce to form a large spherical drop?

(c) (i) Write the Poiseuilli's formula. Using method of dimensions, find the expression for the Poiseuilli's formula.

(ii) Two capillaries of the same length and radii in ration 1: 2 are connected in series and a liquid flows through this system under streamline conditions. If the pressure across the two extreme ends of the combination is 67m of water, what is the pressure difference across the first and second capillary?

(d) Water is flowing through a horizontal pipe having different cross-sections at two points A and B. The diameters of the pipe at A and B are 0.6m and 0.2m respectively. The pressure difference between points A and B is 18m column of water. Calculate the volume of water flowing per second.

Qn.6 (a) (i) Give the difference between types of liquid flow.

(ii) Based on the concept of dimension analysis, prove that the critical velocity is given by:-

$$V_C = \frac{K\eta}{r\rho},$$

Where k=1100 and the symbols carry their usual meaning.

(b) (i) Why does smoke go up a chimney?

(ii) Water flows faster than honey. Why?

(c) A large bottle is fitted a siphon made of glass tubing, compare the coefficient of viscosity of water and petrol. If the time taken to empty the bottle in the two cases is in the ratio of 20:50. Specific gravity of petrol is 0.8

(d) (i) What is terminal velocity?

(ii) An oil drop falls through air with a terminal velocity of 5×10^{-4}m/s. Calculate terminal velocity of a drop of half of this radius.

Qn7.(a) Distinguish between the following terms as applied to the study of fluid dynamics.

i. Streamline and turbulent flow of fluid.
ii. Compressible and incompressible fluid.
iii. Terminal and critical velocity.

(b) Account for the following observations using the knowledge you get by studying fluid dynamics:-

i. Dust generally settles down in a closed room.
ii. Clouds seem floating in the sky. Why?

(c) Two equal drops of water are falling through air with steady velocity $10cm^{-1}$. If they combine to form a single drop, what will be the new terminal velocity?

(d) One of the most interesting applications of the Bernoulli's theorem is Venturimeter which is used to determine the pressure and velocity in the main pipe by utilizing a constricted pipe, the fluid which is passed in the Venturimeter has its density ρ.

i. Show that the velocity at the constricted part of the Venturimeter is inversely proportional to the square root of its density.
ii. State the assumption(s) used in your derivation above.
iii. A venturimeter is 37.5cm in diameter in the mains and 15cm diameter in the throat. The difference between the pressure of water in the mains and throat is 23 cm of mercury. Find the rate of discharge of water from the venturimeter.

6 .PROPERTIES OF MATTER

Qn1 (a) (i) Define the term surface tension
(ii) Describe how can you determine (or measure) the surface tension by microscope slide.

(b)(i) Several spherical drops of a liquid of radius r coalesce to form a single spherical drop of radius R. If T is the force of surface tension, calculate the release of energy during the process, if all energy released is converted into the kinetic energy, Find the velocity acquired by the drop in terms of T, r, R and ρ, where ρ is the density of the drop.

(ii) The lower end of a clean capillary tube of internal diameter 0.8mm is dipped into a beaker containing a soap solution and at the upper end; there is a bubble of diameter 4.0mm of the same soap solution. If the soap solution of density $1.0g/cm^3$ rises 25.6mm up the tube, what is the surface tension of soap solution?

(c) (i) Give four (4) assumptions of kinetic theory of gases.
(ii) Derive an expression for the gas pressure.

(d) (i) Define the term mean free path.
(ii) Derive an expression for the mean free path.

Qn2.(a) (i) How do you distinguish elasticity from plasticity?
(ii) Calculate the work done in stretching copper wire of 100cm long and $0.02cm^2$ cross sectional area when a load of 120N is applied.

(b) (i) Mention any two factors on which modulus of elasticity depend
(ii) A rubber cord of a catapult has cross sectional area of $2mm^2$ and original length 0.2m and is stretched to 0.24m to fire a small stone of 10g.Calculate the initial velocity of the object when it just leave the catapult.

(c) Briefly explain the following observations

i. Soap solution is better cleansing agent than ordinary water.
ii. When a piece of chalk is put into water, it emits bubbles in all directions.

(d) (i) Two spherical soap bubbles are combined. If V is the change in volume of the contained air, A is the change in total surface area, Show that $3PaV + 4AT = 0$, Where T is the surface tension and Pa is the atmospheric pressure.
(ii) There is a soap bubble of radius 3.6×10^{-4} m in air cylinder which is originally at a pressure of 10^5 N/m^2 .The air in the cylinder is now compressed isothermally until the radius of the bubble is halved. Calculate the pressure of air in the cylinder.

Qn3 (a) (i) Water rises to a height h inside a clean glass capillary tube of radius 0.2 mm when the tube is placed vertically inside a beaker of water. Calculate h if the surface tension of water is 0.07N/m^2 and the angle of contact is zero.
(ii) The tube is now pushed into water until 4.0cm of its length is above the surface. Describe and explain what happens.

(b) State Hooke's law and define Elastic limit.

(c) A copper wire LM is fused at one end, M to an iron wire MN. The copper wire has length 0.900m and cross-section 0.90×10^{-6} m^2 .The iron wire has length 1.400m and cross-section 1.3×10^{6} m^2 .The compound wire is stretched; its total length increases by 0.0100m. Calculate:-

i. The ratio of the extensions of the two wires.
ii. The extension applied to the compound wire**.**
iii. The tension applied to the compound wire.

Qn4.(a)(i)Define surface tension in terms of energy.
(ii) What amount of energy will be liberated if 1000 droplets of water each $1o^{-8}$ m diameter coalesce to form a large spherical drop? Surface tension of water is 0.072N/m.

(b)(i)Suppose that 64 raindrops combine into a single drop. Calculate the ratio of the total energy of the 64 drops to that of a single drop.
(ii)If a number of little droplets of water, all of the same radius r, coalesce to form a single drop of radius R, show that the rise in temperature is given by:-

$$\frac{3\gamma}{\rho J}\left[\frac{1}{r} - \frac{1}{R}\right]$$

Where γ is the surface tension of water and J is the mechanical equivalent of heat.

(c)The tension in skin of the left ventricle of the heart is 4.90N/m. A 4cm cut is made on the left ventricle during open-heart surgery. How many stitches must be used to repair the cut? Each stitch will safely support a tension of 0.4N.

(d)A spherical soap bubble of radius R is floating in a gas inside a cylinder fitted with a frictionless piston. The piston is slowly then withdrawn with no rise in temperature of the gas until the radius of the bubble is doubled. Show that the final pressure, P, of the gas in the cylinder is then given by:-

$$P = \frac{P_o}{8} - \frac{3\gamma}{2R}$$

Where P_o the original is pressure of the gas in the cylinder and γ is the coefficient of surface tension of the soap solution.

Qn5.(a) A spring 60cm long is stretched by 2cm by the application of a load of 200g.What will be the length when a load of 500g is applied?

(b) Calculate the percentage increase in length of a wire of diameter 2.2mm stretched by a load of 100kg. Young's modulus of wire is 12.5×10^{10} N/m^2.

(c) An aluminum cube of each side 4cm is subjected to a tangential force. The top face of the cube is sheared 0.012cm with respect to the bottom. Find:-

(i) Shearing strain.
(ii) Shear stress and
(iii) Shearing force. Given that modulus of rigidity is 2.08×10^{10} N/m^2

(d)A 40kg girl whose leg bones are 4cm^2 in area and 50cm long falls through a height of 2m without breaking his leg bones. If the bones can stand a stress of 0.9×10^8Nm^{-2} .Calculate the young's modulus for the material of the bone.

Qn6.(a) Define the following terms

(i) Longitudinal strain.
(ii) Compressibility.
(iii) Poisson's ratio

(b) The rubber cord of catapult has a cross- section area of 1×10^{-6}m^2 and total unstretched length of 0.1m. It is stretched to 0.12m and them released to project a missile of mass 5×10^{-3}Kg. If Young's modulus of rubber is 5×10^8Nm^{-2}. Calculate the value of velocity of projection.

(c) (i) Why iron is more elastic than rubber?
(ii) What is ultimate strength of a material?

(d) (i) Mention two factors that affecting angle of contacts.
(ii) There is a soap bubble of radius 2.4×10^{-4}m in air of cylinder which is originally at a pressure of 10^5Nm^{-2}.The air in the cylinder is now compressed isothermally until the radius of the bubble is halved. Calculate now the pressure of air in the cylinder.

Qn.7(a) (i) All molecular motion ceases at 0K. Explain.
(ii) When does Charle's law fail?

(b) (i) Calculate the root mean square speed of an air molecule of temperature , if one mole of air has a mass of 29g.
(ii) What is ideal gas?

(c) Estimate the mean free path and collision frequency of nitrogen molecule in a cylinder containing nitrogen of 2atm and temperature 17°C. Take the radius of a nitrogen molecule to be roughly 1.0Å. Compare the collision time with the time the molecule moves freely between successive collisions.

(d) (i) What is monatomic gas?
(ii) Calculate the total number of degree of freedom possessed by the molecules of $1cm^3$ of H_2 gas of at N.T.P.

Qn 8 (a) What do you understand by the following terms:-
(i) Elastic bodies.
(ii) Plastic bodies.
(iii) Elastic energy.
(iv) Elastic hysteresis

(b) Explain the following.
(i) Why work is required to be done to stretch a wire? Where does the energy stored?
(ii) What will happen to the potential energy if a wire is:-
- Compressed?
- Stretched?

(iii) Two identical solid balls, one of ivory and the other of wet-clay, are dropped from the same height on the floor. Which will rise to a greater height after striking the floor and why?

(c) What is the density of water at a depth where pressure is 80atm, given that its density at the surface is 1.03×10^3 Kgm^{-3}.

(d)A rigid bar of mass 15 Kg is supported symmetrically by three wires each of 2.0cm long. Those at each end are of copper and the middle one is of iron. Determine the ratios of their diameters if each is to have the same tension.

7. HEAT

Qn1. (a) Two thermometers are based on different properties but they are calibrated by using the same fixed points. To what extent are the thermometers likely to agree when used to measure temperature.
(i) Near one of the fixed points?
(ii) Mid – way of the two fixed points?

(b) (i) Explain why a thermometer registers its own temperature?
(ii) A faulty thermometer has 98.5°C and – 0.5°C marked as upper and lower fixed points. What is the correct temperature if this faulty thermometer reads 23°C?
(c) A thermocouple is constructed of gold and iron whose thermoelectric powers are $25.8+0.01\theta$ and $117.5-0.048\theta$ microvolt's per °C. Find
(i) Neutral temperature.

(ii) The maximum e.m.f obtained with this thermocouple.

Qn2. (a) (i) What is a reversible adiabatic change?

(ii) State the condition for an adiabatic change to take place.

(b) Show that for an ideal gas the curves relating pressure and volume for an adiabatic change have a greater slope than those for an isothermal change at the same pressure.

(c) Is it possible for the temperature of a substance to rise without heat flowing into it? Does the temperature of a substance necessary have to change because heat flows into or out of it ? In each case give your reasoning and use the example of an ideal gas.

Qn3. (a) (i) Brief explain how a temperature scale can be realized.

(ii) Explain why the same temperature measured on two different scales need not have the same value.

(iii) The following readings were obtained with a constant – volume air thermometer

	Level of mercury in closed limb (mm)	Level of mercury in open limb (mm)
Bulb in melting ice	136	112
Bulb in steam at 76cm pressure	136	390
Bulb at room temperature	136	160

Calculate the room temperature.

(b) One face of a sheet of cork, 3mm thick, is placed in contact with one face of a sheet of glass 5mm thick, both sheets being 20cm square. The outer faces of this square composite sheet are maintained at 100°C and 20°C , the glass being at a higher mean temperature. Find:

(i) The temperature of the glass – cork interface.

(ii) The rate at which heat is conducted across the sheet, neglecting edge effects.

(c) The first law of thermodynamic can be written $\Delta Q = \Delta U + \Delta W$.Where ΔQ is the heat supplied to a substance, ΔU is the increase in its internal energy, and ΔW is the external work done by the substance.

(i) What information does the law provide about the energy involved in a given process?

(ii) What situation or process is described by writing?

(1) $\Delta Q = O$. (2) $\Delta U = O$. (3) $\Delta W = O$.

Qn4. (a) Briefly explain why:-

(i) The tile floor feels colder than the wooden floor, even though both floor materials are at the same temperature.

(ii) The good absorber of radiant energy appear black.

(b) An aluminum foil of relative emittance is 0.2 placed between two concentric spheres at temperatures of 200K and 100K respectively. Calculate the:-

(i) Temperature of the foil at steady state condition.

(ii) Rate of heat transfer between one of the spheres and the foil.

(c) (i) How does triple point differ from critical temperature?

(ii) Two absolute scales A and B have triple points of water defined to be150A and 250B. What is the relation between T_A and T_B?

Qn5. (a) What is meant by the following terms as used in thermodynamics:-

(i) Isolated system.

(ii) Closed system.

(b) (i) Briefly explain the idea on which the first law of thermodynamics is based.

(ii) 1.og of water becomes 1254cm^3 of steam at a pressure of 1.013 x 10^5Pa. If the latent heat of vaporization at this pressure is 1857 Jg^{-1}. Calculate the external work and increase in internal energy.

(c) (i) Give two examples of irreversible process.

(ii) A motor car tyre has a pressure of four atmospheres at a room temperature of 27^oC . If the tyre suddenly busts, calculate the temperature of escaping air.

Qn6.(a) Define the following terms:-

(i) Temperature.

(ii) Thermometric property.

(iii) Thermometer.

(iv)Inversion temperature.

(b) (i) What is the difference between a boiling point and the triple point.

(ii) State two advantages of using platinum resistance thermometer.

(c.) In a certain thermocouple, the thermo e.m.f is given by:-

$$E = a\theta + \frac{1}{2}\beta\theta^2$$

Where $\theta$is the temperature of the hot junction; the cold junction be at 0^oC. If $a = 10\,\mu V\,^oC^{-1}$ and$\beta = \frac{-1}{20}\,\mu V\,^oC^{-2}$. Find:-

(i) The neutral temperature.

(ii) The temperature of inversion.

Qn7.(a) (i) Differentiate between heat and temperature.

(ii) Give a brief account of the principles underlying the establishment of temperature scale.

(b) (i) Define the terms perfect black body and emissivity
(ii) State Kirchhoff's law of heat radiation
(iii) A composite bar is made of a bar copper 10cm long and iron 8cm long, both of the same Cross section area and are in series. If the free end of copper is maintained at 100°C and the free end of iron bar at 0°C.Determine the temperature of the junction.

Qn8. (a) (i) Define thermometric property of a material.
(ii) What qualities make a particular property suitable for use in a practical thermometer?

(b) (i) State two conditions for an e.m.f to appear between the junction of the thermocouple.
(ii) The e.m.f ,E (mV) of a certain thermocouple is found to vary with temperature, t , according to the relation:

$$E = 40t - \frac{t^2}{20}$$

Where t is the temperature of the hot junction, the cold junction kept at 0°C.What is the neutral temperature of the thermocouple?

(c) The value of the property X of a certain substance is given by:

$$X_\theta = X_0 + 0.5\theta + 2x10^{-4}\theta^2$$

Where θ is the temperature in degree Celsius. What would be the Celsius temperature defined by the property X which corresponds to a temperature of 50°C on this gas thermometer scale?

Qn9.(a) (i) Describe how mercury in glass thermometer could be made sensitive.
(ii) A sensitive thermometer can be used to investigate the difference in temperature between the top and bottom of the waterfall. Calculate the temperature difference of the water fall 50m high.

(b) (i) The resistance and gas thermometers may show different values in measuring the temperature of the surrounding. Explain the reason behind.
(ii) Give two (2) advantages and disadvantages of the electrical resistance thermometer.

(c)The electrical resistance in ohms of a certain thermometer varies with the temperature according to the approximate law. $RT = R0[1+0.0005(T-T0)]$.The resistance is 101.6Ω at the triple point of water and 165.5Ω at the normal point of lead (600.5K).By graphical method determine the temperature when the resistance is 123.4Ω. Given triple point of water as 273.16K.

Qn10. (a) How is a centigrade temperature defined on:-
(i) the scale of constant – volume gas thermometer?

(ii) the scale of platinum resistance thermometer?

(b) A constant mass of gas maintained at constant pressure has a volume of $200.0cm^3$ at the temperature of melting ice, $273.2cm^3$ at the temperature of water boiling under standard pressure, and $525.1cm^3$ at normal boiling point of sulphur. A platinum wire has resistance of 2.000Ω, 2.778Ω, and 5.280 Ωat the same temperatures. Calculate the values of the boiling point of sulphur given by the two sets of observations and comments on the results

(c)Explain the observations that, a piece of metal when heated it first appears red then white.

Qn11. (a) (i) Brief explain how a temperature scale can be realized.

(ii) Explain why the same temperature measured on two different scales need not have the same value.

(iii)The following readings were obtained with a constant – volume air thermometer.

	Level of mercury in closed limb (mm)	Level of mercury in open limb (mm)
Bulb in melting ice	567	712
Bulb in steam at 76cm pressure	567	990
Bulb at room temperature	567	660

Calculate the room temperature.

(b) One face of a sheet of cork, 3mm thick, is placed in contact with one face of a sheet of glass 5mm thick, both sheets being 20cm square. The outer faces of this square composite sheet are maintained at 100°C and 20°c,the glass being at a higher mean temperature. Find:-

(i) The temperature of the glass – cork interface.

(ii) The rate at which heat is conducted across the sheet, neglecting edge effects.

(c) The temperature of 5.0 moles of oxygen is increased from 290 K to 310 K at a constant pressure of 6.0×10^5 Pa. Take the molar special capacity for oxygen as 39 $Jmol^{-1}K^{-1}$ and calculate:-

(i) The heat supplied.

(ii) The volume change.

(iii) The work done by the gas in expanding.

Qn12.(a) Explain how a centigrade temperature scales is defined, illustrating your answer by reference to a platinum resistance thermometer.

(b) The resistance Rt of platinum wire at temperature t°C, measured on gas scale, is given by $Rt = Ro(1 + at + bt^2)$, where $a=3.800 \times 10^{-3}$ and $b=-5.7 \times 10^{-7}$. What

temperature will the platinum thermometer indicate when the temperature on the gas scale is 200°C?

(c) (i)Define the thermal conductivity of a material.

(ii)A copper kettle has a circular base of radius 10cm and thickness 3.0mm. The upper surface of the base is covered by a uniform layer of scale 1.0mm thick. The kettle contains water which is brought to the boil over an electric heater. In the steady state condition, 5.0g of steam is produced each minute. Determine the temperature of the lower surface of the base assuming the conduction of heat along the surface of the kettle can be neglected .Thermal conductivities of copper and scale are $382Wm^{-1}K^{-1}$ and $1.34Wm^{-1}K^{-1}$respectively.

Qn13.(a) Explain briefly why:-

(i) The tile floor feels colder than the wooden floor, even though both floor materials are at the same temperature?

(ii) You can hold your fingers beside the candle without harm but not above the flame?

(b) (i) State three (3) laws of a black body radiations.

(ii) The roof which measures 20m by 50m is blackened. Find the solar energy incident onto the roof per minute if the temperature of the sun's surface is about 6000K, given that half of the energy is absorbed while passing through the atmosphere, the roof being normal to the sun's rays.

Qn14. (a) (i) State the first law of thermodynamics, defining all the terms involved.

(ii) An ideal gas is kept in the thermal contact with a very large body of constant temperature T and undergoes an isothermal expansion in which its volume changes from V_1 to V_2. Derive an equation for the work done by the gas.

(b) (i) Assuming that the human body has the total surface area of $1.18m^2$ and surface temperature of 30^0C. Find the total rate of radiation energy from the body if emissive power of the body is 30%.

(ii) A metal sphere with a black surface and radius 40mm is cooled to -77°C and placed inside an enclosure at a temperature of 23°C. Calculate the initial rate of temperature rise of the sphere, assuming that the sphere is a black body.

Qn15.(a) (i) State Stefan's law.

(ii) The sun's rays are focused by a concave mirror of diameter 12cm fixed with its axis towards the sun onto a copper calorimeter, where they are absorbed. If the thermal capacity of the calorimeter and its contents is 247.8 Joule per degree centigrade and the temperature rises by8°C in 2 minutes. Calculate the heat received in 1minute by a square metre of the earth's surface when their rays are incident normally.

(b) (i) State two limitation of Newton‟s law of Cooling

(ii) A body cools from 80°C to 70°C in 10minutes. What will be the temperature of the body in 15minutes If surrounding is kept at 28°C.

Qn16.(a) Define the following process:-

(i) Isobaric.

(ii) Isochoric.

(b) What amount of heat is to be transferred to nitrogen gas in an isobaric heating so that the gas may perform 2J of work?

(c) (i) Absolute zero is not the temperature of zero energy. Explain

(ii) What is the specific heat in an isotherm change?

Qn17. Explain what is meant by a scale of temperature and how a temperature is defined in terms of a specified property?

Qn18. When a particular temperature is measured on scales based on different properties it has a different numerical value on each scale except at certain points. Explain why this is so and state:-

a) At what points the values agrees and
b) What scale of temperature is used as a standard?

Qn19. Explain the principles of two different types of thermometer one of which is suitable for measuring a rapidly varying temperature and the other for measuring a steady temperature whose value is required to a high degree of accuracy. Give reasons for your choice of thermometer in each case. Experimental details are not required.

Qn20.(a) What is the value of the temperature θ in 0C on the scale of a platinum resistance thermometer if $R0 = 2.000\,ohms, R100 = 2.760\,ohms$ and $R\theta = 2.480\,ohms$? **(ans. 63.16°C)**

(b)The resistance of a wire at a temperature θ0C measured on a standard scale is given by:- $R\theta = R0\left(1 + A\theta + 10^{-3}A\theta^2\right)$ where A is a constant. When the thermometer is at a temperature of 50.00C on a standard scale, what will be the temperature indicated on the resistance scale? **(ans. 47.7°C)**

Qn21. A particular resistance thermometer has a resistance of 30.00Ω at the ice point, 41.58Ω at the steam point and 34.59Ω when immersed in a boiling liquid. A constant-volume gas thermometer gives readings of 1.333 x10^5Pa, 1.821 x 10^5Pa and 1.528 x 10^5Pa at the same three temperatures. Calculate the temperature at which the liquid is boiling:

a) On the scale of the gas thermometer.**(ans 39.960C)**
b) On the scale of the resistance thermometer.**(ans. 39.640C)**

Qn22.The resistance Rθ of a particular resistance thermometer at a Celsius temperature θ as measured by a constant-volume gas thermometer is given by:-
$R\theta = 50.00 + 0.1700\theta + 3.00x10^{-4}\theta^2$. Calculate the temperature as measured on the scale of the resistance thermometer which corresponds to a temperature of 60°C on the gas thermometer. **(ans. 56.400C)**

Qn23. A bath of oil is maintained at a steady temperature of about 180°C, which is measured both with a platinum resistance thermometer and a mercury-in-glass thermometer. Explain why you would expect the temperatures indicated by the two thermometers to be different. At what temperatures would the two thermometers show the same value?

Qn24.(a) Explain why two thermometers using different thermometric properties and calibrated at two fixed points, would not necessarily show the same temperature except at the fixed points.

(b) Why is the constant volume gas thermometer chosen as a standard?
(c) What type of thermometer is recommended accurately to measure a temperature of :-
(i) About 15K and
(ii) 2000K.

Qn.25.(a) Explain how a temperature scale is defined.
(b) Discuss the relative merits of:-
(i) a mercury-in-glass thermometer.
(ii) a platinum resistance thermometer.
(iii) a thermocouple , for measuring the temperature of an oven which is maintained at about 300°C.

Qn.26

	Steam point 100^0C	Ice point 0^0C	Room temperature
Resistance of resistance thermometer	75.000Ω	63.000Ω	64.992Ω
Pressure recorded by constant volume gas thermometer	$1.10 \times 10^7 Nm^{-2}$	$8.00 \times 10^6 Nm^{-2}$	$8.51 \times 10^6 Nm^{-2}$

Using the above data, which refer to the observations of a particular room temperature using two types of thermometer, calculate the room temperature on the

scale of the resistance thermometer and on the scale of the constant volume gas thermometer. Why do these values differ slightly? **(ans 16.6ºC , 17.0^{0}C)**

Qn27.The value of the property X of a certain substance is given by:-

$$Xt = X0 + 0.50t + (2.0\,x\,10^{-4})t^2,$$

Where t is the temperature in degrees Celsius measured on a gas thermometer scale. What would be the Celsius temperature defined by the property X which corresponds to a temperature of 500C on this gas thermometer scale? **(ans, 49.04ºC)**

Qn28. A particular physical property X of a substance changes in magnitude on heating. Explain how you might use the property to obtain a Celsius temperature scale. The relation connecting the magnitude of X and the absolute temperature T is given by:-

$$\mathbf{X} = \frac{a}{(T-223)}$$

Where T is greater than 223K and ,a is a constant . Derive an expression for the Celsius temperature t based on this scale and establish the relation between t and T. What is the value of t corresponding to T= 423K? **(ans 112.5ºC)**

Qn29.A temperature T can be defined by $T = T_f(\frac{X}{X_f})$, where $T_f$is the assigned temperature of a fixed point and X and $X_f$are the values of a thermometric property of a substance at T and T_f respectively. On the ideal-gas scale , the fixed point is the triple point of water and $T_f = 273.16\,K$.

a) List four thermometric properties which are used in thermometry. Explain why certain thermometric properties of a gas are taken as standard.
b) Explain what is meant by a fixed point and by the triple point of water.
c) Sketch and label the simple form of constant-volume gas thermometer found in school laboratories, and describe how it is used to determine the boiling point of a liquid on the ideal-gas scale.
d) For a thermometer which is not based on the properties of gases, explain how you would calibrate it in terms of the ideal-gas scale.
e) Compare the advantages and disadvantages of the constant-volume gas thermometer with those of any two other types of thermometers.
f) The pressures recorded in a certain constant-volume gas thermometer at the triple point of water and at the boiling point of a liquid were 600mm of Hg and 800mm of Hg respectively. What is the apparent temperature of the boiling point? However, it was found that the volume of the thermometer increases by 1% between the two temperatures. Obtain a more accurate value of the boiling point.(**Ans. 364.21K ; 367.86K)**

Qn30. Mercury in a faulty centigrade thermometer stands at 5° mark when placed in melting ice and at 95° mark when in steam at normal pressure. What will be its reading when it is placed in contact with a body at 40°C**? (Ans 41°C)**

Qn31 .A thermometer has wrong calibration. It reads the melting point of ice as -10°C.It reads 60°C in place of 50°C.What is the temperature of boiling point of water on this scale? **(Ans 130°C)**

Qn32 .(a) If two temperatures differ by 25 degree on Celsius scale, what is the difference on Fahrenheit scale? **(Ans. 45°F)**

(b)The triple point of neon and carbon dioxide are 24.57K and 216.55K respectively. Express these temperatures on the Celsius and Fahrenheit scales. **(Ans.On Celsius scale -248.58°C, -56.6°C) and On Fahrenheit -415.44°F, -69.88°F**)

(c) Two absolute scales A and B have triple points of water defined to be 200A and 350B. What is the relation between TA and TB?

Qn33.(a)What is meant by a thermometric property? What qualities make a particular property suitable for use in a practical thermometer? .A Celsius temperature scale may be defined in terms of a thermometric property X by the following:-

$$\theta = \frac{X - X_0}{X_{100} - X_0} \times 100^0 C \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where X_0 is the value of the property at the ice point, X_{100} at the steam point, and X at some intermediate temperature. If X is plotted against θ a straight line always results no matter what thermometric property is chosen. Explain this.

(b)The ideal gas scale of temperature is one based on the properties of an ideal gas. What is the particular virtue of this scale? Describe very briefly how readings on such a scale can be obtained using a thermometer containing a real gas.

Qn34.(a) How is centigrade temperature defined

(i) On the scale of a constant-pressure gas thermometer.
(ii) On the scale of a platinum thermometer?

(b)A constant mass of gas maintained at constant pressure has a volume of 200.0cm^3 at the temperature of melting ice, 273.2cm^3 at the temperature of water boiling under standard pressure, and 525.1cm^3 at the normal boiling-point of sulphur. A platinum wire has resistances of 2.000Ω, 2.778Ω and 5.280Ω at the same temperatures. Calculate the values of the boiling-point of sulphur given by the two sets of observations, and comment on the results. (**Ans. 444.1°C and 421.6°C)**

Qn35. (a) How is a scale of temperature defined? What is meant by a temperature of 15^{o}C? On what evidence do you accept the statement that there is an absolute zero of temperature at about -273^{o}C.

(b) In a special type of thermometer a fixed mass of gas has a volume of 100.0cm^3 and a pressure of 81.6cm of mercury at ice point, and volume 124.0cm^3 with pressure 90.0 cm of mercury at steam point. What is the temperature when its volume is 120.0cm^3 and pressure 85.0 cm of mercury and what value does the scale of this thermometer give for absolute zero? Explain the principle of your calculation**. (ans,68^{o}C , -272^{o}C)**

(c) (i) On the kinetic theory model of a gas what is the interpretation of temperature?

(ii) How does this theory explain:-

- the rise in pressure when the temperature of a gas is increased at constant volume and
- the rise in temperature which occurs when a gas is compressed quickly?

Qn36.(a) How may a scale of temperature be defined?

(b) Draw a clearly labeled diagram of a simple constant volume gas thermometer which could be used to calibrate a thermocouple on the constant gas scale of temperature. Describe the procedure you would adopt to measure a temperature on the constant volume gas scale.

(c) Describe a simple form of thermocouple suitable for use at about room temperature.

Qn37.(a).Explain what is meant by a change in temperature of 1^{o}C on the scale of a platinum resistance thermometer?

(b)Draw and label a diagram of a platinum resistance thermometer together with a circuit in which it is used.

(c)(i) Give two advantages of this thermometer and explain why, in its normal form, it is unsuited for measurement of varying temperatures.

(ii)The resistance Rt of platinum varies with the temperate t^{o}C as measured by a constant volume gas thermometer according to the equation.

$Rt = R\,0(1+8000\,\alpha t - \alpha\, t^2)$. Where α is constant. Calculate the temperature on the platinum scale corresponding to 400^{o}C on this gas scale.**(ans. 3850C)**

Qn38. Describe briefly how temperature is measured on each of the following types of meter.

(i) Resistance thermometer.

(ii) Thermocouple, and
(iii) Optical pyrometer.

Details of structure and circuitry are not required. State the reasons, the use for which each of the three above types of thermometer is particularly suitable.

Qn39. A liquid-in-glass thermometer uses liquid of which the volume varies with temperature according to the relationship $V\theta = V\,0\left(1 + a\theta + b\,\theta^2\right)$

Where $V\theta$ and $V\,0$ are the volumes at θ°C and 0°C on the gas scale respectively and a and b are constants. If a= b x 10^3, what temperature will be indicated on the liquid-in - glass scale when that on the gas thermometer is 60°C? **(ans. 57.8°C)**

Qn40.(a) Give a brief account of the principles underlying the establishment of a scale of temperature and explain precisely what is meant by the statements that the temperature of a certain body is:-

(i) t^oC on the constant volume air scale.
(ii) t_p°C on the platinum resistant scale, and
(iii) t_T°C on the Cu-Fe thermocouple scale.

Why are these three temperatures usually different?.

(b)Describe an optical pyrometer and explain how it is used to measure the temperature of a furnace.

Qn41.(a) Tabulate various physical properties used for measuring temperature. Indicate the temperature range for which each is suitable.

(b)Discuss the fact that the numerical value of a temperature expressed on the scale of the platinum resistance thermometer is not the same as its value on the gas scale except at the fixed points.

(c) If the resistance of a platinum thermometer is 1.500 ohms at 0°C, 2.060 ohms at 100°C and 1.788 ohms at 50°C on the gas scale, What is the difference between the numerical values of the latter temperature on the two scales? **(Ans 1.43°C)**

Qn42. The electrical resistance in ohms of a certain thermometer varies with temperature according to the approximate law; $R = R\,0\{1 + \alpha(T - T\,0)\}$. The resistance is 101.6 Ω at the triple-point of water 273.16K and 165.5Ω at the normal melting point of lead (600.5K). What is the temperature when the resistance is 123.4Ω? **(Ans. T2 = 384.8K)**

Qn43. (a)Answer the following:-

(i) The triple-point of water is a standard fixed point in modern thermometry. Why? What is wrong in taking the melting point of ice and the boiling point of water as standard fixed points (as was originally done in the Celsius scale?
(ii) There were two fixed points in the original Celsius scale as mentioned above which were assigned the number 0°C and 100°C

respectively. On absolute scale, one of the fixed points is the triple-point of water, which on the kelvin absolute scale is assigned the number 273.16K What is the other fixed point on this (Kelvin) scale)

(b) The absolute temperature (Kelvin scale) T is related to the temperature tc on the Celsius scale by, $tc = [T - 273.15]$.Why do we have 273.15 in this relation and not 273.16?

(c) What is the temperature of the triple–point of water on an absolute scale whose unit interval size is equal to that of the Fahrenheit scale? **(Ans.491.69ºF).**

Qn44. Two ideal gas thermometers A and B use oxygen and hydrogen respectively. The following observations are made:-

Temperature	Pressure thermometer A	Pressure thermometer B
Triple-point of water	1.250×10^5 Pa	0.200×10^5 Pa
Normal melting point of sulphur	1.797×10^5 Pa	0.287×10^5 Pa

(i) What is the absolute temperature of normal melting point of sulphur as read by thermometers A and B? **(Ans. 392.69K and 391.98K)**

(ii) What do you think is the reason behind the slight difference in answers of thermometers A and B? (The thermometers are not faulty).What further procedure is needed in the experiment to reduce the discrepancy between the two readings?

Qn45.(a) Calculate the quantity of heat conducted through $2m^2$ of brick-wall 12cm thick in 1hour if the temperature on one side is 8ºC and the other side is 28ºC. Given that thermal conductivity of brick = $0.13 Wm^{-1}K^{-1}$ **(Ans.156, 000J).**

(b) Estimate the rate at which ice melts in a wooden box 2cm thick and inside measurements 60cm x 60cm x 60cm.Assume that external temperature is 27ºC and the coefficient of thermal conductivity of wood= $0.1674 Wm^{-1}K^{-1}$.Specific latent heat of fusion of ice = $336 \times 10^3 JKg^{-1}$ **(Ans. 1.45×10^{-3} kgs^{-1})**

(c) A composite bar is made of a bar of copper 10cm long , a bar of iron 8cm long and a bar of aluminum 12cm long all having the same cross-sectional area.If the extreme ends of the bars are maintained at 100ºC and 10ºC respectively. Find the temperature at the two junction. Given that thermal conductivity of copper, iron and aluminum are 400, 40, and 20 $Wm^{-1}K^{-1}$ respectively.

(d) Calculate the theoretical percentage change in heat loss by conduction achieved by replacing a single glass window consisting of two sheets of glass separated by 10mm of air. In each case the glass is 2mm thick. (The ratio of thermal conductivities of glass to air is 3:1)**(Ans.94%).**

8. VIBRATION AND WAVES

Qn1. (a) (i) Define the term phase difference.

(ii) What is the working principle of musical instrument?

(b) (i) The equation of a progressive wave traveling in positive x - direction is given by:- $y = A\sin(wt - kx)$. Show that the maximum velocity, $V_{max} = \frac{2\pi a}{T}$.

(ii) For a string stretched between two supports, two successive standing waves with the frequencies 525Hz and 630Hz. If the speed of transverse wave on the string is 384m/s, what is the length of the string? Assume that the mass of the wire is small enough for its effect on the tension in the wire to be neglected.

(c) The sun rotates with a period of 24.7 days and has a radius of 7.00 x 10^8 m. For a terrestrial observer, calculate the resultant Doppler shift of light of wavelength 500nm which is emitted from the solar equation at which side of the disc.

(d) (i) Why do clouds appear white?

(ii) If there were no atmosphere, what would be the colour of the sky?

Qn2.(a) (i) What is polarization?

(ii) The refractive index of diamond for sodium light is 2.417. Find the angle of incidence for which the light reflected from diamond is completely plane polarized.

(b) (i) What is diffraction grating?

(ii) A source emits speed lines of wavelength 589 nm and 615nm. This light is incident normally on the diffraction grating of 600 lines per mm. Calculate the angular separation between the 1^{st} orders diffracted waves.

(c) (i) What is monochromatic source?

(ii) A two slits young's experiments is done with a monochromatic light of wavelength 6000Å. The slits are 2 mm apart and the fringes are observed on a screen placed 10 cm away from the slits and it is found that the interference pattern shifts by 5mm when a transparent of thickness 0.5mm is introduced in the path of one of the slits. What is the refractive index of the transparent plate?

(d) Newton's rings apparatus is to be used to determine the radius of curvature of a lens. The radii of the n^{th} and $(n+20)^{th}$ bright rings are measured and found to be 0.162cm and 0.368cm respectively in light of wavelength 546nm. Calculate the radius of curvature of the lower surface of the lens.

Qn3.(a)(i) Give two characteristics of wave motion

(ii) Distinguish between longitudinal and transverse waves. Give at least four (4) points.

(b) (i) What factors determine the velocity of a wave in the medium

(ii) Explain and show how the Newton's formulae for the velocity of sound wave in air is incorrect. How is corrected?

(c)(i) State the principle of superposition

(ii) A tube of a certain diameter and of length 48cm is open at both ends. Its fundamental frequency of resonance is found to be 320HZ. The velocity of sound in air is $320ms^{-1}$.Estimate the diameter of the tube. One end of the tube is now closed, Calculate the lowest frequency of resonance for the tube.

(d)(i) Prove that when the source approaches the stationary listener with a particular velocity, the apparent frequency is higher than that, if the listener approaches a stationary source with the same velocity.

(ii)What do you understand by Doppler broadening?. The Doppler broadening of a line in the spectrum of light emitted by a gaseous source is due to the motion of the atoms emitting the light.

- State two factors on which the speed of the atoms in the source depends.
- Determine which gaseous source would have less Doppler broadening, a mercury lamp at 200^{o}C or a krypton at 0^{o}C.

Qn4 (a)(i) State the Huygens principle.

(ii) Name four (4) important conditions required for suitable interference of light wave to take place.

(iii) List and explain with examples, the methods of achieving coherence.

(b)(i) Two coherent source of intensity ratio K: 1 interface. Prove that in the interference on the screen formed on a distant screen:-

$$\frac{I_{max}+I_{min}}{I_{max}-I_{min}} = \frac{1+K}{2\sqrt{K}}$$

(ii) In young's experiment, the wavelength of red light is 780nm, and that of blue light is 520nm. Find the value of n for which the $(n + 1)^{th}$ blue band coincides with the n^{th} red band.

(c) (i) Explain how Newton rings can be used to test the accuracy of grinding of the face of a lens.

(ii)The face of a lens has a radius of curvature of 50cm.It is placed in contact with a flat face and Newton's rings are observed normally with reflected light of wavelength 5×10^{-7}m. Calculate the radii of the fifth and tenth bright ring?.

(d) (i) List down two (2) uses of Polaroids

(ii) State Brewster's law. The polarized angle of a transparent medium is 60^{o}. Determine the refractive index of the medium and the refracting angle. Assume that light is incident in air.

Qn5. (a) (i) What are three characteristics of stationary wave?

(ii) Given; $y = 0.8\sin 16\pi\{t + x/40\}$ metre . Identify the equation is it stationary or progressive? Calculate the wavelength and the velocity of the wave represented by this equation**.**

(b) (i) What happens to velocity of sound produced by vibrating sonometer wire if its tension multiplied by four**?**

(ii) A 50 cm long wire is unison with a tuning fork of frequency 256Hz when stretched by a load of density $9gcm^{-3}$ hanging vertically. The load is then immersed in water. By how much the length of the wire should be reduced to bring it again in unison with the same tuning fork?

(c) A resonance tube resonates with a tuning fork of frequency 256Hz. If the lengths of the resonates air column are 32cm and 100cm. what is the value of the end correction?

(d) A car moving at 72km/h with its horn blowing is chasing another car moving at 54 km/h. Calculate the apparent frequency of the horn as heard by the driver being chased. Given that frequency of a horn is 1200Hz**.**

Qn6. (a) Use the formulae $V = \sqrt{\frac{\gamma P}{\rho}}$, to explain why the speed of sound in air

(i) Is independent of pressure.

(ii) Increases with temperature.

(iii) Increases with humidity.

(b) A stone dropped from the top of a tower of height 300m high splashes into the water of a pond near the base of the tower. When is the splash heard at the top?

(c)A transverse harmonic wave on a string is described by:-

$Y(x,t) = 3.0\sin(36t + 0.018x + \pi/4)$

Where x and y are in cm and t in seconds. The positive direction of x is from left to right.

(i) Is this a travelling wave or stationary wave?

(ii) What are its amplitude, frequency, wavelength and speed?

(iii) What is the initial phase at the origin?

(iv)What is the least distance between two successive crests in the wave?

(d)(i) Obtain the formula for the Doppler Effect when the source is moving with respect to a stationary observer.

(ii) A whistle giving out 500Hz moves away from a stationary observer in a direction towards and perpendicular to a flat wall with a velocity of $1.5ms^{-1}$ .How many beats per second will be heard by the observer?

Qn7. (a) Why can't interference fringes be observed if oil film is thick?

(b) In Young's double slit experiment, the slits are 2mm apart and are illuminated with a mixture of two wavelengths 750nm and 900nm.The distance from the common central bright fringe on a screen is 2.0m from the plate of the slits .

(i) Find the distance of the fourth bright fringe on the screen from the central maxima for the wavelength of 900nm.

(ii) At what minimum distance from the common central fringe on the screen will a bright fringe from one interference pattern coincide with the bright fringe from the other?

(c)(i) Identify three ways in which Young's experiment can be improved.

(ii) In a thin wedge experiment using light source of wavelength 600nm a paper of thickness 0.02mm is placed 11cm from the point of contact of slides. Calculate the fringe separation and the angle between slides.

(d) (i) What is a plane polarized light?

(ii) Unpolarized light is incident on a material of refractive index 1.5. At what angle of incident will the reflected and refracted ray form an angle of 90^o with each other?

Qn8.(a)(i) Name two properties which are common to all types of mechanical waves.

(ii) Why a stationary wave is so named?

(iii) An observer places his ear at the end of a long steel pipe. He can hear two sounds, when a workman hammers the other end of the pipe. Why?

(b) The displacement of the medium in a sound wave is given by the equation:- $Y = A\cos(ax+bt)$,Where A, a and b are positive constants. The wave is reflected by an obstacle situated wave is 0.64 times that of the incident wave.

(i) What are the wavelength and frequency of the incident wave?

(ii) Write the equation of the reflected wave.

(iii) In the resultant wave formed after reflection, find the maximum and minimum values of the particles speeds in the medium.

(c)Describe the dust tube experiment. How may it be used to compare the velocities of sound in different gases? The fundamental frequency of longitudinal vibration of a rod clamped at its centre is 1500Hz. If the mass of the rod is 396.0g, find the increase in its total length produced by a tension due to a load of mass 71kg.

(d)(i) Why Doppler Effect in light is symmetrical?

(ii) The wavelength of yellow sodium line (5896Å) emitted by a star is red shifted to 6010Å. What is the component of the of sight?.

Qn 9.(a) (i) Explain what is meant by the term path difference with reference to the interference of two wave motions?

(ii) Why is it not possible to see interference where the light beams from the head lamps of a car overlap?

(b) In young's experiment, the wavelength of red light is 9780nm, and that the blue light is 7828nm. Find the value of n for which the $(n + 1)^{th}$ blue band coincides with the n^{th} red band.

(c) (i) What are the Newton rings and under what conditions can they be observed?

(ii) The face of a lens has a radius of curvature of 70cm. It is placed in contact with a flat phase and Newton's rings are observed normally with reflected light of wavelength $5x\ 10^{-7}m$. Calculate the radii of the fifth and tenth bright rings?

(d) (i) State Malus law.

(ii) A beam of unpolarised light is sent through three ideal Polaroid sheets. The orientation of the line along which the second sheet no oscillating electric field is rotated in a certain sense by an angle of 20^o with respect to the orientation of that line in the first sheet. The orientation of that line in the third sheet is rotated in the same sense with respect to the orientation in the first sheet by 80^0 . What fraction of the light intensity incident on the system passes through it?

9.ELECTROSTATICS

Qn1. (a) (i) State the coulomb's law

(ii) Derive the expression for Coulomb's law from Gauss's law.

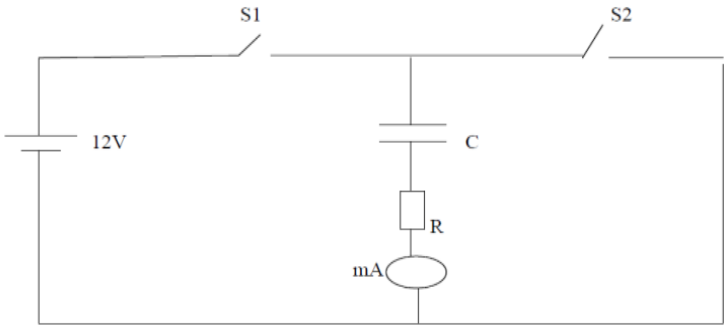
(iii) Four charges $+5\mu C, +5\mu C, -5\mu C$ and $-5\mu C$ are placed at the corners A, B, C and D at a square of side 1m. Calculate the electric field intensity at the center of the square.

(b) Briefly explain the following:-

(i) Does coulomb's law of electric force obey Newton's third law of motion?

(ii) Given two point charges q_1 and q_2 such that $q_1.q_2$¿0. What is the nature of the force between them?

(c) In the circuit below the resistance R is 10KΩ, C is the capacitance of $1000\mu F$ and the resistance of the battery and the milliameter are negligible.

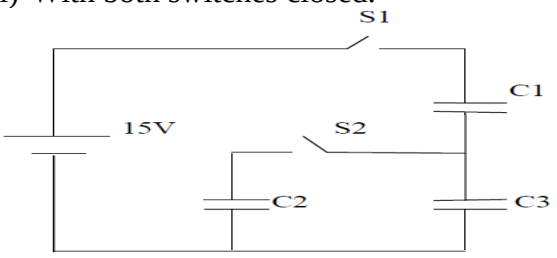


Calculate the milliameter reading expected:-

(i) Immediately after the switch is S1 is closed.
(ii) 15 seconds later.
(iii) After several minutes.

(d) The following circuit is set up with both switches open. Assume that the internal résistance of the 15V cell is negligible.

(i) Calculate the charges stored on the capacitors C_1, C_2 and C_3.
(ii) With S_1 closed but S_2 left open.
(iii) With both switches closed.



Qn2.(a) (i) What do you understand by specific charge?

(ii)An electron is liberated from the lower end of two large parallel metal plates Separated by a distance $h = 20\,mm$.The upper plate has a potential of +240V relative to the lower. How long does the electron take to reach it?

(b) (i) Define the terms capacitance and electric potential

(ii)The capacitance C of a capacitor is fully charged by a 200V battery. It is then discharged through a small coil of resistance wire embedded in a thermal isolated block of specific heat capacity 2.5 x 10^2 $JKg^{-1}K^{-1}$ and of mass 0.1 kg. If the temperature of the block rises by 0.4K, What is the value of C?

(c) (i) Calculate the value of two equal charges if they repel one another with a force of 0.1N when situated 50cm apart in a vacuum.

(ii) What would be the size of the charges if they were situated in an insulating liquid whose permittivity was ten times that of vacuum?

(d) An electron of charge 1.6 x 10^{-19}C is situated in a uniform electric field of intensity 120000Vm^{-1} .Find the force on it, its acceleration, and the time it takes to travel 20mm from rest.

Qn3.(a) ABC is a right angled triangle where AB and BC are 25cm and 60cm respectively. A metal sphere of 2cm radius charged to a P.D of 9.0 x 10^5V is placed at B. Find the amount of work done in carrying a positive charge of 1C from C to A.

(b) Electrostatic force partly resembles and partly differs Gravitation force. Explain.
(c) By using the coulomb's law of electrostatics, derive an expression for the electric field strength E, due to a point charge if the material is surrounded by a material of permittivity ε and hence show how it relates with charge density δ.

(d)Describe the structure and the mode of action of a simplified version of the Van de Graff generator.

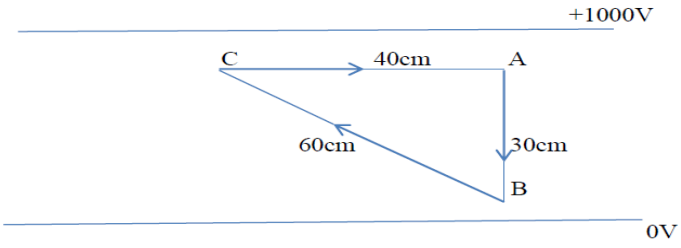
Qn4. (a) (i) State Coulomb's law and define the term „Relative permittivity"
(ii) Two similar balls of mass, m are hang from silk thread of length „L" and carries similar charge, q. Assume that angle is so small in such a way that $\tan\theta$ can be replaced by approximate equal to $\sin\theta$ .To this approximate, Show that:-

$$X = \left(\frac{q^2 L}{2\pi\varepsilon_0 mg}\right)^{1/3}$$

Where x is the separation between the balls. If L=120cm, mass m=10g and x= 5cm what is q?

(b) (i) State the relationship between electric field intensity and potential gradient**.**
(ii) Draw the graph to show how potential V inside and outside the hollow sphere varies with distance r**.**

(c) An electric field is established between two parallel plates as shown below.



The plates are 50cm apart and a PD of 1000V is applied between them. A point charge of value +1.0μC is held at point A, it is moved first to B then to C and finally back to A. Find:-

(i) The force experienced by the charge at A.
(ii) The force experienced by the charge at B.
(iii) The energy involved in moving the charge from A to B.
(iv)The energy involved in moving the charge from C to A.

(v) The net energy needed to move the charge along the route ABCA.

Qn5.(a) What is Van de Graf generator? And mention two uses of that generator

(b) (i) Briefly describe three factors affecting the capacitance of the capacitors

(ii) Calculate the capacitance of a parallel plate air capacitor of plate's area $30m^2$, the plates being separated by a dielectric 2mm thick and of relative permittivity 6. If the electric field strength between the plates is 500V/m, calculate the charge on each plate.

(c) Derive an expression for energy stored in a charged capacitor of capacitance C connected across the potential V**.**

(d) A 5μF capacitor (X) is charged by a 40V supply, and is then connected across an uncharged 20μF capacitor Y. Calculate;

(i) The final p.d across each.

(ii) The final charge on each.

(iii) The initial and final energies stored by the capacitors.

(e) A 5μF capacitor is charged by a 12V supply and then discharged through a 2.0MΩ resistor. What is the charge on the capacitor at the start of the discharge and at 5seconds?

Qn6.(a)If you rub a strip polythene with a cloth the polythene will pick up small piece of paper.

(i) What is happening when the polythene is being rubbed with cloth?

(ii) Explain how the polythene is able to pick up the piece of paper.

(b)Find the force between two point charges +6μC and +5μC situated 0.3m apart in air. Is the force of attraction or repulsion?

(c) Two large horizontal, parallel metal plates are 2.0cm apart in vacuum and the upper is maintained at a positive potential relative to the lower so that the field strength between them is $2.5x\ 10^5 V/m$.

(i) What is the p.d .between the plates?

(ii) If an electron of charge $1.6 \times 10^{-19}C$ and mass $9.1 \times 10^{-31}Kg$ is liberated from rest at the lower plate. What is its speed on reaching the upper plate?

(d) (i) Give four similarities and four differences between gravitational and electrostatic forces

(ii) Compare the electrical and gravitational forces between a proton of charge +e and mass $M = 1.7 \times 10^{-27}$ Kg at distance r from an electron of charge –e and mass $m = 9.1 \times 10^{-31}$ Kg. Given that electronic charge $e = 1.6x10^{-19}$ C.

Qn7.(a) (i) State gauss's law.

(ii) Use gauss's law to Prove that the coulomb force as given by;

$$F = \frac{Kq_1q_2}{r^2}$$

Where all symbol carry their usual measuring.

(b) (i) Mention three factors that affect capacitance of the capacitor.

(ii) A 600pF Capacitor is charged by a 200v supply. If is then discharged from the supply and is connected to another unchanged 600pF capacitor. How much electrostatic energy is lost in the process?

(iii) Two positive charges of 16×10^{-10}C and 12×10^{-10}C are placed 10cm a part. Find the work done in bringing the two changes 4cm closer.

Prep: Sir: ALPHONCE JACKSON RICHARD.
Holder of Bachelor of Science with Education (Physics and Chemistry)
Graduate from the University of Dodoma (UDOM)
A Physics Teacher at Lion of Judah Academy. Busega district,Simiyu Region.
Physical address: Ilemela-Mwanza, TANZANIA.
Mobile number: +255 762 510 757/+255 787 061 259
Email address: arisongrace12@gmail.com