Hillcrest High School

Grade 12

PHYSICAL SCIENCE P1

JUNE 2023

MARKS: 100

TIME: 2 Hours

EXAMINER: Ms. N. Badenhorst

MODERATOR: Mrs. J. Knox-Whitehead

Instructions

1. Answer ALL the questions
2. This question paper consists of TWO sections:
3. SECTION A (10)

   SECTION B (90)

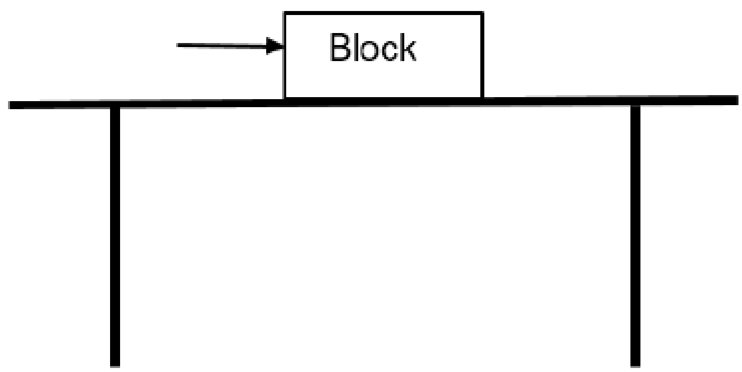
   Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Data sheets are attached for your use
7. Give brief motivations, discussions et cetera where required.
8. Final answers 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 (1.1-1.10) in the answer book.

1.1 A wooden block placed on a table is pushed, causing it to accelerate. Which ONE of the following statements regarding the frictional force is correct?



The frictional force is:

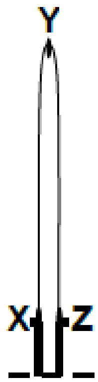
A Increasing as the speed increases

B Equal and opposite to the pushing force

C Great than the pushing force

D Less than the pushing force

1.2 A ball thrown vertically upwards from point **X** reaches its greatest height a point **Y** and returns to the same level as **X** at point **Z**, as shown in the diagram below.



Ignore the effects of air resistance.

Which ONE of the following statements is CORRECT?

A The acceleration at point **Y** equals zero

B The speed at **X** equals the speed at **Z**

C It takes longer time from **X** to **Y** than **Y** to **Z**

D The velocity at **X** equals the velocity at **Z**

1.3 The kinetic energy of an object with momentum ‘p’ and mass ‘m’ is:

A 2 pm

B $\frac{\mathrm{p^2m}}{2}$

C $\frac{p^2}{2m}$

D $\frac{pm}{2}$

1.4 A car with mass *m* moves at a constant velocity *v* and covers a distance Δx under the action of a constant frictional force *f*. The power required to keep the body in motion at this constant velocity is …

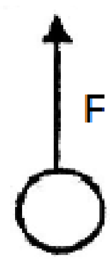
A $f\Delta x$.

B $\frac{1}{2}mv^2$.

C fv.

D $f\Delta t$.

1.5 An object, with mass m, is accelerated vertically upwards by an applied force F acting on it. Ignore the effects of air friction.



Which ONE of the following is true for the work done by the applied force F and the net force $Fnet$ respectively? (U represents Ep and K represents Ek)

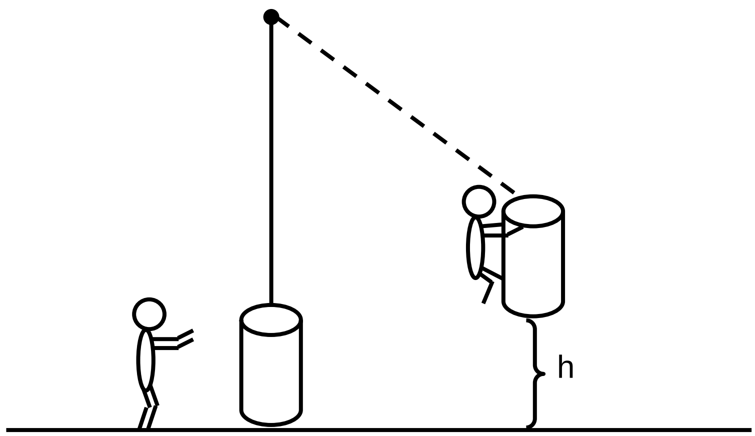
	WORK DONE BY F	WORK DONE BY Fnet
A	ΔU + ΔK	$\frac{1}{2}mv^2$
B	ΔU - ΔK	$\frac{1}{2}mv^2$
C	ΔU + ΔK	ΔK
D	mgh + $\frac{1}{2}mv^2$	ΔU

[2 x 5 = 10]

SECTION B:

Question 2

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. James, who has a of mass 85 kg runs horizontally. and collides with the bag with a speed of 8 $m.s^{-1}$. On colliding with the bag, he grabs onto the bag in such a way that he and the bag swing away upwards as shown.



2.1 State, in words, the Law of Conservation of Linear Momentum. (2)

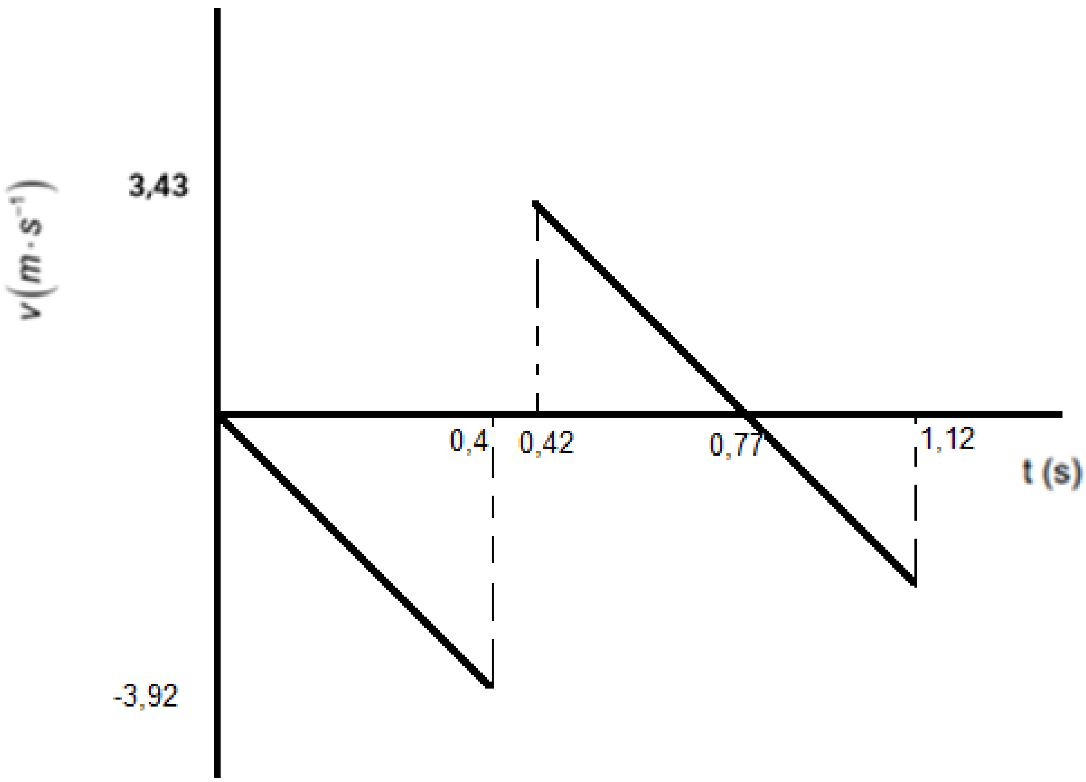
2.2 Prove that the combined speed of James and the bag, immediately after he collides with the bag is 5,44 $m.s^{-1}$. (4)

2.3 Calculate the maximum height, h, to which James, and the bag will swing. (6)

[12]

Question 3

A 50 g ball is dropped from a certain height. The velocity-time graph below represents the motion of the ball as it bounces vertically on a concrete floor. The time of contact during the bounce is 0.02s. Ignore all effects of air friction.



3.1 Define a *projectile.* (2)

3.2 Write down the magnitude of the velocity with which the ball leaves the ground after bouncing. (1)

3.3 Draw a labelled free-body diagram showing all the forces acting on the ball at 0,77 s. (2)

3.3 Use the information given on the graph and calculate the:

3.4.1 Acceleration of the ball (3)

3.4.2 Height from which the ball was dropped. (4)

3.5 On a set of axes, draw a position-time graph for the motion of the ball from 0 s to 1.12 s. Use the ground as zero reference. Indicate the height from which the ball was dropped and all the relevant times on the t-axis on your graph. (4)

3.6 Give ONE term for the rate of change of momentum. (2)

3.7 Calculate the magnitude of the force exerted by the floor on the ball for the time of contact. (5)

3.8 If a softer ball is used and the time of contact with the floor is increased while the change in momentum remains constant, how will it influence the force on the ball? Write only INCREASES, DECREASES or REMAINS THE SAME. (3)

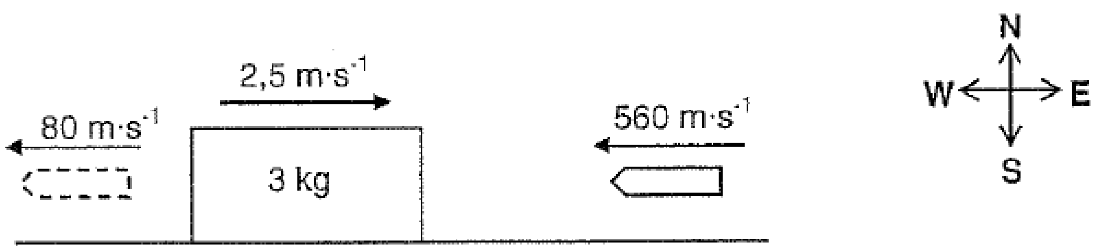
Explain the answer. [26]

Question 4

A bullet moves west at a velocity of 560 $m.s^{-1}$. It hits a wooden block with a mass of 3 kg which is moving at 2,5 $m.s^{-1}$ east on a frictionless floor. The bullet takes 0,02 s to move through the wooden block and leaves the block with a velocity of 80 $m.s^{-1}$ west.

The magnitude of the momentum of the bullet before it hits the block is 8,4 kg.$m.s^{-1}$. See the diagram below.

Ignore the effects of air friction as well as any loss of mass of both the block and bullet.
Assume that the block-bullet system is an isolated system.



4.1 Explain the meaning of the term *isolated system*. (2)

4.2 Calculate the:

4.2.1 Mass of the bullet (3)

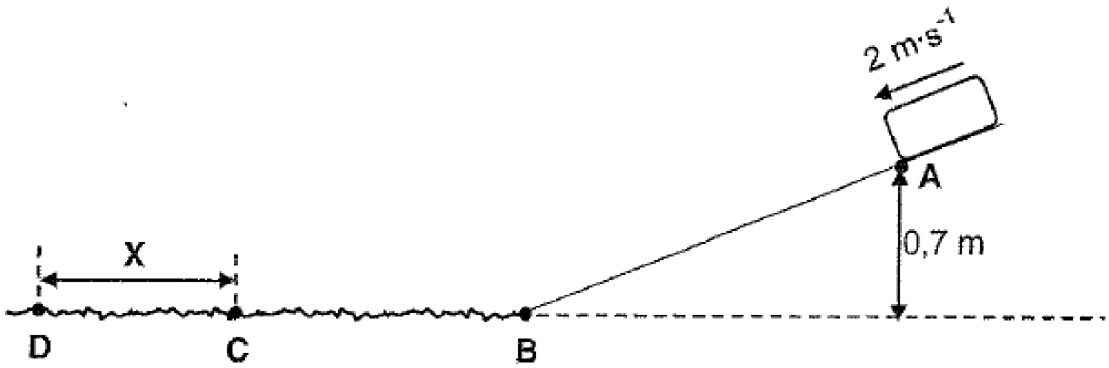
4.2.2 Speed of the block after the bullet left the block (4)

4.2.3 Average net force the block exerted on the bullet during the collision (4)

[13]

Question 5

A block of mass **m** slides down a frictionless slope to point **B**. At point **A**, which is 0,7 m above the ground, the speed of the block is $2 m.s^{-1}$ as shown in the diagram below.



5.1 Use the LAW OF CONSERVATION OF MECHANICAL ENERGY to calculate the speed of the block at point **B**. (3)

The block moves from point B to point D on a rough, horizontal surface. The kinetic frictional force between the block and the rough surface is 3 N. The block reaches point **C** with a momentum of 5,79 $kg.m.s^{-1}$ to the left and kinetic energy of 11,17 J.

5.2 Calculate the speed of the block at point **C**. (3)

The block comes to rest at point **D**, a distance **X** from point **C.**

5.3 State the *work-energy theorem* in words. (2)

5.4 Use energy principles ONLY to calculate the distance **X**. (5)

[13]

Question 6

An ambulance moves away from an accident scene at a constant speed. Its siren produces sound waves with a frequency of 890 Hz. A person standing at the accident scene measures a change of 89 Hz in the frequency of the sound produced by the siren as it moves away.

6.1 NAME and DESCRIBE the phenomenon above. (3)

6.2 If the speed of sound in air is $340 m.s^{-1}$, calculate the speed of the ambulance (5)

6.3 How will the frequency measured by the person be affected if the speed of the ambulance increases? (1)

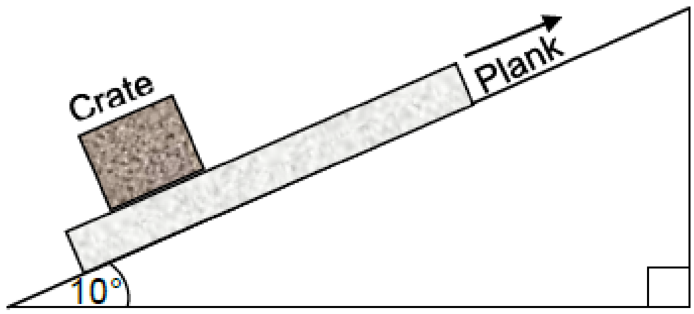
Choose from INCREASES, DECREASES or REMAINS THE SAME.

6.4 State ONE use of the Doppler-flow meter in the medical field. (1)

[10]

Question 7

7.1 A crate is at rest on top of a wooden plank. The wooden plank is then pushed upwards over a surface inclined at an angle of 10°, as shown in the diagram below.
The coefficient of static friction between the plank and the crate is 0,35.



7.1.1 Define the term *static friction force* in words. (2)

7.1.2 Draw a labelled free-body diagram for the crate as the plank accelerates up the incline. (3)

7.1.3 Calculate the magnitude of the maximum acceleration that the plank can attain before the crate begins to slip backwards. (5)

7.2 The radius of Earth is 5 times, and the mass is 153 times that of planet **X**.

7.2.1 State *Newton's law of universal gravitational* in words. (2)

7.2.2 Calculate the acceleration due to gravity on the surface of planet **X**. (3)

7.2.3 How does the gravitational constant **G** on planet **X** compare with that on the surface of EARTH? Write down only GREATER THAN, LESS THAN, or EQUAL TO. (1)

[16]

Total: 100

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8 \text{ m·s}^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11} \text{ N·m}^2\text{·kg}^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6 \text{ m}$
Mass of the Earth *Massa van die Aarde*	M_E	$5,98 \times 10^{24} \text{ kg}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^8 \text{ m·s}^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34} \text{ J·s}$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^9 \text{ N·m}^2\text{·C}^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19} \text{ C}$
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31} \text{ kg}$

MOTION/*BEWEGING*

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

FORCE/*KRAG*

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

WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING*

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

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or/*of* $E = h\frac{c}{\lambda}$
$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \frac{1}{2}mv^2$	