HILLCREST HIGH SCHOOL

PHYSICAL SCIENCE P1

June 2025

Grade 12

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)
4. Answer SECTIONS A and B in the ANSWER BOOK.
   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 are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to two decimal places

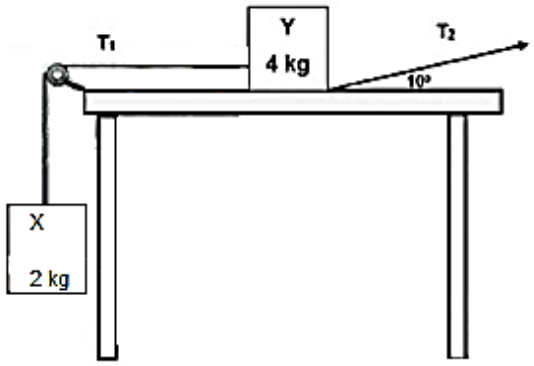
SECTION A

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 (1.1-1.5) in the answer book.

Question 1

1.1 In the diagram below, a 4 kg wooden block, **Y**, connected to a 2 kg mass, **X**, by an inelastic rope, $\mathbf{T_1}$, and a frictionless pulley, is held in place by a light, inelastic rope, $\mathbf{T_2}$, at an angle of 10°.



How do the magnitudes of the tension in ropes $\mathbf{T_1}$ and $\mathbf{T_2}$ compare respectively?

A $T_1 = T_2$

B $T_1 > T_2$

C $T_1 + T_2 = 0$

D $T_1 < T_2$

1.2 The MASS of an object on Earth is represented by $\frac{x}{g}$

Which ONE of the following represents the MASS of the object on a planet, that has TWICE the mass of earth and HALF the radius of the Earth?

A $\frac{8x}{g}$

B $\frac{x}{g}$

C $\frac{x}{2g}$

D $\frac{x}{8g}$

1.3 Ball A of mass **m** is projected vertically upwards from the ground with an initial velocity v. Ball **A** rises to a maximum height **h** above the ground. Ball **B** of mass $\frac{1}{2}$ **m** is now projected vertically upwards with an initial velocity of **2v**. Ignore the effects of air friction.

In terms of **h**, to what maximum height does ball **B** rise above the ground?

A h

B $\sqrt{2}$h

C 2h

D 4h

1.4 A police car, with its siren on, is travelling at a constant speed TOWARDS a stationary sound detector. The siren emits sound waves of frequency f and speed v. Which ONE of the following combinations best describes the frequency and speed of the detected sound waves.

	FREQUENCY	**SPEED**
A	Less than f	v
B	Less than f	Less than v
C	Greater than f	Less than v
D	Greater than f	v

1.5 In which of the following rows does the type of collision match with total linear momentum and kinetic energy?

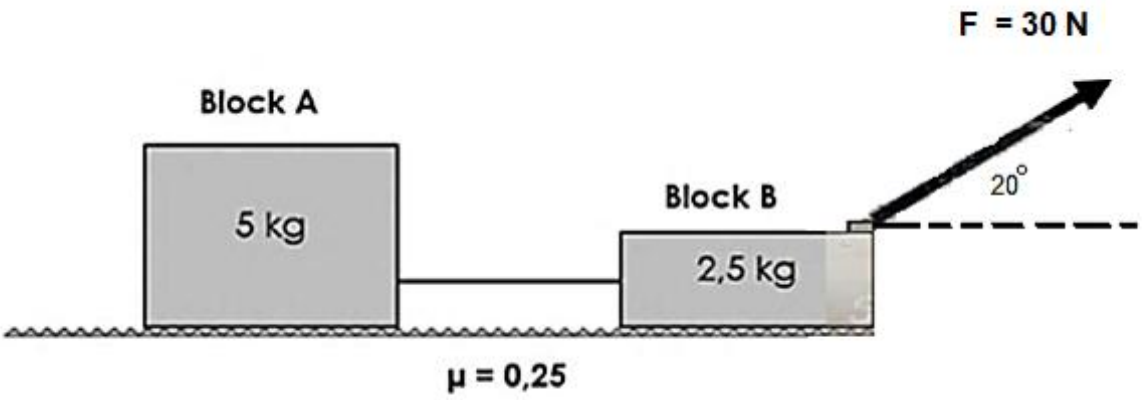
	TYPE OF COLLISION	**MOMENTUM**	**KINETIC ENERGY**
A	Elastic	Conserved	Not conserved
B	Inelastic	Conserved	Not conserved
C	Inelastic	Not conserved	Conserved
D	Elastic	Not conserved	Conserved

[2 x 5 = 10]

Section B

Question 2

2.1 Two blocks, **A**, of mass of 5 kg, and **B**, of mass 2.5 kg are connected by a light inextensible string. A 30 N force is applied at an angle of 20° to block **B** as shown in the diagram. The applied force causes both blocks to accelerate across a rough floor which has a kinetic coefficient of 0,25.



2.1.1 State *Newton's Second Law of Motion* in words. (2)

2.1.2 Calculate the magnitude of the frictional force acting on the 5 kg block. (3)

2.1.3 Draw a fully labelled free-body diagram of the forces acting on block **A**. (5)

2.1.4 Determine the acceleration of the blocks. (6)

2.2 On a particular day, the distance between the surface of Earth and the surface of Mars was $4,5 \times 10^9$ m. Mars has a mass of $6,417 \times 10^{23}$ kg and a diameter of 6 779 km.

2.2.1 State Newton's Law of Universal Gravitation in words. (2)

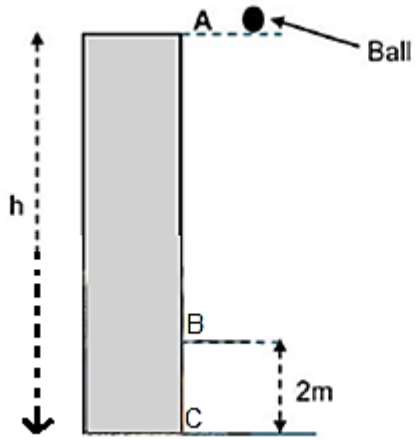
2.2.2 Calculate the magnitude of the gravitational force Earth exerts on Mars. (4)

[22]

Question 3

A group of learners set up an experiment to determine the height h of their school. They release a tennis ball from point **A** at the edge of the roof of the school building as shown in the diagram below. Point **B** is 2 m above the ground and the ball takes 0,125 s to cover the distance from point B to the ground (point **C**).

Ignore the effects of air friction.



3.1 Write down the magnitude of the rate of change of velocity of the ball. (1)

3.2.1 Prove that the height, h, of the building is 14,08 m. (4)

3.2.2 Calculate the time for the ball to reach the ground. (4)

3.2.3 Calculate the velocity with which the ball strikes the ground. (3)

3.3 Sketch a position versus time graph for the motion of the ball from the moment it was released until it strikes the ground. Use the ground as the zero-reference point.

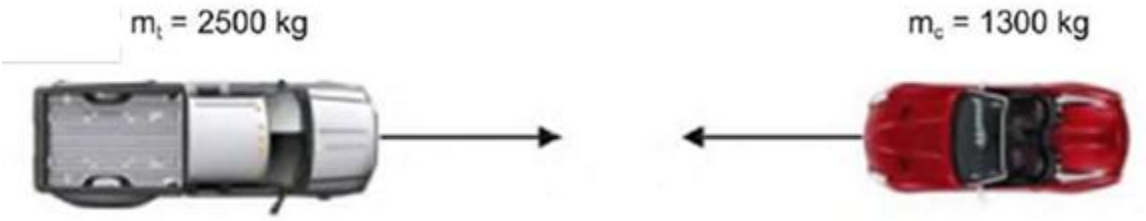
Indicate the following on the graph:

- The height from which the ball was released.
- Time when the ball strikes the ground. (3)

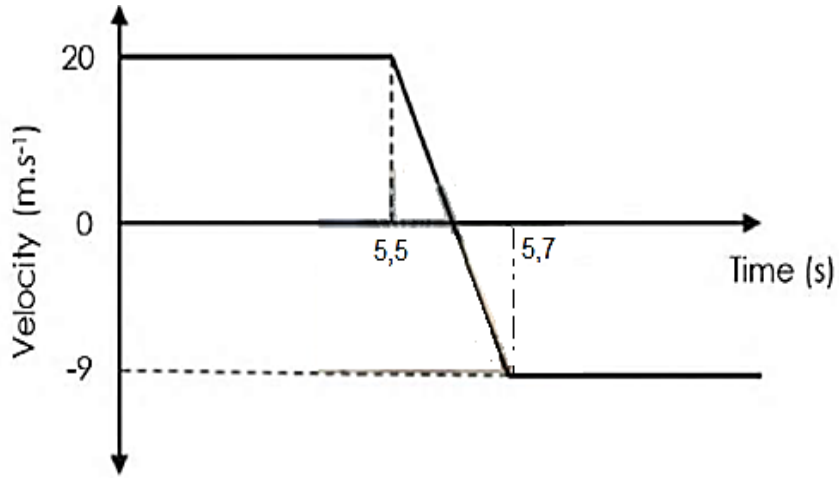
[15]

Question 4

A car, mass 1300 kg, moves to the left on a narrow road. It collides head-on with a pickup truck, mass 2500 kg, moving in the opposite direction as shown. After the collision the two vehicles move together.



The following velocity-time graph is plotted for the car:



4.1 Calculate the magnitude of the velocity of the pickup truck before the collision. (4)

4.2 Calculate the magnitude of the net force on the car. (4)

4.3 What is the magnitude of the force of the car on the truck? (1)

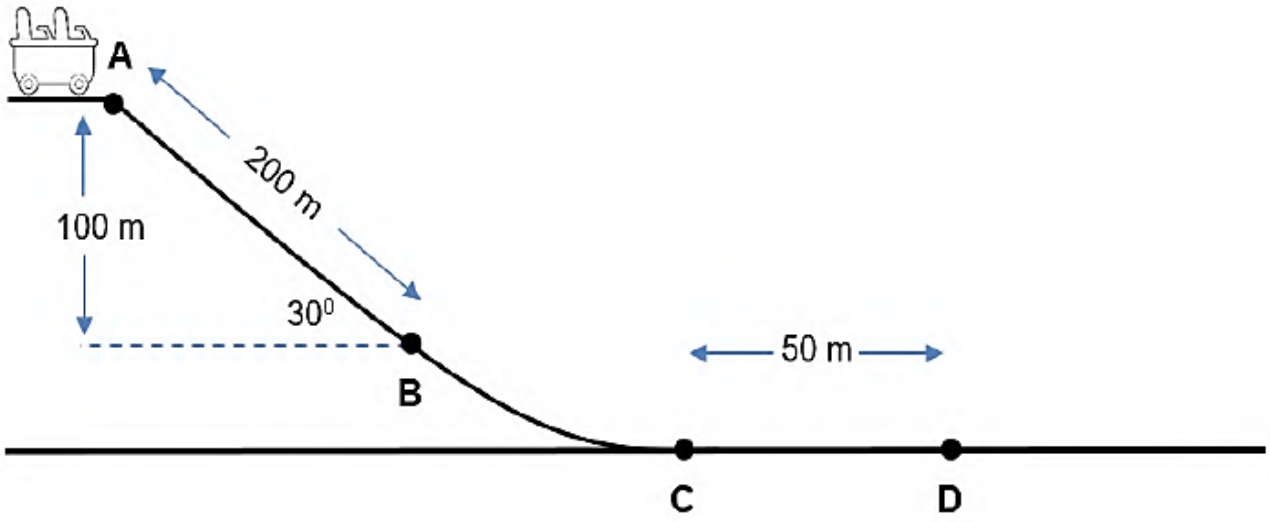
4.4 Determine, by means of calculations, whether this collision is elastic or inelastic. (5)

[14]

Question 5

A 850 kg roller-coaster is released from rest at point **A** on the track shown in the figure below. It travels along the straight decline section **A** to **B** and continues along the curved section **B** to **C** where the brakes are the applied from point **C**. The roller-coaster comes to a stop at **D**, 50 m from **C**. The coefficient of kinetic friction of the track 0,42.

Ignore the rotational effects of the roller coaster's wheels.



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

5.2 Draw a labelled free body diagram showing all the forces acting on the roller-coaster as it moves from **A** to **B**. (3)

5.3 Calculate the net work done on the roller-coaster as it moves from **A** to **B**. (5)

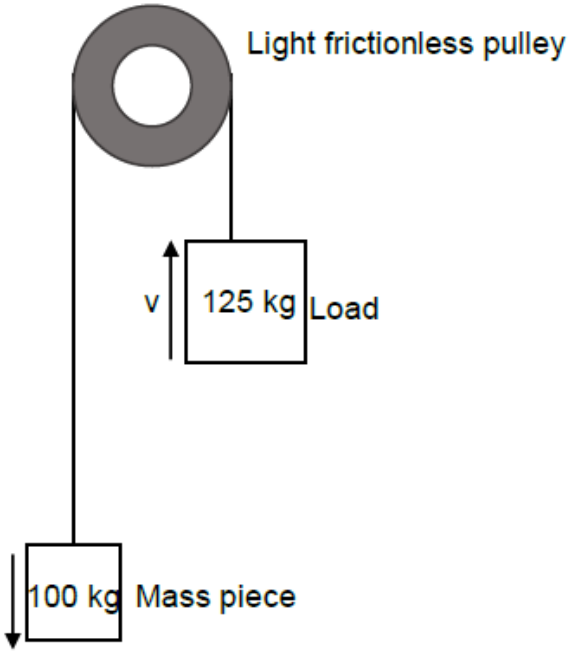
5.4 Along the curved section **BC**, the kinetic energy of the roller-coaster decreases by 108 950 J. The brakes are applied at point **C**.

Calculate the magnitude of the average braking force required by the braking system to bring the roller-coaster to a stop at point **D**. **Use ENERGY PRINCIPLES ONLY.** (7)

[17]

Question 6

A pulley system with a mass piece is operated by an electric motor. It is used to lift a load of 125 kg vertically upwards at a constant speed, as shown in the diagram below.



The load covers a distance of 6.8 m in 0.01 seconds.
Neglect all the effects of friction.

6.1 Draw a free body diagram showing all the forces acting on the 125 kg load. (3)

6.2 Determine the average power output required by the electric motor to lift the load through 6,8 m in 0,01 s. (7)

[10]

Question 7

A siren of a stationery ambulance emits sound waves of frequency 280 Hz. A car is moving towards a stationary ambulance at a constant speed that is 30 $m.s^{-1}$.

7.1 Define the *Doppler Effect.* (2)

7.2 Calculate the frequency of sound detected by the driver of the car.
Use the speed of sound in air as 340 $m.s^{-1}$. (5)

7.3 How will the answer in QUESTION 6.2 be affected if the car moves away from the ambulance at the same constant speed?
Write down only GREATER THAN, SMALLER THAN, or EQUAL TO.
Explain the answer. (2)

7.4 Give ONE use of the Doppler flow meter. (1)

7.5 When a line in a hydrogen spectrum is measured in a laboratory, it has a wavelength of $1,32 \times 10^{-15}$ m. The same line in the light of a star has a wavelength of $1,38 \times 10^{-15}$ m.

Is the star moving TOWARDS or AWAY from the earth?
Explain your answer. (2)

[12]

Total 100

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE GRAAD 12
VRAESTEL 1 (FISIKA)

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

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

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

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* $E_k = \frac{1}{2}mv^2$	