KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

COMMON TEST

JUNE 2024



MARKS : 100

TIME: 2 Hours

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INSTRUCTIONS AND INFORMATION

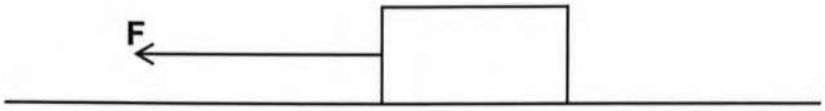
1. Write your NAME in the appropriate spaces on the ANSWER BOOK.
2. This question paper consists of SIX questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subquestions, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. Show ALL formulae and substitutions in ALL calculations.
9. Round off your final numerical answers to a minimum of TWO decimal places.
10. Give brief motivations, discussions et cetera where required.
11. You are advised to use the attached DATA SHEETS.
12. Write neatly and legibly.

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QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) next to the question number (1.1-1.6) in the ANSWER BOOK, for example, 1.7 D.

1.1 A box moves on a smooth horizontal surface when a constant force, **F**, is applied.



Which **ONE** of the following physical quantities will **ALWAYS** remain constant while the box is moving?

A Momentum

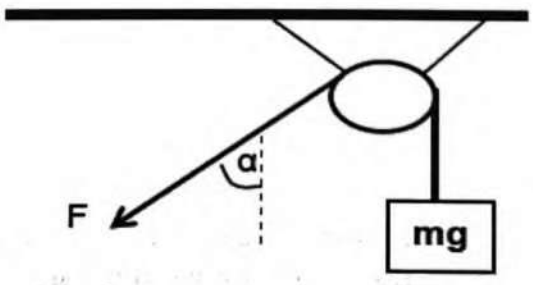
B Acceleration

C Kinetic energy

D Velocity

(2)

1.2 An object of WEIGHT **mg** hangs from a light cord passing over a light, frictionless pulley, as shown in the diagram below. A pulling force of magnitude **F** is applied such that the object is kept at **REST**.



What force is responsible for keeping the object at REST?

A F

B F x sin α

C ½ F

D F x cos α

(2)

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1.3 An object is thrown vertically upwards. At the highest point of the object's motion, which one of the following is CORRECT? Ignore the effects of friction.

A Mechanical Energy is zero.

B Gravitational acceleration is zero.

C Gravitational potential energy is zero.

D Kinetic energy is zero. (2)

1.4 When airbags inflate in a car during a collision, the chances of serious injury to passengers are reduced because the …

A passengers are brought to rest in a shorter time.

B the net force acting on the passengers is reduced.

C passengers' change in momentum is reduced.

D passengers' change in momentum is increased. (2)

1.5 A car has kinetic energy $\mathbf{E}_k$ when it is traveling at a velocity **v**. Which ONE of the following expressions represents the magnitude of the car's momentum?

A $\frac{E_k}{2v}$

B $\frac{E_k v}{2}$

C $\frac{2v}{E_k}$

D $\frac{2E_k}{v}$ (2)

1.6 A truck moving at a constant velocity toward a stationary observer sounds its hooter. The sound waves detected by the observer have a greater…

A wavelength.

B frequency.

C period.

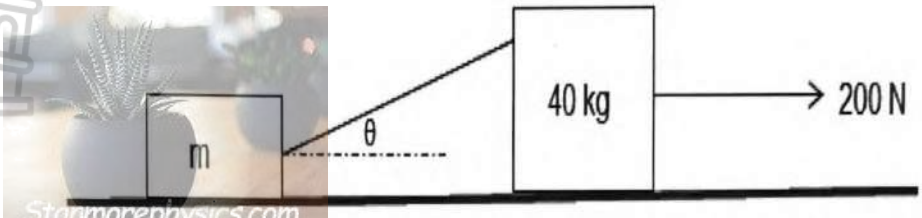
D speed. (2)

[12]

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QUESTION 2

Two blocks of masses m and 40kg resting on a rough horizontal surface are connected by a light, inextensible string as shown in the diagram below.



Stanmorephysics.com

When a force of 200 N is applied to the 40 kg block, both blocks accelerate to the right at 2,5 $m \cdot s^{-2}$. The block of mass m and 40 kg block, experience constant frictional forces of 10 N, and 20 N, respectively.

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

2.2 Draw a labeled free-body diagram indicating all the forces acting on the 40 kg block as it moves across the surface. (5)

2.3 Calculate the magnitude of mass **m**. (6)

The coefficient of kinetic friction, between the block of mass **m** and the surface is 0,1.

2.4 Give a reason why the coefficient of kinetic friction has no SI unit. (2)

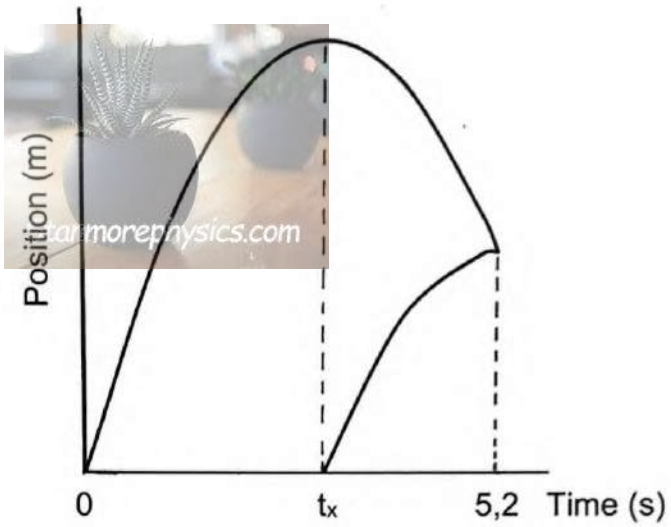
2.5 Calculate the magnitude of the angle (θ), shown in the diagram above. (6)

[21]

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QUESTION 3

Two learners are practising target shooting. One learner throws a tennis ball vertically upwards at 30 $m \cdot s^{-1}$ from the ground. When the tennis ball reaches a maximum height above the ground, the other learner throws a stone toward the tennis ball. The stone hits the tennis ball 5,2 s later. The graphs of position versus time for part of the motion of both the stone and the tennis ball are shown below. Ignore the effect of air friction.



3.1 Define the term free fall. (2)

3.2 Which graph, **S** or **T**, represents the motion of the stone? (1)

3.3 Calculate the time, t_x, shown on the graph. (3)

3.4 Calculate the velocity with which the stone was thrown. (6)

3.5 On the same set of axes, sketch a velocity versus time graph for the motion of both, the stone and the tennis ball, until the stone hits the tennis ball.

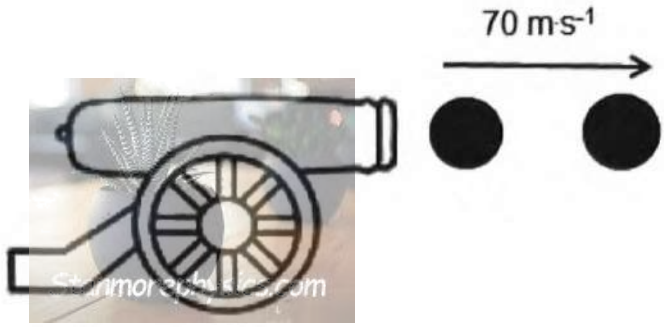
Indicate the following on your graph:
- Initial velocities of both, the stone and the tennis ball.
- The time at which the stone was fired.
- The time taken at which the stone hits the tennis ball. (4)

[16]

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QUESTION 4

4.1 A cannon has a mass of 2150 kg and it fires cannonballs during a routine training exercise.
Each cannonball travels at a speed of 70 $m \cdot s^{-1}$ to the right when it leaves the cannon. (Take the initial velocity of a cannonball, before being fired, as zero.)



The cannon fires 200 cannonballs per minute. The mass of each cannonball is 30 g.

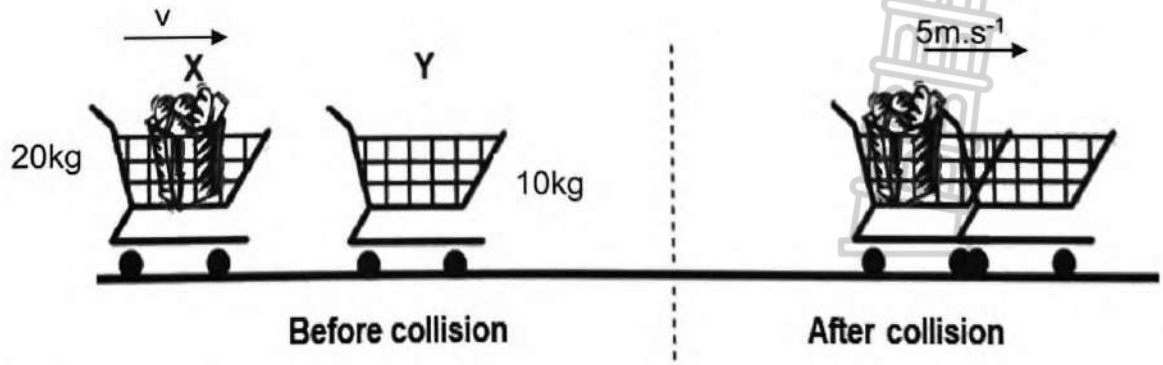
4.1.1 Define, in words, the term *impulse.* (2)

Calculate the magnitude of :

4.1.2 The momentum of each cannon ball when it leaves the gun. (3)

4.1.3 The net average force that each cannonball exerts on the cannon. (5)

4.2 Trolley **X** of mass 20 kg moving at speed v collides with a stationary trolley **Y** of mass 10 kg. The trolleys stick together on impact. After the collision, the combined velocity of the trolleys is 5 $m \cdot s^{-1}$ to the right.



Ignore the effects of friction.

4.2.1 State the principle of *conservation of linear momentum* in words. (2)

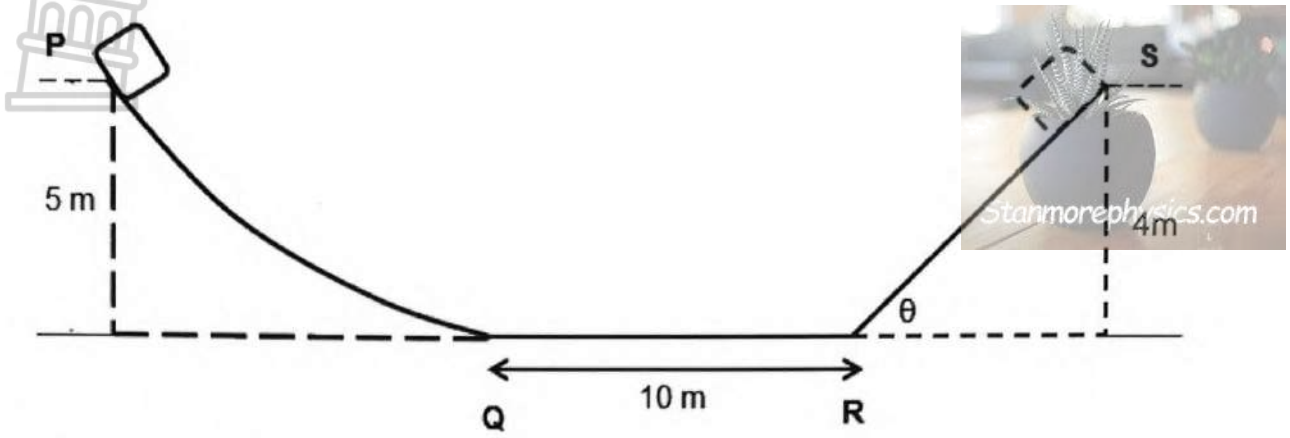
4.2.2 Calculate the speed of trolley X before the collision. (4)

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QUESTION 5

5.1 An object of mass 20 kg is released from rest at point **P** which is 5 m above the ground. It slides down the track and comes to rest at point **S** which is 4m above the ground.



The curved section, **PQ**, is frictionless. The horizontal section, **QR**, is 10 m long and is also frictionless. Section, **RS**, is inclined at an unknown angle (θ) to the horizontal and is rough. The frictional force, a non-conservative force, between the surface and the object is 20 N.

5.1.1 State the *principle of conservation of mechanical energy* in words. (2)

5.1.2 Is mechanical energy conserved as the object slides from **P** to **S**? Write only YES or NO. (1)

The kinetic energy of the object at point **Q** is equal to that at point **R**.

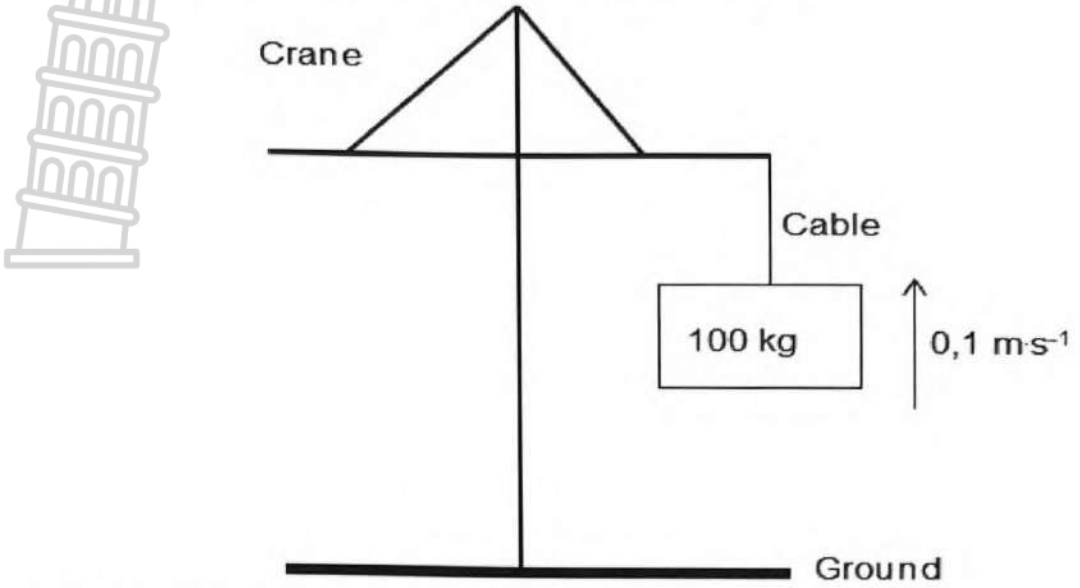
5.1.3 Using ENERGY PRINCIPLES only, determine the speed of an object at point **R**. (5)

5.1.4 Explain the term non-conservative force. (2)

5.1.5 Calculate the magnitude of the angle θ. (6)

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5.2 At a construction site, a 100 kg block is lifted upwards at a constant speed of 0.1 $m \cdot s^{-1}$ by a crane, as shown in the diagram below.



5.2.1 Define power. (2)

5.2.2 Calculate the average power delivered by the crane while lifting the block upwards. (3)

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QUESTION 6

6.1 An ambulance, moving at a constant speed of 140 $m \cdot s^{-1}$ towards a detector, emits sound at a constant frequency. The detector records a frequency of 5 200 Hz. Take the speed of sound in the air to be 340 $m \cdot s^{-1}$.

6.1.1 State the Doppler effect in words. (2)

Calculate the:

6.1.2 frequency of the sound emitted by the source. (4)

6.1.3 wavelength of the sound emitted by the source. (3)

6.2 Spectral lines of star **Y** at an observatory are observed to be *red-shifted*.

6.2.1 Explain the term *red-shifted* in terms of wavelength. (2)

6.2.2 Will the frequency of the light observed from the star INCREASE, DECREASE or REMAIN THE SAME? (1)

6.3 Name TWO applications of the Doppler effect in medicine. (2)

[14]

TOTAL MARKS: [100]

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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 gravitasiekonstante	G	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
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 electron	e^-	$-1,6 \times 10^{-19}\ C$
Electron mass Elektronmassa	m_e	$9,11 \times 10^{-31}\ kg$
Mass of Earth Massa van Aarde	M	$5,98 \times 10^{24}\ kg$
Radius of Earth Radius van Aarde	R_E	$6,38 \times 10^{6}\ m$

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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

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

WORK, ENERGY AND POWER / 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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{av} = F \cdot v_{av}$ / $P_{gem} = F \cdot v_{gem}$	

WAVES, SOUND AND LIGHT / GOLWE, KLANK EN LIG

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/of $E = h\frac{c}{\lambda}$

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