UNIVERSITY EXAMINATIONS

UNIVERSITEITSEKSAMENS

UNISA university of south africa

PHY1505

October/November 2015

MECHANICS (PHYSICS)

Duration 2 Hours

100 Marks

EXAMINERS
FIRST PROF GJ RAMPHO
SECOND PROF SC RAY

Use of a non-programmable pocket calculator is permissible.

Closed book examination

- This paper consists of 3 pages
- Mark allocation to each question is indicated in brackets to the right
- ANSWER ALL THE QUESTIONS

1 Given the acceleration

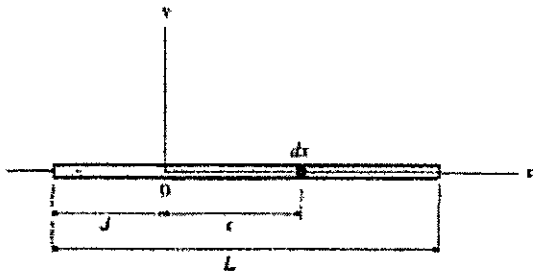
$$a = \frac{dv}{dt},$$

derive two equations of motion for constant acceleration, a [15]

2 (a) State Newton's third law of motion (5)

(b) A 100 g ball on a 60-cm-long string is swung in a vertical circle about a point 200 cm above the floor The string suddenly breaks when it is parallel to the ground and the ball is moving upward The ball reaches a height of 600 cm above the floor What was the tension in the string an instant before it broke? (15)
[20]

3 Consider a thin rod of mass M, length L and uniform linear density ρ



(a) Use direct integration to determine the expression for the moment of inertia I of the rod about an axis that is perpendicular to the rod and passing through the rod at a distance d from one end of the rod (10)

(b) Show that when $d = \frac{1}{2}L$ then $I = \frac{1}{12}ML^2$ (5)
[15]

4 (a) State the quantities that are conserved in a perfectly elastic collision (6)

(b) Consider two particles A and B that undergo an elastic head-on collision Particle B of mass m_B is initially at rest and particle A of mass m_A approaches particle B with speed v Derive expressions, in terms of m_A, m_B and v, for

i the speed of particle A after the collision (8)

ii the speed of particle B after the collision (8)
[20]

5 (a) Consider the equation

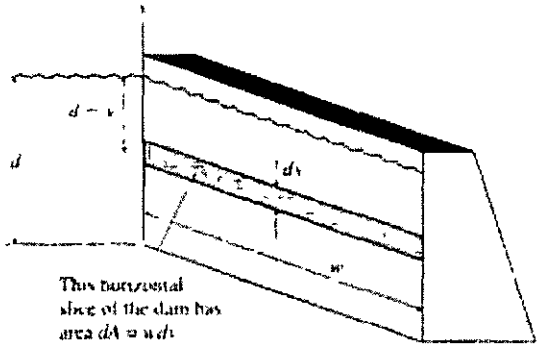
$$F = G\frac{m_1 m_2}{r^2}$$

concerning masses Explain the meaning of all the symbols in the equation (5)

(b) Two spherical objects have a combined mass of 150 kg The gravitational attraction between the objects is $8\,00 \times 10^{-6}$N when their centers are 20 cm apart What is the mass of each object? (10)
[15]

[TURN OVER]

6 Water stands at depth d behind a dam of width w



(a) Find an expression for the net force of the water on the dam
Hint The problem requires an integration (6)

(b) Evaluate the net force on the 100 m wide dam with a 60 m water depth (5)

(c) State Bernoulli's equation for flowing ideal fluids (4)
[15]

Physical Constants

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gravitational constant	$G = 6\,67 \times 10^{-11}\,\mathrm{N\,m^2\,kg^{-2}}$
gravitational acceleration	$g = 9\,81\,m\,s^2$
mass of the Earth	$M_E = 6\,0 \times 10^{24}\,\mathrm{kg}$
radius of the Earth	$R_E = 6\,4 \times 10^{6}\,\mathrm{m}$
density of water	$\rho_w = 1000\,\mathrm{kg/m^3}$