**UNIVERSITY OF ESWATINI**

**FACULTY OF SCIENCE AND ENGINEERING**

**DEPARTMENT OF PHYSICS**

**MAIN EXAMINATION 2019/2020**

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| **TITLE OF PAPER:** | INTRODUCTORY PHYSICS I |
| **COURSE NUMBER:** | PHY101 |
| **TIME ALLOWED:** | THREE HOURS |
| **INSTRUCTIONS:** | ANSWER ANY FOUR OUT OF FIVE QUESTIONS |
| | EACH QUESTION CARRIES 25 MARKS |
| | MARKS FOR EACH SECTION ARE IN THE RIGHT HAND MARGIN |
| | GIVE CLEAR EXPLANATIONS AND USE CLEAR DIAGRAMS IN YOUR SOLUTIONS. MARKS WILL BE LOST WHERE IT IS NOT CLEAR HOW THE EQUATIONS USED WERE OBTAINED |

THIS PAPER HAS SEVEN PAGES INCLUDING THE COVER PAGE

THE LAST PAGE CONTAINS DATA THAT MAY BE USEFUL IN SOME QUESTIONS

DO NOT OPEN THE PAPER UNTIL PERMISSION HAS BEEN GIVEN BY THE CHIEF INVIGILATOR

QUESTION 1

(a) Find the unit vector products:

i. $\hat{\imath} \times \hat{\jmath}$, **(1 mark)**

ii. $\hat{k} \times \hat{\imath}$, and **(1 mark)**

iii. $\hat{\jmath} \times \hat{k}$. **(1 mark)**

(b) A person leaves his home from Manzini and travels to Johannesburg which is 425 km away and returns. What is the total distance travelled by the person and what is his displacement. Why are the answers different? **(4 marks)**

(c) A ball is kicked at an angle of $\theta = 53.0°$ with the horizontal from the ground, and reaches a wall $h_1 = 7.00$ m high which is a distance $d = 24.0$ m away as in Figure 1. It finally lands on roof at a height $h_3 = 6.00$ m from the ground. The ball takes 2.20 s to reach a point vertically above where the wall starts.

i. Find the initial velocity of the ball. **(3 marks)**

ii. Find the $x$- and $y$-components of the initial velocity of the ball. **(2 mark)**

iii. Find the distance by which the ball clears the wall at first encounter. **(3 marks)**

iv. What is the maximum height reached by the ball? **(3 marks)**

v. How much time does the ball spend in flight? **(5 marks)**

vi. What is the range of the ball? **(2 marks)**

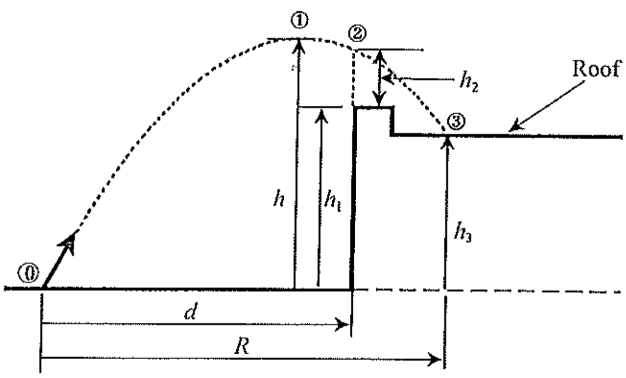



**Figure 1. Illustration of the problem in Part (c).**

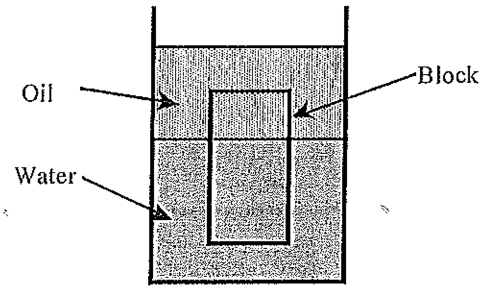
## QUESTION 4

(a) Explain by illustrating with an example why stress is more important that force in deforming a material. **(2 marks)**

(b) A wire of length 2.00 m and cross-sectional area $1.00 \times 10^{-4}$ $m^2$ suspends a load of 102 kg in air. The wire is stretched 10.0 mm by the load within the proportional region. Find the Young's Modulus for this wire. **(4 marks)**

(c) A body at sea is barely visible. Fully explain what will happen if you place it in fresh water. (*Densities of fresh and sea water are given in the last page*). **(4 marks)**

(d) A layer of oil with density 800 $kg/m^3$ floats on top of a volume of fresh water. A block of some material of density 950 $kg/m^3$, a uniform cross-sectional area $A$ and height $h$ floats at the oil-water interface, as shown in the figure below. What fraction of the block is in water and in oil? **(8 marks)**




(e) When a car overtakes a truck at high speed it veers towards it. Use Bernoulli's equation to explain this effect. **(7 marks)**

## DATA SHEET

***General Data***

Air refractive index $n_{\text{air}} = 1.00$
Avogadro's number $N_A = 6.022 \times 10^{23}$ mol$^{-1}$
Boltzmann's constant $k_B = 1.38 \times 10^{-23}$ J/K
Density of mercury = $1.36\ x\ 104$ kg/m$^3$
Gas constant $R = 8.314$ J/(mol·K)
Gravitational acceleration $g = 9.81$ m/s$^2$
Standard atmospheric pressure = $1.013 \times 10^5$ Pa
Speed of light in vacuum $c = 2.997\,8 \times 10^8$ m/s
Speed of sound in air $v_{sound} = 343$ m/s
Stefan-Boltzmann constant $\sigma = 5.67 \times 10^{-8}$ W/(m$^2$·K$^4$)Type equation here.
Threshold of hearing $I_0 = 10^{-12}$ W/m$^2$
Universal gravitational constant $G = 6.67 \times 10^{-11}$ N. m$^2$/kg$^2$
1 calorie = 1 c = $4.186\,J$
1 food calorie = 1 Calorie = 1C = $10^3$ calories = $4.186 \times 10^3$ J

***Water data***

$c(ice) = 2\,090$ J/(kg·K)  $c(water) = 4186$ J/(kg·K)  $c(steam) = 2\,079$ J/(kg·K)
$L_f(ice) = 3.33 \times 10^5$ J/kg  $L_v(water) = 2.260 \times 10^6$ J/kg  $\rho(water) = 1000$ kg/m$^3$
$\rho(sea\ water) = 1029$ kg/m$^3$  $n_w = 1.333$

***Electricity and nuclear data***

Alpha particle mass = $6.644\,657 \times 10^{-27}$ kg
Charge of an electron $-e = -1.6 \times 10^{-19}$ C
Charge of a proton $e = +1.6 \times 10^{-19}$ C
Coulomb's constant $k_e = 8.987\,5 \times 10^9$ Nm$^2$/C$^2$
Deuteron mass = $3.343\,583 \times 10^{-27}$ kg
Electron mass, $m_e = 9.109 \times 10^{-31}$ kg
Neutron mass $m_n = 1.675 \times 10^{-27}$ kg
Proton mass, $m_p = 1.673 \times 10^{-27}$ kg
1 atomic mass unit = 1 amu = 1 u = $1.66 \times 10^{-27}$ kg
$\epsilon_0 = 8.85 \times 10^{-12}$ C$^2$(N·m$^2$)
1 Ci = $3.7 \times 10^{10}$ decays/s
1Bq = 1 decay/s