


PHY1505
PHY105A

(498149)

(472214)

May/June 2011

MECHANICS (PHYSICS)

100 Marks

Duration · 2 Hours

EXAMINERS :**FIRST :****SECOND :****MR GJ RAMPHO****MR DF MASITA**

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

- This paper consists of 6 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.
 - Mark 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
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SECTION A (Multiple Choice)

1. The velocity v of an object is given as a function of position x by $v = 2x^2 - 4$. The acceleration of the object as a function of position x is given by (3)

- 1) $\frac{2}{3}x^3 - 4x$
- 2) $4x^3 - 8x$
- 3) $4x^4 + 16$
- 4) $8x^3 - 16x$
- 5) $4x + 2$

[TURN OVER]

2. At time $t = 0$ a car has a speed of 16 m/s. It slows down with an acceleration defined by $a(t) = -0.50t$, in m/s^2 for t in seconds. At the end of 4.0 s it has traveled
- (1) 0
 - (2) 12 m
 - (3) 14 m
 - (4) 25 m
 - (5) 59 m
- (3)
3. A stone is thrown vertically upward with an initial speed of 19.5 m/s. It will rise to a maximum height of
- (1) 4.9 m
 - (2) 9.8 m
 - (3) 19.4 m
 - (4) 38.8 m
 - (5) 42.3 m
- (3)
4. The angle between the vector $\vec{A} = (-25\text{ m})\hat{i} + (45\text{ m})\hat{j}$ and the positive x -axis is
- (1) 29°
 - (2) 61°
 - (3) 119°
 - (4) 151°
 - (5) 209°
- (3)
5. A crate resting on a rough horizontal floor is to be moved horizontally. The coefficient of static friction is 0.40. To start moving the crate with the weakest possible applied force, in what direction should the force be applied?
- (1) Horizontal
 - (2) 24° below the horizontal
 - (3) 22° above the horizontal
 - (4) 24° above the horizontal
 - (5) 66° below the horizontal
- (3)

6. A large cannon is fired from ground level at an angle of 30° above the horizontal. The muzzle speed is 980 m/s. Neglecting air resistance, what horizontal distance will be travelled by the projectile before striking the ground?
- (1) 4.3 km
 - (2) 8.5 km
 - (3) 43 km
 - (4) 85 km
 - (5) 170 km
- (3)
7. The work done by gravity during the descent of a projectile
- (1) is positive
 - (2) is negative
 - (3) is zero
 - (4) depends on the direction of the y -axis
 - (5) depends on the direction of both the x -axis and y -axes
- (3)
8. The center of mass of a uniform disk of radius R is located
- (1) on the rim
 - (2) a distance $R/2$ from the center
 - (3) a distance $R/3$ from the center
 - (4) a distance $2R/3$ from the center
 - (5) at the center
- (3)
9. A 5 kg block is suspended by a rope from the ceiling of an elevator as the elevator accelerates downward at 3.0 m/s^2 . The tension on the rope is
- (1) 15 N, up
 - (2) 34 N, up
 - (3) 34 N, down
 - (4) 64 N, up
 - (5) 64 N, down
- (3)

10. A wheel, turning at a constant rate, completes 100 revolutions in 10 s. Its angular speed is
- (1) 0.31 rad/s
 - (2) 0.63 rad/s
 - (3) 10 rad/s
 - (4) 31 rad/s
 - (5) 63 rad/s
- (3)
[30]
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SECTION B**ANSWER ALL THE QUESTIONS IN THIS SECTION IN AN EXAMINATION BOOK**

1. A 30 g bullet moving at a horizontal velocity of 500 m/s comes to a stop 12 cm within a solid wall
- (a) What is the change in the mechanical energy of the bullet? (6)
 - (b) What is the magnitude of the average force from the wall stopping the bullet? (7)
- [13]
2. Two objects *A* and *B* of the same mass collide elastically. Before collision object *A* is moving with a speed of 500 m/s and object *B* is at rest. After the collision the two objects move along perpendicular paths, with the path of object *A* making an angle of 60° from the original direction. After the collision, what is the speed of each object? [10]
3. During a time interval t the flywheel of a generator turns through the angle
- $$\theta(t) = at + bt^3 - ct^4,$$
- where a , b and c are constants. Determine the expressions of the following quantities as a function of t
- (a) The angular speed of the wheel. (5)
 - (b) The angular acceleration of the wheel. (5)
- [10]
4. A cube with a total surface area of 24 m^2 floats upright in water. If the density of water is 4 times the density of the cube, how far does the cube sink into the water? [10]

[TURN OVER]

5. A vertical spring stretches 9.6 cm when a 1.3 kg block is hung from its end. The block is then displaced an additional 5.0 cm downward and released from rest. Calculate
- (a) the spring constant, (3)
 - (b) the period of the simple harmonic motion, (3)
 - (c) the frequency of the simple harmonic motion, (3)
 - (d) the amplitude of the simple harmonic motion, and (3)
 - (e) the maximum speed of the simple harmonic motion (3)
- [12]
6. Water is flowing down through a vertical pipe with a speed of 5.0 m/s at the top. The cross-sectional area of the pipe at the top is 4.0 cm² and the cross-sectional area of the pipe at the bottom is 8.0 cm². The water gradually descends 10 m as the pipe increases in the cross-sectional area from 4.0 cm² to 8.0 cm².
- (a) Calculate the speed of the water at the bottom level (7)
 - (b) If the water pressure at the upper level is 1.5×10^5 Pa, calculate the pressure at the bottom level (8)
- [15]

USEFUL INFORMATION

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

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

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

$$\frac{d(kx^n)}{dx} = nkx^{n-1}$$

$$E_T = E_K + E_P$$

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

$$E_P = mgh$$

$$A_1 v_1 = A_2 v_2$$

[TURN OVER]

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

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

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

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

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

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

MARK READING SHEET INSTRUCTIONS

Your mark reading sheet is marked by computer and should therefore be filled in thoroughly and correctly

USE ONLY AN HB PENCIL TO COMPLETE YOUR MARK READING SHEET

PLEASE DO NOT FOLD OR DAMAGE YOUR MARK READING SHEET

Consult the illustration of a mark reading sheet on the reverse of this page and follow the instructions step by step when working on your sheet

Instruction numbers ① to ⑩ refer to spaces on your mark reading sheet which you should fill in as follows

- ① Write your paper code in these eight squares, for instance

P	S	Y	1	0	0	-	X
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- ② The paper number pertains only to first-level courses consisting of two papers

WRITE

0	1
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 for the first paper and

0	2
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 for the second. If only one paper, then leave blank

- ③ Fill in your initials and surname
- ④ Fill in the date of the examination
- ⑤ Fill in the name of the examination centre
- ⑥ WRITE the digits of your student number HORIZONTALLY (from left to right) Begin by filling in the first digit of your student number in the first square on the left; then fill in the other digits, each one in a separate square
- ⑦ In each vertical column mark the digit that corresponds to the digit in your student number as follows. [-].
- ⑧ WRITE your unique paper number HORIZONTALLY
NB Your unique paper number appears at the top of your examination paper and consists only of digits (e.g. 403326)
- ⑨ In each vertical column mark the digit that corresponds to the digit number in your unique paper number as follows: [-]
- ⑩ Question numbers 1 to 140 indicate corresponding question numbers in your examination paper. The five spaces with digits 1 to 5 next to each question number indicate an alternative answer to each question. The spaces of which the number correspond to the answer you have chosen for each question and should be marked as follows. [-].



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