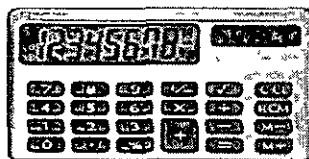


UNIVERSITY EXAMINATIONS

UNIVERSITEITSEKSAMENS
UNISA | university of south africa**PHY1505**

(470233)

October/November 2013

MECHANICS (PHYSICS)

Duration 2 Hours

100 Marks

EXAMINERS .
FIRST

PROF ML LEKALA

PROF GJ RAMPHO

Use of a non-programmable pocket calculator is permissible

Closed book examination.

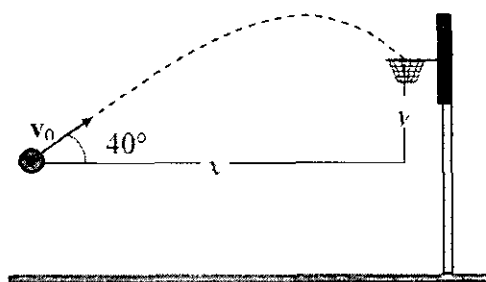
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- This paper consists of 5 pages plus instructions for the completion of a mark reading sheet
- This examination consists of two sections **SECTION A** and **SECTION B**
- Answer **SECTION A** (Multiple Choice) on the mark reading sheet
- Answer **SECTION B** (Written Solutions) on the examination answer book
- Marks allocation for each question is indicated in brackets to the right
- The information given at the end of Section B may be used without proof

SECTION A (Multiple Choice)

- 1 A basketball is launched with an initial speed of 8.5 m/s and follows the trajectory shown. The ball enters the basket 0.92 s after it is launched. What are the distances x and y ? **Note** The drawing is not to scale

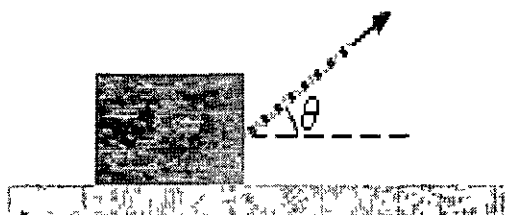
- 1) $x = 6.0$ m, $y = 0.88$ m
- 2) $x = 5.4$ m, $y = 0.73$ m
- 3) $x = 5.7$ m, $y = 0.91$ m
- 4) $x = 7.6$ m, $y = 1.1$ m
- 5) $x = 6.3$ m, $y = 0.96$ m



(3)

[TURN OVER]

- 2 A cannon fires a ball vertically upward from the Earth's surface. Which one of the following statements concerning the net force acting on the ball at the top of its trajectory is correct?
- 1) The net force on the ball is instantaneously equal to zero newtons at the top of the flight path
 - 2) The direction of the net force on the ball changes from upward to downward
 - 3) The net force on the ball is less than the weight, but greater than zero newtons
 - 4) The net force on the ball is greater than the weight of the ball
 - 5) The net force on the ball is equal to the weight of the ball
- (3)
- 3 A ball moves with a constant speed of 4 m/s around a circle of radius 0.25 m. What is the period of the motion? [Hint: For this calculation, you need to know the circumference of the circle.]
- 1) 0.1 s
 - 2) 0.4 s
 - 3) 0.7 s
 - 4) 1 s
 - 5) 2 s
- (3)
- 4 Jennifer is walking at 1.22 m/s. If Jennifer weighs 552 N, what is the magnitude of her momentum?
- 1) 97.0 kg m/s
 - 2) 137 kg m/s
 - 3) 68.6 kg m/s
 - 4) 672 kg m/s
 - 5) 951 kg m/s
- (3)
- 5 A certain spring compressed 0.20 m has 10 J of elastic potential energy. The spring is then cut into two halves and one of the halves is compressed by 0.20 m. How much potential energy is stored in the compressed half of the spring?
- 1) 5 J
 - 2) 10 J
 - 3) 14 J
 - 4) 20 J
 - 5) 40 J
- (3)
- 6 A concrete block is pulled 7.0 m across a frictionless surface by means of a rope. The tension in the rope is 40 N, and the net work done on the block is 247 J. What angle does the rope make with the horizontal?

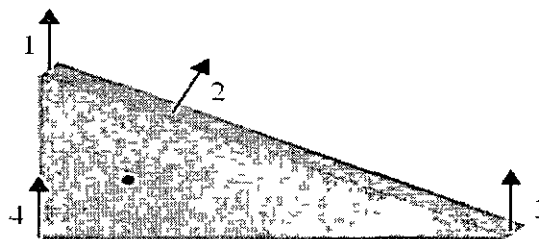


- 1) 28°
- 2) 41°
- 3) 47°
- 4) 62°
- 5) 88°

(3)

- 7 An object with a triangular cross-section is free to rotate about the axis represented by the black dot shown. Four forces with identical magnitudes are exerted on the object. Which one of the forces, if any, exerts the largest torque on the object?

- 1) 1
- 2) 2
- 3) 3
- 4) 4



- 5) The same torque is exerted by each force (3)

- 8 An object is raised from the surface of Earth to a height of two Earth radii above Earth. Then

- 1) its mass increases and its weight remains constant
- 2) both its mass and weight remain constant
- 3) its mass remains constant and its weight decreases
- 4) both its mass and its weight decrease
- 5) its mass remains constant and its weight increases

(3)

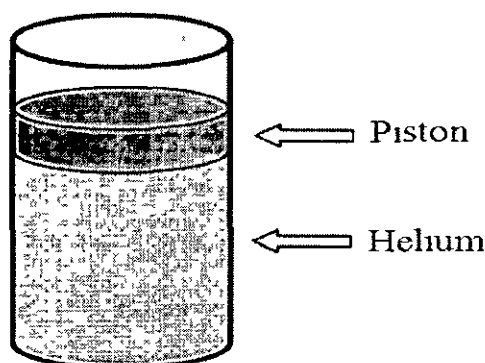
- 9 A steel ball is hung from a vertical ideal spring where it oscillates in simple harmonic motion with an amplitude of 0.157 m and an angular frequency of π rad/s. Which one of the following expressions represents the acceleration, in m/s^2 , of the ball as a function of time?

- 1) $a = -1.55 \cos(\pi t)$
- 2) $a = -1.55 \cos^2(\pi t)$
- 3) $a = -0.157 \cos(\pi t)$
- 4) $a = -0.493 \cos^2(\pi t)$
- 5) $a = -0.493 \cos(\pi t)$

(3)

- 10 Helium gas is confined within a chamber that has a moveable piston. The mass of the piston is 8.7 kg, and its radius is 0.013 m. If the system is in equilibrium, what is the pressure exerted on the piston by the gas?

- 1) 1.639×10^4 Pa
- 2) 8.491×10^4 Pa
- 3) 1.013×10^5 Pa
- 4) 1.606×10^5 Pa
- 5) 2.619×10^5 Pa



(3)

[30]

SECTION B**ANSWER ALL THE QUESTIONS IN THIS SECTION IN AN EXAMINATION BOOK**

- 1 A rabbit runs across the parking lot on which a set of coordinate has, strangely enough, been drawn. The coordinates (meters) of the rabbit's position as a function of time (seconds) are given by

$$x = -0.31t^2 + 7.2t + 28$$

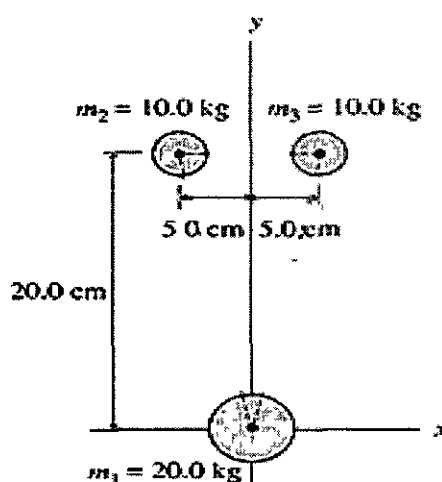
and
$$y = 0.22t^2 - 9.1t + 30$$

At $t = 15$ s, find in unit vector notation, the rabbit's

- (a) position vector $\vec{r}$, (5)
 (b) velocity vector $\vec{v}$, and (5)
 (c) acceleration vector $\vec{a}$ (5)

[15]

- 2 A particle of mass m moving along the x axis experiences a net force $F_x = ct$ where c is a constant and t is time. The particle has a velocity v_{0x} at $t = 0$. Determine the expression for the velocity $v_x(t)$ of the particle at a later time t . **[10]**
- 3 A 5000 kg interceptor rocket is launched at an angle of 44.7° . The thrust of the rocket motor is 140 700 N. Find the equation $y(x)$ that describes the rocket's trajectory. **[10]**
- 4 Three identical train cars, coupled together, are rolling east at 2 m/s. A fourth identical car traveling east at 4 m/s catches up with the three and couple to make a four-car train. What is the speed of the four-car train? **[5]**
- 5 A 1000 kg elevator accelerates upwards at 1 m/s^2 for 10 m, starting from rest.
 (a) How much work does the tension in the elevator cable do on the elevator? (5)
 (b) What is the speed of the elevator as it reaches 10 m? (5)
- [10]**
- 6 What is the total gravitational potential energy of the three masses in the figure below?

**[5]****[TURN OVER]**

- 7 A 1 kg block is attached to a spring with spring constant 20 N/m and is oscillating [5]
- 8 Water flowing out of a horizontal pipe emerges through a nozzle. The radius of the pipe is 1.9 cm, and the radius of the nozzle is 0.48 cm. The speed of the water in the pipe is 0.62 m/s. Treat the water as an ideal fluid, and determine the absolute pressure of the water in the pipe. [HINT: density of water to be $\rho = 1000 \text{ kg/m}^3$] [10]
-

USEFUL INFORMATION

$$\vec{r} = x(t)\hat{i} + y(t)\hat{j}$$

$$g = 9.8 \text{ m/s}^2$$

$$G = 6.67 \times 10^{-11} \text{ N m}^2/\text{kg}^2$$

$$P_{\text{atm}} = 1.01 \times 10^5 \text{ Pa}$$

$$\rho_w = 1000 \text{ kg/m}^3$$

$$T = 2\pi\sqrt{\frac{m}{k}}$$

$$|\vec{r}|^2 = x^2 + y^2 + z^2$$

$$E_T = E_K + E_P$$

$$\int k dx = kx + C$$

$$E_K = \frac{1}{2}mv^2$$

$$\int kx dx = \frac{1}{2}kx^2 + C$$

$$E_P = mgh$$

$$s = ut + \frac{1}{2}at^2$$

$$A_1 v_1 = A_2 v_2$$

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

$$\frac{1}{2}m_1 u_1^2 + \frac{1}{2}m_2 u_2^2 = \frac{1}{2}m_1 v_1^2 + \frac{1}{2}m_2 v_2^2$$

$$E_{K(A)} + E_{P(A)} = E_{K(B)} + E_{P(B)}$$

$$p_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

PART 1 (GENERAL/ALGEMEEN) DEEL 1

STUDY UNIT e.g. PSY100-X
STUDIE EENHEID by PSY100 X

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VPAESTELNOMMER

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INITIALS AND SURNAME
VOORLETTERS EN VAN

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DATE OF EXAMINATION
DATUM VAN EKSAMEN

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EXAMINATION CENTRE (E.G. PRETORIA)
EKSAMENSENTRUM (BY PRETORIA)

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STUDENT NUMBER
STUDENTENOMMER

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7

UNIQUE PAPER NO
UNIEKE VPAESTEL NR

8

9

For use by examination invigilator
Vir gebruik deur eksamenopsiener

IMPORTANT

1. USE ONLY AN HB PENCIL TO COMPLETE THIS SHEET
2. MARK LIKE THIS ➡
3. CHECK THAT YOUR INITIALS AND SURNAME HAS BEEN FILLED IN CORRECTLY
4. ENTER YOUR STUDENT NUMBER FROM LEFT TO RIGHT
5. CHECK THAT YOUR STUDENT NUMBER HAS BEEN FILLED IN CORRECTLY
6. CHECK THAT THE UNIQUE NUMBER HAS BEEN FILLED IN CORRECTLY
7. CHECK THAT ONLY ONE ANSWER PER QUESTION HAS BEEN MARKED
8. DO NOT FOLD

BELANGRIK

1. GEBUIK SLEGS N HB POTLOOD OM HIERDIE BLAD TE VOLTOOI
2. MERK AS VOLG ➡
3. KONTROLEER DAT U VOORLETTERS EN VAN REG INGEVUL IS
4. VUL U STUDENTENOMMER VAN LINKS NA REGS IN
5. KONTROLEER DAT U DIE KORREKTE STUDENTENOMMER VERSTREK HET
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7. MAAK SEKER DAT NET EEN ALTERNATIEF PER VRAAG GEMERK IS
8. MOENIE VOU NIE

PART 2 (ANSWERS/ANTWOORDE) DEEL 2

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