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

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.

　　　　　　　　　　　　　　　　　　　　　　　　　　　Please turn over

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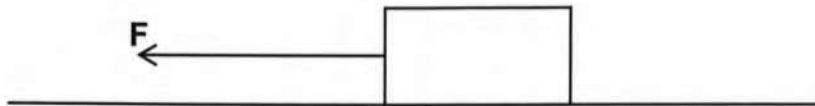
Which **ONE** of the following physical quantities will **ALWAYS** remain constant while the box is moving?

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**.
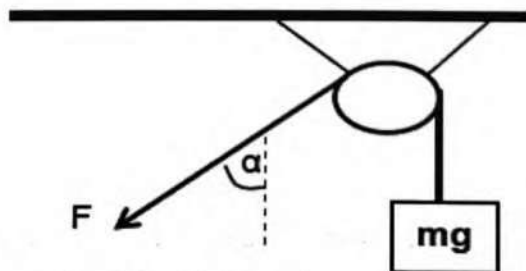
What force is responsible for keeping the object at REST?

A   F

B   F x sin α

C   ½ F

D   F x cos α
                                                                                                    (2)

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 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 $\dfrac{E_k}{2v}$

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

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

D $\dfrac{2E_k}{v}$ (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]

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.

When a force of 200 N is applied to the 40 kg block, both blocks accelerate to the right at 2,5 m·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]

QUESTION 3

Two learners are practising target shooting. One learner throws a tennis ball vertically upwards at 30 m·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.
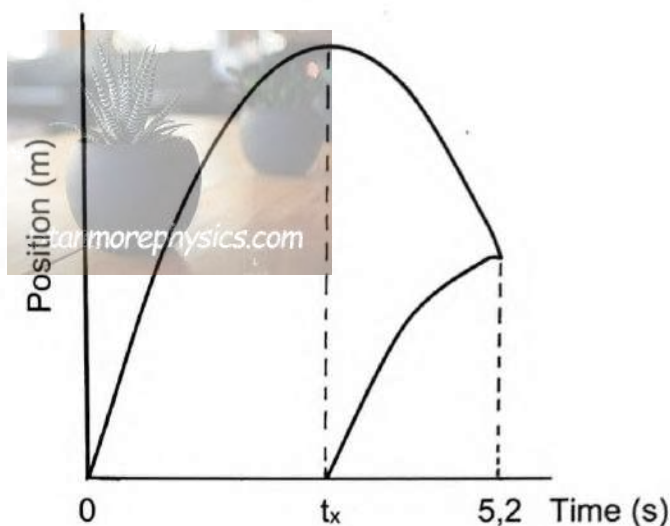
3.1 Define the term free fall. (2)

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]

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·s⁻¹ to the right when it leaves the cannon. (Take the initial velocity of a cannonball, before being fired, as zero.)
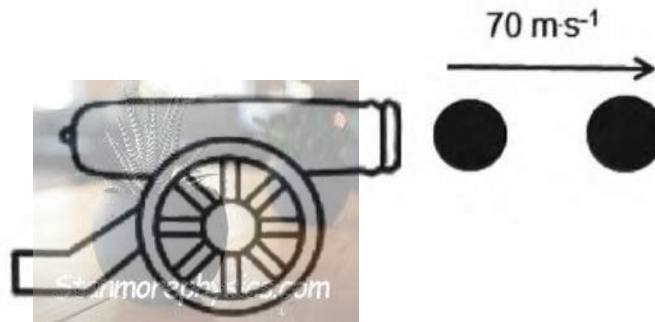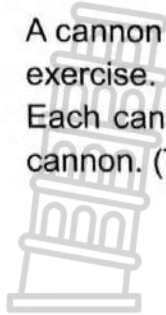
The cannon fires 200 cannonballs per minute. The mass of each cannonball is 30 g.

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·s⁻¹ to the right.

Before collision   **After collision**
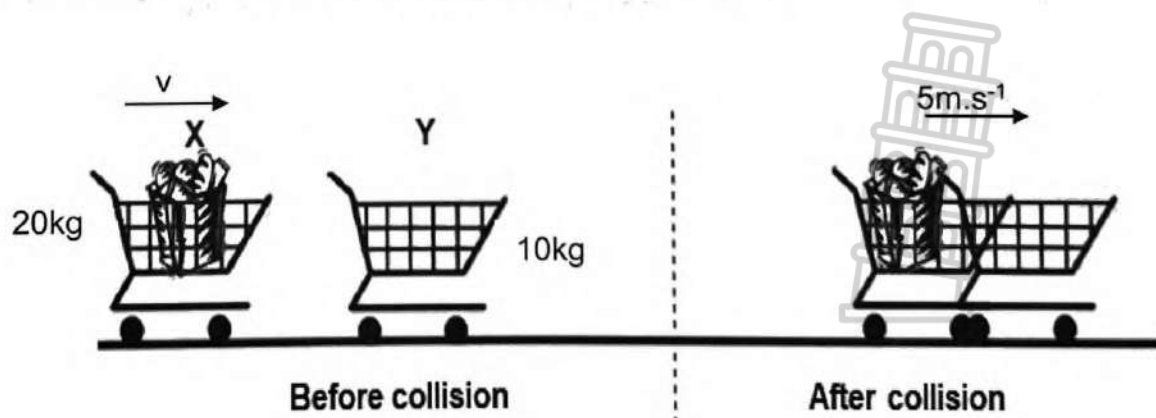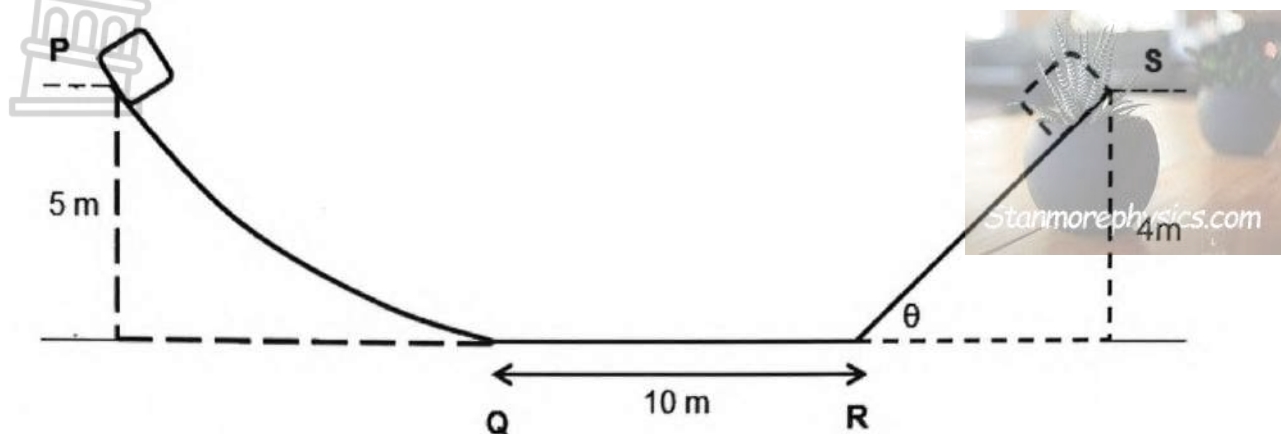
Ignore the effects of friction.

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)

[16]

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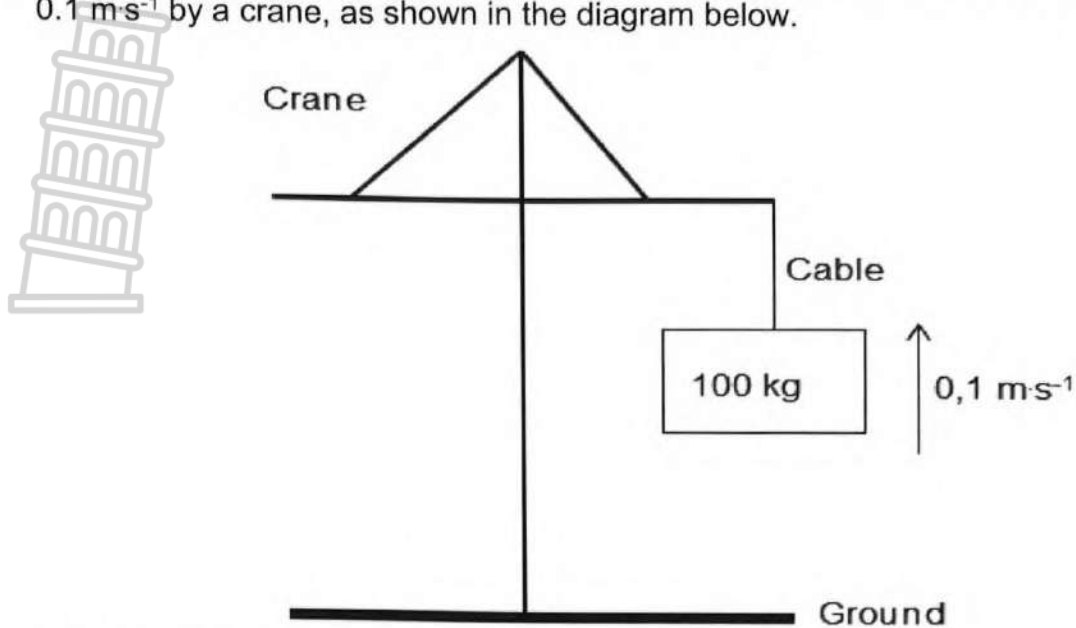
The kinetic energy of the object at point **Q** is equal to that at point **R**.

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)

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)

                                                                                [21]

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]**

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	$9{,}8 \text{ m·s}^{-2}$
Universal gravitational constant Universele gravitasiekonstante	G	$6{,}67 \times 10^{-11} \text{ N·m}^2\text{·kg}^{-2}$
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 electron	e^-	$-1{,}6 \times 10^{-19} \text{ C}$
Electron mass Elektronmassa	m_e	$9{,}11 \times 10^{-31} \text{ kg}$
Mass of Earth Massa van Aarde	M	$5{,}98 \times 10^{24} \text{ kg}$
Radius of Earth Radius van Aarde	R_E	$6{,}38 \times 10^6 \text{ m}$

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

FORCE / KRAG

$F_{net} = ma$	$p = mv$
$f_{s(max)} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$	
$\Delta p = mv_f - mv_i$	$w = mg$
$F = \dfrac{Gm_1 m_2}{r^2}$	$g = \dfrac{GM}{r^2}$

WORK, ENERGY AND POWER / ARBEID, ENERGIE EN DRYWING

$W = F\Delta x \cos\theta$	$U = mgh$ or/of $E_p = mgh$
$K = \dfrac{1}{2}mv^2$ or/of $E_k = \dfrac{1}{2}mv^2$	$W_{net} = \Delta K$ 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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \dfrac{W}{\Delta t}$
$P_{av} = F \cdot v_{av}$ / $P_{gem} = F \cdot v_{gem}$	

WAVES, SOUND AND LIGHT / GOLWE, KLANK EN LIG

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

KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

FINAL

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

MARKING GUIDELINES

JUNE 2024

Stanmorephysics.com

MARKS : 100

This Marking guideline consists of 7 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

1.1	B✔✔	(2)
1.2	A✔✔	(2)
1.3	D✔✔	(2)
1.4	B✔✔	(2)
1.5	D✔✔	(2)
1.6	B✔✔	(2)

[12]

QUESTION 2

2.1   When a net force is applied to an object, it accelerates the object in the direction of the net force. The <u>acceleration is directly proportional to the net force</u>✔ and <u>inversely proportional to the mass</u> of the object.✔

OR

The net (or resultant) force acting on an object is equal to the rate of change of momentum of the object in the direction of the net force. ✔✔ **(2 or 0)**   (2)

2.2
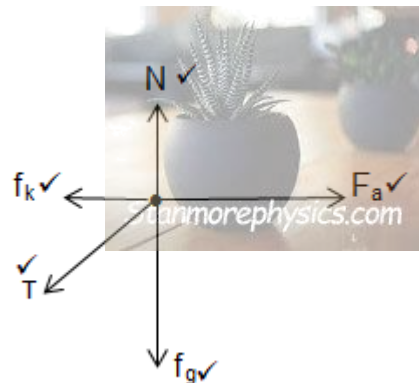
Notes: Accepted Labels		MARK
w	F_g/F_w/weight/40 x 9,8 N/mg/gravitational force	✔
f	F_f/f_k/friction	✔
N	F_N/Normal	✔
T	F_T/Tension force	✔
F	**F$_{Applied}$** / 200 N	✔
	Any additional force: deduct 1 mark maximum	
	Lines must touch the dot, otherwise	
	Do not penalise if angle is shown/not shown	
	No mark for the component of force	(5)

2.3

40 kg:

$F_{net} = ma$ ✔
$F_A + (-f_k) + (-T\cos\theta) = ma$
$\underline{200 + (-20) + (-T\cos\theta)}$ ✔ $= (40)(2,5)$ ✔
$\qquad\qquad\qquad T\cos\theta = 80N$

Block m:
$F_{net} = ma$
$T\cos\theta + (-f_k) = ma$
$\underline{80 - 10}$✔ $= m(2,5)$ ✔
$m = 28kg$✔

(6)

Systems approach = 3/6

2.4	It is a ratio of forces.✓✓	(2)

2.5   **POSITIVE MARKING FROM 2.3**

$f = \mu_k N$ ✓

10✓$= (0,1)[(28)(9,8)$✓$ - T \sin \theta]$ ✓

Tsinθ = 174,4
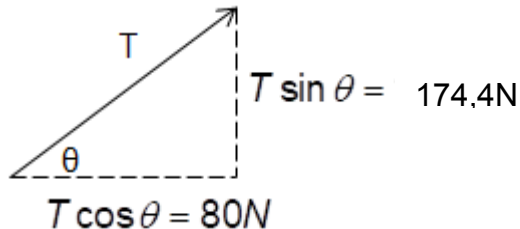
$\tan \theta = \frac{174,4}{80}$✓

$\theta = 65,36^0$✓   (6)

[21]

QUESTION 3

3.1	A motion during which the <u>only force acting on an object is the gravitational force</u>.✓✓ **(2 or 0)**	(2)
3.2	**T**✓ (Do not mark this question, but award the 1 mark to all candidates.)	(1)

3.3   **Marking Criteria**

- Mark for formula to calculate t

- Mark for substitution

- Mark for the answer t = 3.06

DOWNWARD NEGATIVE:

$v_f = v_i + a\Delta t$ ✓
$\underline{0 = 30 + (-9,8)\Delta t}$ ✓
$\Delta t = t_x = 3,06s$✓
DOWNWARD POSITIVE:

$v_f = v_i + a\Delta t$ ✓
$\underline{0 = -30 + (9,8)\Delta t}$ ✓
$\Delta t = t_x = 3,06s$✓   (3)

3.4

DOWNWARD NEGATIVE:

Tennis ball:

$\Delta y = v_i \Delta t + \frac{1}{2}a\Delta t^2$✓

$\underline{\Delta y = (30)(5,2) + \frac{1}{2}(-9,8)(5.2)^2}$✓

$\Delta y = 23,50m$

POSITIVE MARKING FROM 3.3 for the stone calculation

(6)

Stone:

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$$
$$23{,}50\checkmark = v_i(2{,}14) + \frac{1}{2}(-9{,}8)(2{,}14)^2\checkmark$$
$$v_i = 21{,}47 \text{m·s}^{-1}\checkmark \text{ Upwards}\checkmark$$

DOWNWARD POSITIVE:

Tennis ball:

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2\checkmark$$
$$\Delta y = (-30)(5{,}2) + \frac{1}{2}(9{,}8)(5{,}2)^2\checkmark$$
$$\Delta y = -23{,}50 \text{m}$$

Stone:

$$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$$
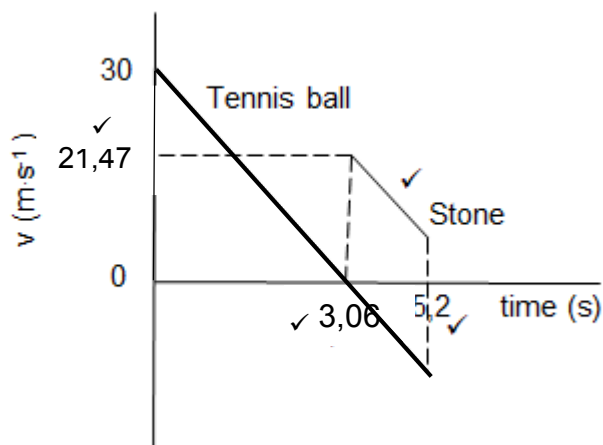$$-23{,}50\checkmark = v_i(2{,}14) + \frac{1}{2}(9{,}8)(2{,}14)\checkmark$$
$$v_i = -21{,}47 \text{m·s}^{-1}$$
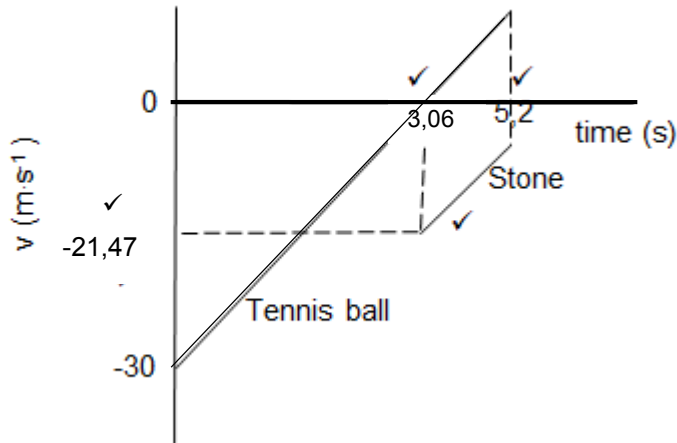$$v_i = 21{,}47 \text{m.s}^{-1}\checkmark \text{ Upwards}\checkmark$$

3.5   **Criteria for marking**
- Initial velocities of both indicated
- Time at which the stone was fired
- Time taken for the stone to hit the ground
- The two graphs must be parallel

POSITIVE MARKING FROM 3.3 & 3.4

DOWNWARD NEGATIVE:

(4)

DOWNWARD POSITIVE:

[16]

QUESTION 4

4.1

4.1.1 Impulse is the <u>product of the resultant / net force acting on an object and the time</u> the net force acts on the object.✓✓ **(2 or 0)**

(2)

4.1.2 $p = mv$ ✓
$p = (0,03)(70)$ ✓
$p = 2,10 \text{ kg·m·s}^{-1}$✓

(3)

4.1.3

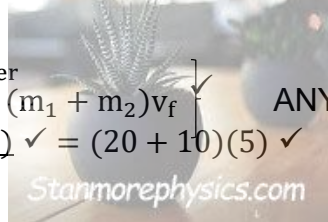| **Option 1**	**Option 2**
200 cannon balls per minute = frequency $= 3.33 \text{ s}^{-1}$✓ $\therefore f = \frac{1}{\Delta t}$ $3.33 = \frac{1}{\Delta t}$✓ $\Delta t = 0,30$ $F_{net} = \frac{\Delta p}{\Delta t}$✓ $F_{net} = \frac{m(v_f - v_i)}{\Delta t}$ $F_{net} = \frac{0.03(70-0)}{0,30}$✓ $F_{net} = 7N$✓	$\Delta t = 60/200$✓✓ $= 0,30 \text{ s}$ $F_{net} = \frac{\Delta p}{\Delta t}$✓ $F_{net} = \frac{m(v_f - v_i)}{\Delta t}$ $F_{net} = \frac{0.03(70-0)}{0,30}$✓ $F_{net} = 7N$✓

(5)

4.2

4.2.1 The total linear momentum of an isolated system remains constant (is conserved).✓✓

(2)

4.2.2 $\sum p_{before} = \sum p_{after}$
$m_1 v_{i_1} + m_2 v_{i_2} = (m_1 + m_2)v_f$ ANY
$\underline{(20)v_{i_1} + (10)(0)}$ ✓ $= (20 + 10)(5)$ ✓
$v_{i_1} = 7,5 \text{m·s}^{-1}$✓

(4)

[16]

QUESTION 5

5.1

5.1.1   The total mechanical energy in an isolated system remains constant.✓✓

        (2 or 0) (2)

5.1.2   NO.✓ (1)

5.1.3   **OPTION 1:**

$\sum \text{Mech}_i = \sum \text{Mech}_f$

$mgh + \frac{1}{2}mv^2 = mgh + \frac{1}{2}mv^2$ ✓ ANY

$\underline{(20)(9,8)(5)}$✓ $+ \frac{1}{2}(20)(0)^2$✓ $= (20)(9,8)(0) + \frac{1}{2}(20)v^2$✓

$v = 9,90 \text{m·s}^{-1}$✓

OPTION 2:

$W_{nc} = \Delta E_k + \Delta E_p$✓

$0 = \Delta E_k + \Delta E_p$

0✓ $= \frac{1}{2}(20)(v_f{}^2 - 0^2)$ ✓ $+ (20)(9,8)(0 - 5)$ ✓

$v = 9,90 \text{m·s}^{-1}$✓ (5)

5.1.4   Non-conservative force is a force for which the work done in moving an object between two points depends on the path taken.✓✓ **(2 or 0)** (2)

5.1.5   **POSITIVE MARKING FROM 5.1.3**

$W_{nc} = \Delta E_k + \Delta E_p$

$W_{f_k} = \frac{1}{2}m(v_f{}^2 - v_i{}^2) + mg(h_f - h_i)$ ✓

$20\Delta x \cos 180^0$✓ $= \frac{1}{2}(20)(0^2 - 9,90^2)$ ✓ $+ (20)(9,8)(4 - 0)$ ✓

$\Delta x = 9,81 \text{m}$

$\sin\theta = \dfrac{\text{opposite}}{\text{hypotenuse}}$

$\sin\theta = \dfrac{4}{9,81}$✓

$\theta = \sin^{-1}(\dfrac{4}{9,81})$

$\theta = 24,06°$✓ (6)

5.2

5.2.1   Power is the rate at which work is done/energy is transferred.✓✓ **(2 or 0)**

        OR

        Power is the rate at which energy is transferred (2)

5.2.2 $P_{av} = Fv_{av}$✓

        $P_{av} = mgv_{av}$

        $P_{av} = (100)(9,8)(0,1)$ ✓

        $P_{av} = 98W$✓ (3)

[21]

QUESTION 6

6.1

6.1.1   Doppler effect is the change in frequency (or pitch) of the sound detected by a listener, because the sound source and the listener have different velocities relative to the medium of sound propagation.✓✓ **(2 or 0)**   (2)

6.1.2 $f_L = \dfrac{v \pm v_L}{v \pm v_s} f_s$ ✓

5200✓ $= \dfrac{340+0}{340-140} f_s$ ✓

$f_s = 3058{,}82 \text{Hz}$✓   (4)

6.1.3   **POSITIVE MARKING FROM 6.1.2**

$v = f \times \lambda$ ✓
$\underline{340 = (3058{,}82)\lambda}$ ✓
$\lambda = 0{,}11m$✓   (3)

6.2.1   The spectral lines from the star are shifted towards longer wavelengths.✓✓
Or
Light emitted from the star is shifted towards the longer wavelength.   (2)

6.2.2   Decrease✓   (1)

6.3   Determine whether arteries are clogged /narrowed.✓
Determine heartbeat of a foetus.✓   (2)

[14]

TOTAL: [100]