HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 1- Physics

JUNE 2015
TIME: 2 HRS

Total 100

Instructions

1. Answer ALL the questions.

2. This question paper consists of TWO sections:

3. SECTION A (12)
   SECTION B (88)

   Answer SECTIONS A and B in the ANSWER BOOK.

4. Non-programmable calculators may be used.

5. Appropriate mathematical instruments may be used.

6. Number the answers correctly according to the numbering system used in this question paper.

7. Data sheets and a periodic table are attached for your use.

8. Give brief motivations, discussions, et cetera where required.

9. Numbers must be rounded off to **two decimal** places

SECTION A

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.7) in the ANSWER BOOK.

1.1 If the mechanical energy of a free falling body is conserved, then the ...

- A frictional force acting on the body is zero.
- B work done by the earth on the body is zero throughout its fall.
- C gravitational potential energy is equal to the kinetic energy at any point in the motion.
- D sum of the gravitational potential energy and kinetic energy at any point in the motion is zero.

1.2 A vehicle with mass *m* is moving horizontally at a constant velocity on a frictionless path. The kinetic energy of the vehicle is K and the momentum is p. The velocity of the vehicle can be given as:

- A $\frac{K}{2p}$
- B $\frac{2K}{p}$
- C $\frac{K}{P}$
- D $\frac{p}{K}$

1.3 When an airbag inflates in a car during a collision, the chances of serious injury to a passenger is reduced because the …

- A passenger is brought to rest in a shorter period of time.
- B net force acting on the passenger is reduced.
- C passenger's change in momentum is reduced.
- D passenger's change in momentum is increased.

1.4 A rocket of mass M, experiences a gravitational force F on the surface of the Earth, which has a radius R. The rocket blasts off to a distance R, vertically above the surface of the Earth, where its mass is now $\frac{1}{2}$ M. The gravitational force it experiences at his height is….

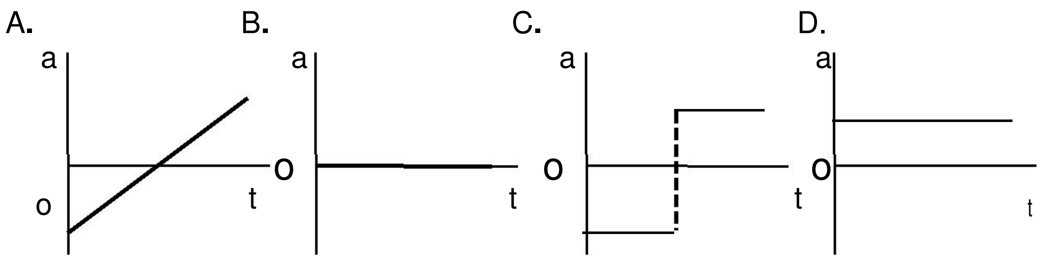
A F

B 3F

C $\frac{1}{8}$F

D $\frac{1}{2}$F

1.5 An object has a momentum **p** for a time of **t** seconds. Which ONE of the following graphs correctly shows the acceleration-time relationship for this time interval?



1.6 A ball is projected vertically upwards. If air friction is ignored, which ONE of the following statements about the motion of the ball is INCORRECT, at the instant the ball changes direction?

A The velocity of the ball is zero.
B The momentum of the ball is zero.
C The acceleration of the ball is zero.
D The kinetic energy of the ball is zero.

[2 x 6 = 12]

SECTION B

INSTRUCTIONS AND INFORMATION

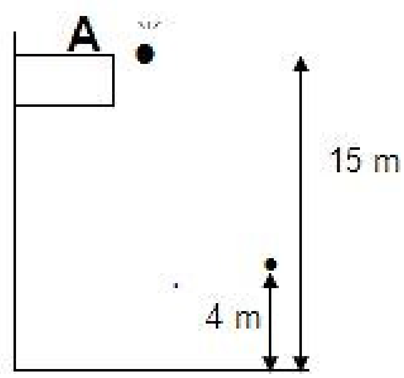
1. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.

2. Show the formulae and substitutions in ALL calculations.

3. Round off your numerical answers to **TWO decimal** places

QUESTION 2

A cricket ball, mass 156 g, is dropped from point **A** on a tall building, 15 m high. It strikes the concrete pavement and it then bounces to a maximum height of 4 m. **(Use all downward motion as positive.)**



2.1 Calculate the velocity with which the cricket ball strikes the pavement. (Ignore effects of air friction) (3)

2.2 If the effects of air friction are NOT ignored during the fall of the cricket ball, how would the value you calculated in QUESTION 2.1 change? Write down HIGHER, LOWER or STAYS THE SAME. (1)

2.3 The cricket ball is in contact with the concrete pavement of 0,8 s. Ignore the effects of air friction. Take DOWNWARD motion as POSITIVE.

2.3.1 Calculate the impulse of the cricket ball on the pavement. (8)

2.3.2 Calculate the (net) average force exerted by the pavement on the cricket ball. (4)

2.4 Sketch the **position versus time** graph for the motion of the cricket ball from the moment it is dropped until it reaches its maximum height after the bounce.

USE POINT **A** AS THE ZERO POSITION. Indicate the following on the graph:

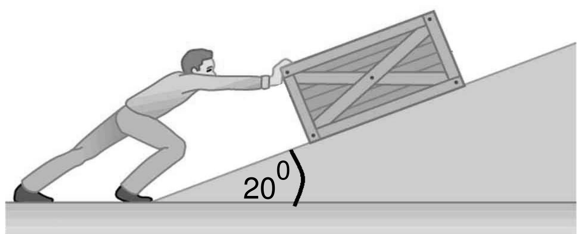
- The height from which the cricket ball is dropped
- The height reached by the cricket ball after the bounce
- Time with which the cricket ball is in contact with the concrete pavement (4)

2.5 The cricket ball is now replaced with a softer ball of similar mass. State how the (net) average force exerted by the concrete pavement on the softer ball compares with your answer in QUESTION 2.3.2. (Write down only GREATER, SMALLER or STAYS THE SAME). Use physics principles to explain your answer. (3)

[23]

QUESTION 3

A man pushes a crate, of mass 10 kg, up a rough surface inclined at 20º to the horizontal, with a 100 N force parallel to the surface.



The crate is pushed 5 m up the surface with an initial speed of 1,5 $m.s^{-1}$. The coefficient of kinetic friction between the crate and surface is 0,4.

3.1 Draw a labelled free body diagram to show all the forces acting on the crate. (4)

3.2 Calculate the work done by gravity. (3)

3.3 Calculate the:

3.3.1 energy lost due to friction. (6)

3.3.2 work done by the man in pushing the crate up the surface. (3)

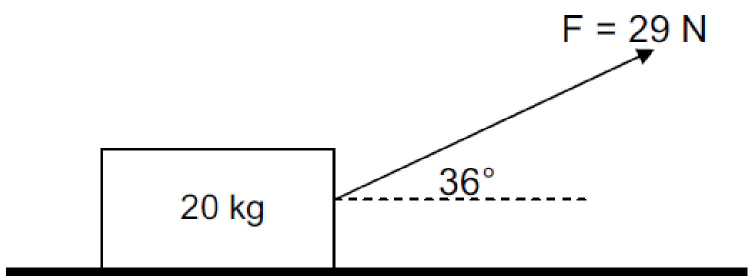
3.4 State the Work Energy Theorem in words. (2)

3.5 Use the Work Energy Theorem to calculate the magnitude of the final velocity of the crate after it has been pushed 5 m up the surface. (4)

[22]

QUESTION 4

A block of mass 20 kg is pulled at constant velocity to the right on a rough horizontal surface by a force, F, of magnitude 29 N. F acts at an angle of 36° to the horizontal as shown in the diagram below:



4.1 Draw a labelled free body diagram to show all the forces that act on the block as it moves to the right. (4)

4.2 Calculate the magnitude of the frictional force that acts on the block as it moves to the right. (3)

The force F now acts parallel to the surface.

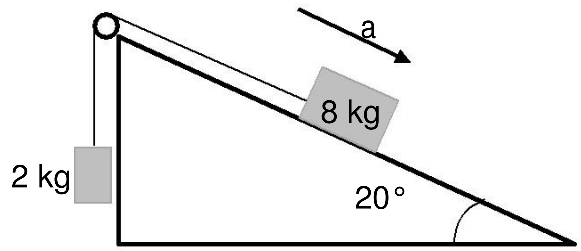
4.3 Will the magnitude of the frictional force between the block and the surface INCREASE, DECREASE or REMAIN THE SAME. (1)

4.4 Give an explanation for your answer to QUESTION 4.3 by making reference to the relevant equation. (3)

[11]

Question 5

An 8 kg wooden block is attached to a 2 kg wooden block by means of a weightless inelastic string which passes over a frictionless pulley. The block accelerates down a rough plane inclined at 20° to the horizontal as shown below.



The tension in the string is 21 N.

5.1 Define *acceleration*. (2)

5.2 Draw a labelled force diagram of all the forces acting on the 8 kg block. (3)

5.3 Prove using a calculation that the magnitude of the acceleration of the system is 0,7 $m \cdot s^{-2}$. (3)

5.4 Calculate the magnitude of the frictional force experienced by the 8 kg block. (4)

[12]

Question 6

A boy in a wheelchair is moving to the right, as shown in the sketch below, at a constant speed of 3 $m.s^{-1}$ on a straight horizontal frictionless track. The combined mass of the boy and the wheelchair is 75 kg. A parcel of mass 2 kg is thrown horizontally, towards the boy with a speed of 5 $m.s^{-1}$.

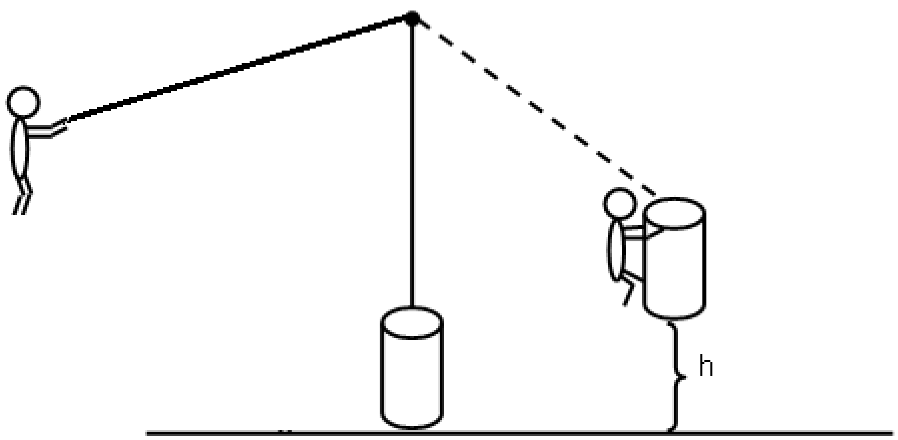
6.1 Write down the *principle of conservation of linear momentum* in words. (2)

6.2 Calculate the velocity of the boy immediately after he catches the parcel. (4)

[6]

Question 7

A large padded bag of mass 40 kg is suspended at rest just above the ground by a long light nylon rope hanging from a tall tree. Chad, who has a mass of 120 kg drops down from a height of 5 m and collides with the bag. On colliding with the bag, he grabs onto the bag in such a way that he and the bag swing away upwards as shown.



7.1 Prove that the combined speed of Chad and the bag, immediately after he collides with the bag is 7,5 $m.s^{-1}$. (9)

7.2 Calculate the maximum height, h, to which Chad and the bag will swing. (5)

[14]

<u>Total 120</u>

Information sheets – Paper 1 (Physics)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9,8\ m \cdot s^{-2}$
Universal gravitational constant	G	$6,67 \times 10^{-11}\ N \cdot m^2 \cdot kg^{-2}$
Speed of light in a vacuum	c	$3,0 \times 10^8\ m \cdot s^{-1}$
Planck's constant	h	$6,63 \times 10^{-34}\ J \cdot s$
Coulomb's constant	k	$9,0 \times 10^9\ N \cdot m^2 \cdot C^{-2}$
Charge on electron	e	$-1,6 \times 10^{-19}\ C$
Electron mass	m_e	$9,11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE

MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ OR $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ OR $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ OR $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$

WORK, ENERGY AND POWER

$W = F\Delta x \cos\theta$	$U = mgh$ OR $E_P = mgh$
$K = \frac{1}{2}mv^2$ OR $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ OR $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ OR $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ OR $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ OR $E = h\frac{c}{\lambda}$
$E = W_o + K_{max}$ OR $E = W_o + E_{k(max)}$ where $E = hf$ and $W_o = hf_o$ and $K_{max} = \frac{1}{2}mv^2_{max}$ OR $E_{k(max)} = \frac{1}{2}mv^2_{max}$	

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ OR $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	emf (E) = I(R + r)
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I\,\Delta t$
$W = Vq$ $W = VI\,\Delta t$ $W = I^2R\,\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$	$P_{average} = V_{rms}I_{rms}$ $P_{average} = I^2_{rms}R$ $P_{average} = \frac{V^2_{rms}}{R}$