

**PHY1505**

May/June 2015

## MECHANICS (PHYSICS)

**Duration**      **2 Hours**

**100 Marks**

## EXAMINERS

## EXAMIN FIRST

**FIRST  
SECOND**

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PROF GS RAIMI  
PROF SC RAY

**Use of a non-programmable pocket calculator is permissible.**

**Closed book examination**

**This examination question paper remains the property of the University of South Africa and may not be removed from the examination venue.**

- This paper consists of 3 pages plus instructions for the completion of a mark reading sheet
- Mark allocation for each question is indicated in brackets to the right
- Physical constants and mathematical formulae are given at the end of the paper
- **ANSWER ALL THE QUESTIONS**

[TURN OVER]

- 1 A small ball rolls horizontally off the edge of a tabletop that is 1.20 m high. It strikes the floor at a point 1.52 m horizontally away from the edge of the table
    - (a) How long is the ball in the air? (8)
    - (b) What is its speed at the instant it leaves the table? (7)

[15]
  - 2 A block is projected up a frictionless inclined plane with initial speed  $v_0 = 3.50$  m/s. The angle of incline is  $\theta = 32.0^\circ$ 
    - (a) How far up the plane does it go? (5)
    - (b) How long does it take to get there? (5)
    - (c) What is its speed when it gets back to the bottom? (5)

[15]
  - 3 Two 2.0 kg bodies,  $A$  and  $B$ , collide. The velocities before the collision are  $\vec{v}_A = 15\hat{i} + 30\hat{j}$  and  $\vec{v}_B = -10\hat{i} + 50\hat{j}$ . After the collision  $\vec{v}_A = -50\hat{i} + 20\hat{j}$ . All speeds are given in meters per second
    - (a) What is the final velocity of  $B$ ? (8)
    - (b) How much kinetic energy is gained or lost in the collision? (7)

[15]
  - 4
    - (a) State Newton's laws of Universal Gravitation (5)
    - (b) Derive an expression for the escape velocity from a planet of mass  $M$  and radius  $R$  (10)

[15]
  - 5 An oscillating block-spring system has a mechanical energy of 1.00 J, an amplitude of 10.0 cm, and a maximum speed of 1.20 m/s. Find
    - (a) the spring constant, (7)
    - (b) the mass of the block and (7)
    - (c) the frequency of oscillation (6)

[20]
  - 6 A block of wood floats in fresh water with two-thirds of its volume submerged. In oil the block floats with 0.90 of its volume submerged. Find the
    - (a) density of the wood (10)
    - (b) density of the oil (10)

[20]
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**Physical Constants**

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|                            |                                                          |
|----------------------------|----------------------------------------------------------|
| gravitational constant     | $G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$ |
| gravitational acceleration | $g = 9.81 \text{ m s}^{-2}$                              |
| mass of the Sun            | $M_S = 1.99 \times 10^{30} \text{ kg}$                   |
| radius of the Sun          | $R_S = 6.96 \times 10^8 \text{ m}$                       |
| mass of the Earth          | $M_E = 6.0 \times 10^{24} \text{ kg}$                    |
| radius of the Earth        | $R_E = 6.4 \times 10^6 \text{ m}$                        |
| 760 mm of Hg               | $1 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$           |
| density of water           | $\rho_w = 1000 \text{ kg/m}^3$                           |