# THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

**(A Constituent College of JKUAT)**
***Faculty of Applied & Health Sciences***

DEPARTMENT OF MATHEMATICS & PHYSICS

## UNIVERSITY EXAMINATION FOR BACHELOR OF SCIENCE/ENGINEERING IN BUILDING & CIVIL ENGINEERING, MECHANICAL & AUTOMOTIVE ENGINEERING, ELECTRICAL & ELECTRONIC ENGINEERING AND BACHELOR OF TECHNOLOGY IN INFORMATION TECHNOLOGY

SPH 2170/APS 4101: PHYSICS FOR ENGINEERS I/ PHYSICS I

**END OF SEMESTER EXAMINATION**

SERIES: APRIL 2012

**TIME: 2 HOURS**

**Instructions to Candidates:**
You should have the following for this examination
- *Answer Booklet*

This paper consists of **FIVE** questions
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are clearly shown
This paper consists of **FOUR** printed pages

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**The following may be useful**

Gravitational acceleration g = 10ms$^{-2}$
Mass of the Earth $M_e$ = 6.0 x10$^{24}$ kg
Mass of the Moon $M_m$ = 7.36 x 10$^{22}$ kg
Radius of the Earth $R_e$ = 6400km
Radius of the Moon $R_m$ = 1740km
Specific heat capacity of water = 4200 Jkg$^{-1}$ K$^{-1}$
Specific heat capacity of ice = 2100 Jkg$^{-1}$ K$^{-1}$
Latent heat of fusion of ice = 3.4 x 10$^5$ Jkg$^{-1}$
Latent heat of vaporization of water = 2.26 x 10$^6$ J/Kg
Critical angle of water = 49$^o$

**Question 1 (30 Marks)**

a) (i) State the sensitivity and reading error associated with meter rule (1 mark)
(ii) Outline any **TWO** applications/uses of dimensions of quantities (2 marks)

b) (i) Distinguish Absolute and relative errors (2 marks)

(ii) Show that absolute error in the product of X and Y would be approximately $(X\delta_y + Y\delta_x)$. State clearly what is ignored and why. (4 marks)

c) A car starts at 5ms$^{-1}$ and travels between two stations 1.5km apart. It accelerates uniformly for the first 10 seconds and covers 250m. It then travels with a constant speed until it is finally retarded uniformly in the last 50m.

(i) Sketch velocity-time graph for the motion of the car (2 marks)
(ii) Determine the maximum velocity attained by the car (2 marks)
(iii) Calculate the time it takes to complete the whole journey (3 marks)

d) A student gave an expression for the time of oscillation T of a small drop of liquid of radius r and liquid density $\rho$, under surface tension force S as follows.

$$T = k\sqrt{\frac{\rho r^3}{S}}$$

where k is a dimensionless constant. Prove that this expression is dimensionally correct (3 marks)

e) Given that $\vec{A} = 3\hat{i} + 4\hat{j} + 4\hat{k}$ and $\vec{B} = 2\hat{i} + 3\hat{j} + 7\hat{k}$, find the:

(i) Magnitude of $\vec{A} + \vec{B}$ (2 marks)
(ii) Angle between $\vec{A}$ and $\vec{B}$ (3 marks)
(iii) Unit vector perpendicular to both $\vec{A}$ and $\vec{B}$ (4 marks)

f) A bus travelling at 80ms$^{-1}$ is negotiating a curve of radius 50m. Calculate the force exerted on a 60 kg person leaning on the inner wall of the 50m from the centre of the curve. (2 marks)

**Question 2 (20 Marks)**

a) (i) Name **TWO** types of error, and list one measure which can be taken to minimize each of type in a measurement. (3 marks)

(ii) State the Newton's second and third laws of motion and discuss briefly the one that relates to the law of conservation of momentum (4 marks)

b) A particle moves along the x-axis according to the equation $x(t) = 2.0t + 3.0t^2 - 1.0t^3$, where t is in second. Find the:

(i) Average velocity between t = 1.0 and t = 3.0 seconds (3 marks)
(ii) Acceleration of the particle at t = 2.5 seconds (2 marks)

(iii) A 200kg body is lowered by a mean of a cable with a downward acceleration of $10ms^{-2}$ find the tension in the cable (2 marks)

c) The nucleus of a Helium atom travels uniformly along the inside of a straight hollow tube 2.0m long which forms part of the particle accelerator. The nucleus enters and leaves the tubes at speeds $1000ms^{-1}$ and $9000ms^{-1}$ respectively.

(i) Determine the acceleration of the Helium atom (3 marks)
(ii) How long it will take to travel through the tube (2 marks)

d) Why do we talk of an acceleration for a body moving in a uniform circular motion (2 marks)

**Question 3 (20 Marks)**

a) What is a projectile? (2 marks)

b) A projectile is fired from ground, with an initial velocity $40ms^{-1}$ at an angle $\theta^o$ with the horizontal and it attain a maximum height of 45m.

(i) Find the angle $\theta^o$ of firing (3 marks)
(ii) Find the time of flight (2 marks)
(iii) Calculate the horizontal range covered (3 marks)

c) Given that the horizontal distance S covered by a projectile from ground with a velocity $U_o$ at an angle $\alpha$ with the horizontal is.

$$S = \frac{U_0^2 \sin 2\alpha}{g}$$

Where g is the acceleration due to gravity. Determine an angle $\alpha$ for which S would be maximum (3 marks)

d) (i) State the Newton's law of universal gravitation and give its equation (2 marks)

(ii) Obtain the dimension of the gravitational constant in the equation d (i) above (2 marks)

**Question 4 (20 Marks)**

a) (i) Explain briefly terms:
I. coefficient of static friction (1 mark)
II. coefficient of kinetic friction (1 mark)

(ii) State TWO factors influencing the frictional force on the body (1 mark)

(iii) A $3.1 \times 10^5$ kg electric train is travelling up a plane inclined at $30^o$. If the coefficient of

dynamic friction is $\mu_k$ = 0.25, calculate the force F that the engine should apply to maintain the motion at constant velocity. (5 marks)

b) (i) Distinguish temperature and heat (2 marks)
(ii) Define two heats of transformation /phase change (2 marks)

c) (i) Write short notes on **Conduction** as mode of heat transfer (3 marks)

(ii) How much heat would one require to heat 50g of ice from -10°C to complete evaporation at 100°C at normal atmospheric pressure. (5 marks)

**Question 5 (20 Marks)**

a) (i) Distinguish between a real image and a virtual image. Illustrate how a plane mirror can give either kind of image. (3 marks)

(ii) A diver underwater shines a light up toward the smooth surface of the water with an angle of incidence of 53°. Explain what happens to the light (2 marks)

b) A ray of light enters a triangular glass prism at face XY and emerges out at face XZ. At the face XY, the angles of incidence and refraction are $i_1$ and $r_1$ respectively; and $r_2$ and $i_2$ are the angles of incidence and refraction respectively at the face XZ through which the emergent ray leaves the glass prism.

If the glass prism has refraction angle A, show that the emergent ray would leave the prism at angle of deviation D to the initial direction of the incident ray expressed in terms of $i_1$, $i_2$ and $r_2$ as:

(i) $A = r_1 + r_2$ and $D = (i_1 + i_2) - A$ (5 marks)

(ii) Hence deduce that at the minimum deviation; A and $D_{min}$ become:
$A = 2r$ and $D_{min} = 2i - A$ (2 marks)

(iii) A $60^{o}$ glass prism has an index of refraction of 1.65 for a certain light. Calculate the angle of the minimum deviation $D_{min}$ (2 marks)

c) (i) Explain briefly the two types of interference of wave giving the numerical validity under which each occurs (3marks)

(ii) A microscope has an objective of 5.8cm; focal length and eyepiece of 7cm each. If the distance between focal length and eyepiece is 19.4cm, find the magnification of the microscope. (3 marks)