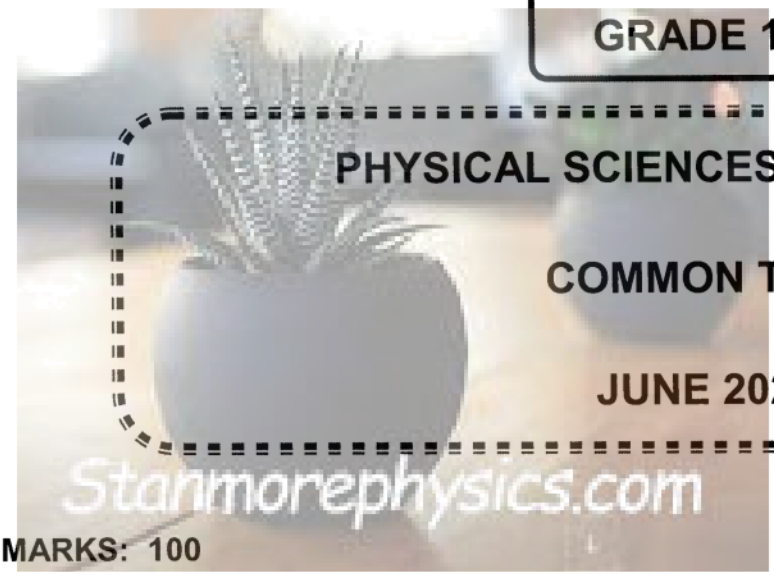
KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12



PHYSICAL SCIENCES P1 (PHYSICS)

COMMON TEST

JUNE 2022

MARKS: 100

TIME: 2 hours

This question paper consists of 8 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number 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 sub questions, 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. You are advised to use the attached DATA SHEETS.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round off your final numerical answers to a minimum of TWO decimal places.

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

12. Write neatly and legibly.

QUESTION 1

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

1.1 According to Newton's third law, the action-reaction pairs of forces do not cancel each other because …

A the two forces are parallel to each other.
B the two forces are in the same direction.
C the two forces act on different bodies.
D the action force is greater than the reaction force. (2)

1.2 A passenger standing on a scale in a lift observes that his apparent weight is greater than his true weight.

Which ONE of the following statements is TRUE for the motion of the lift?

A The lift is either at rest or moving at constant velocity
B The lift is accelerating upwards
C The lift is in free fall
D The lift is accelerating downwards (2)

1.3 Two identical metal spheres, each of mass **m** and separated by a distance **r**, exert a gravitational force of magnitude **F** on each other.

The distance between the spheres is now HALVED. What will be the magnitude of the force the two spheres now exert on each other in terms of **F**?

A ½**F**
B **F**
C 2**F**
D 4**F** (2)

1.4 A ball is thrown vertically upwards with an initial velocity **v** and it reaches the maximum height **y** in a time **t**. If the initial velocity of the ball is now DOUBLED, how long will it take the ball to reach maximum height and what would be the maximum height reached, in terms of **t** and **y** respectively?

A 2**t** and 4**y**
B 4**t** and 2**y**
C 2**t** and 2**y**
D 4**t** and 4**y** (2)

1.5 Impulse is equal to the …

A initial momentum of a body.
B final momentum of a body.
C change in momentum of a body.
D rate of change in momentum of a body. (2)

1.6 Forces F_1 and F_2 act simultaneously on an object and they do work W_1 and W_2 respectively. If the speed of the object does not change as the forces act, which ONE of the following statements is TRUE?

A W_1 is zero and W_2 is positive
B $W_1 = W_2$; W_2 is negative and W_1 is positive
C W_1 is positive and W_2 is zero
D $W_1 = W_2$; W_1 is positive and W_2 is positive (2)

1.7 A trumpet player standing on stage of a hall is playing some musical notes through his trumpet.

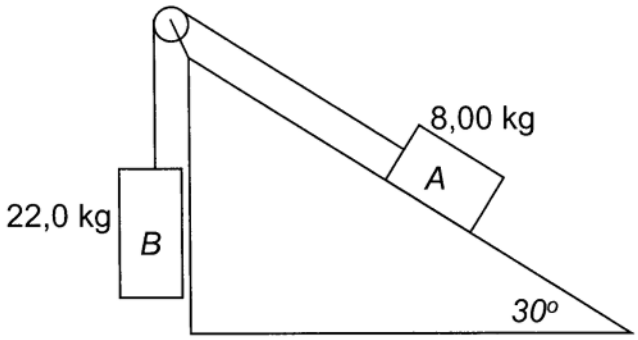
Which one of the following situations may result in a listener in an audience hearing a note at a lower pitch?

A The listener must sit facing away from the stage
B The listener must run away from the stage
C The listener must run towards the stage
D The trumpet player must play seated on stage (2)

[14]

QUESTION 2

Block A of mass 8,00 kg is moving up on a frictionless surface inclined at 30°. This block is connected to block B of mass 22,0 kg by a light inextensible cord that passes over a frictionless pulley as shown in the sketch below.



2.1 Why is it important that the cord must be light as well as inextensible? (2)

2.2 State *Newton's Second Law* in words. (2)

2.3 Draw a labelled free body diagram for block A. (3)

2.4 Calculate the magnitude of the acceleration of the blocks. (5)

2.5 How will the acceleration of the blocks be affected if:

(Choose from: INCREASES, DECREASES or REMAINS THE SAME)

2.5.1 The mass of block A was increased? (1)

2.5.2 The mass of block B was increased? (1)

A rock of mass 5,0 kg is placed on the surface of the Earth.

2.6 State the Universal Law of Gravitation in words. (2)

2.7 Calculate:

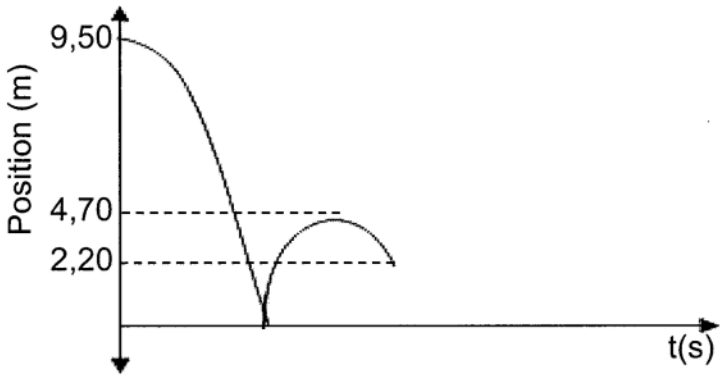
2.7.1 Force exerted by the Earth on the rock. (3)

2.7.2 Gravitational acceleration on the surface of the Earth. (4)

[23]

QUESTION 3

A golf ball is dropped from rest from a height of 9,50 m. It hits the pavement, then bounces back up, rising just 4,70 m before falling down again. The ball is caught on its way down when it is at a height of 2,20 m above the pavement. The position vs time graph for the ball is shown below. Ignore air resistance.



3.1 Define *free fall.* (2)

3.2 Calculate:

3.2.1 The speed with which the ball hits the pavement. (3)

3.2.2 The speed with which the ball leaves the pavement after hitting it. (3)

3.2.3 The total time the ball was in motion. (7)

3.3 If the golf ball is now replaced with a softer ball of similar size and is dropped from the same height, how will this affect the following:

(Choose from: GREATER THAN, LESS THAN, or EQUAL TO)

3.3.1 The height reached after the first bounce. (1)

3.3.2 The time taken for the ball to hit the pavement after being dropped. (1)

3.4 Draw a velocity vs time graph for the entire motion of the golf ball.

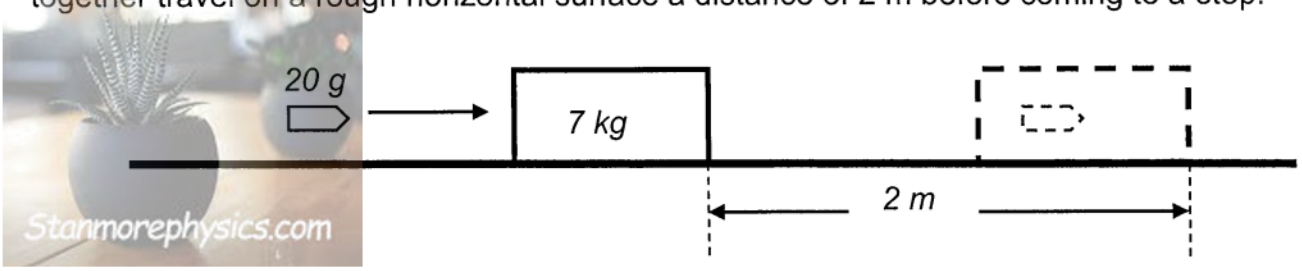
Indicate the following on the graph:

- The speed at which the ball hits the pavement.
- The speed at which the ball leaves the pavement after hitting it. (4)

[21]

QUESTION 4

The diagram below shows a bullet of mass 20 g that is travelling horizontally. The bullet strikes a stationary 7 kg block and becomes embedded in it. The bullet and block together travel on a rough horizontal surface a distance of 2 m before coming to a stop.



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

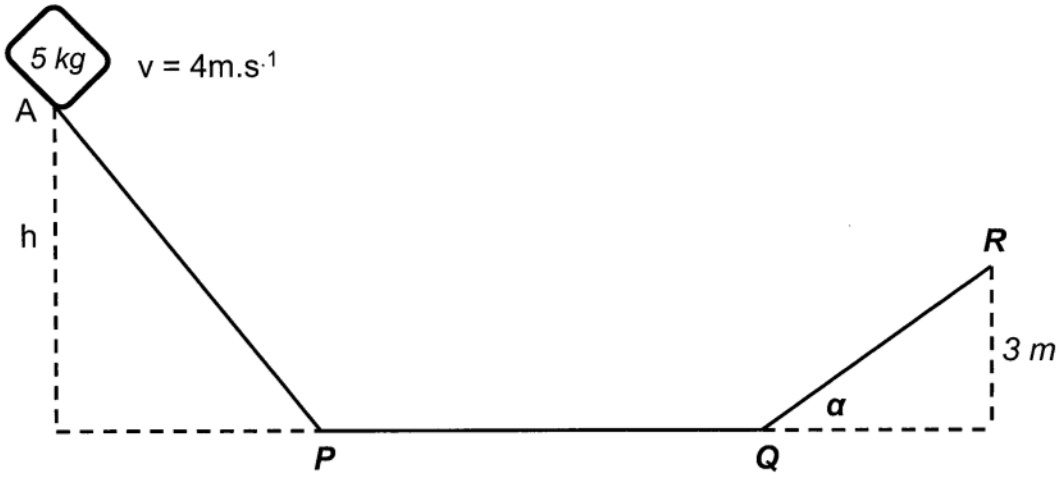
4.2 USING ENERGY PRINCIPLES, calculate the magnitude of the velocity of the bullet-block system immediately after the bullet strikes the block. The frictional force between the block and surface is 10 N as the block moves. (4)

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

4.4 Calculate the magnitude of the velocity with which the bullet hits the block. (4)
[12]

QUESTION 5

A 5 kg block is moving down a frictionless incline. It passes a point A with a speed of 4 $m \cdot s^{-1}$ and reaches point P. Point A is at a height **h** metres above the ground.
It then moves along a frictionless horizontal portion PQ.
The kinetic energy of the block at point P is 285J.



5.1 Using ENERGY PRINCIPLES only, calculate the height **h**. (5)

5.2 Give a reason why the kinetic energy at point P is the same as that at point Q. (1)

The block finally moves in the ROUGH inclined plane QR. It stops momentarily at point R which is 3 m above the horizontal before sliding down to Q. The frictional force, which is a non-conservative force, between the surface and the block is 18 N.

5.3 Define the term *non-conservative force*. (2)

5.4 Draw a free body diagram for the block whilst it is sliding down from R to Q. (3)

5.5 Calculate the angle (**α**) of the slope QR. (5)

[16]

QUESTION 6

A little boy has been given a remote-controlled car for his birthday. It has a red light on top, and a siren that produces a single note with a frequency of 265 Hz. When playing with the car, the boy notices that the frequency of the note produced by the siren seems to change as the speed and direction of the car changes.
Take the speed of sound in air to be 340 $m \cdot s^{-1}$.

6.1 State the *Doppler Effect* in words. (2)

6.2 On one occasion the car is moving away from the boy. As it slows down and stops, he notices that the frequency of the sound changes. Explain the changes in frequency that the boy hears as the car slows down and stops. (2)

6.3 Explain why there is a noticeable change in the frequency of the sound from the siren, but not a noticeable change in the colour of the red light, as the car changes speed and direction. (2)

6.4 Calculate the frequency of the sound heard by the boy as the car is moving towards him at a speed of 15 $m \cdot s^{-1}$. (5)

6.5 Write down three uses of the Doppler effect. (3)

[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 $m \cdot s^{-2}$
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

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

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

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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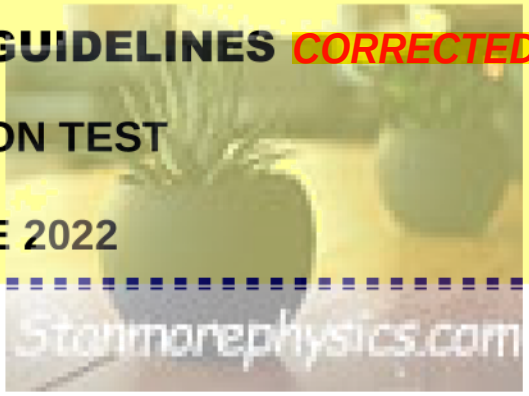
GRADE 12

PHYSICAL SCIENCES P1 (PHYSICS)

MARKING GUIDELINES *CORRECTED*

COMMON TEST

JUNE 2022



MARKS: 100

This marking guideline consists of 10 pages.

QUESTION 1

1.1 C✓✓ (2)

1.2 B✓✓ (2)

1.3 D✓✓ (2)

1.4 A✓✓ (2)

1.5 C✓✓ (2)

1.6 B✓✓ (2)

1.7 B✓✓ (2)

[14]

QUESTION 2

2.1 Light cord – the mass of the cord can be ignored for calculation purposes / will interfere with the quantities to be calculated. ✓
Inextensible cord – the elastic forces of the cord can be ignored / ensures connected bodies move with the same acceleration. ✓ (2)

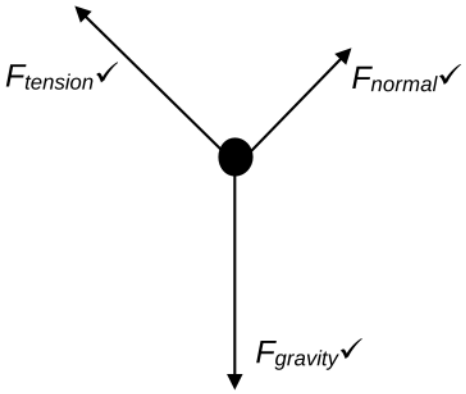
2.2 When a net force acts on an object, the object will accelerate in the direction of the force and the acceleration is directly proportional to the force and inversely proportional to the mass of the object. ✓✓

NOTE: If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.

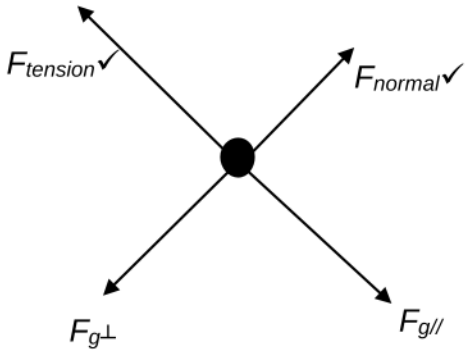
OR

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)

2.3



OR



Both components✓

Notes

- Mark is awarded for label and arrow.
- Do not penalise for length of arrows.
- Deduct 1 mark for any additional force.
- If force(s) do not make contact with body / dot: *Max:2/3*
- If arrows missing but labels are there: *Max:2/3*

Accept the following symbols	
F_{Normal}	N/ Normal
$F_{Tension}$	T/F_T/F_{BA}/ F_{AB}
$F_{Gravityl}$	w/gravity

(3)

2.4 CONSIDERING BLOCK A

Upward Positive

$F_{net} = ma$

$T - F_{g//} = ma$

$\underline{T - 8(9,8)\sin 30^o}$✓ = 8a✓ ------(1)

CONSIDERING BLOCK B

$F_{net} = ma$

$F_g - T = ma$

$\underline{22(9,8) - T}$ ✓= 22a--------(2)

$176,4 = 30a$

$a = 5,88\ m{\cdot}s^{-2}$✓

CONSIDERING BLOCK A

Upward Negative

$F_{net} = ma$✓

$-T + F_{g//} = ma$

$\underline{-T + 8(9,8)\sin 30^o}$✓ = 8a✓ -----(1)

CONSIDERING BLOCK B

$F_{net} = ma$

$-F_g + T = ma$

$\underline{-22(9,8) + T}$ ✓= 22a -----(2)

$-176,4 = 30a$

$a = -5,88\ m{\cdot}s^{-2}$✓ (5)

2.5

2.5.1 decreases✓ (1)

2.5.2 increases✓ (1)

2.6 Every body in the universe attracts every other body with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres. ✓✓

NOTE: If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.

(2)

2.7

2.7.1

OPTION 1	**OPTION 2**
$F = G\frac{m_1 m_2}{r^2}$ ✓ $F = (6{,}67\times10^{-11})(\frac{(5)(5{,}98\times10^{24})}{(6{,}38\times10^{6})^2})$ ✓ F =49, 00 N ✓	F = mg ✓ = 5(9,8) ✓ = 49 N ✓

(3)

2.7.2

OPTION 1	**OPTION 2 (POSITIVE MARKING FROM 2.7.1)**
$g = \frac{GM}{r^2}$ ✓ $g = \frac{(6{,}67\times10^{-11})(5{,}98\times10^{24})}{(6{,}38\times10^{6})^2}$ ✓ ✓ g = 9,80 m·s^{-2}✓	F = mg ✓ 49✓ = 5g ✓ g= 9,8 m·s^{-2} ✓

(4)

[24]

QUESTION 3

3.1 Motion during which the only force acting on an object is the gravitational force. ✓✓ (2)

NOTE: If the word ONLY is missing, max 1/2.

3.2

3.2.1

TAKING DOWNWARD AS POSITIVE	TAKING DOWNWARD AS NEGATIVE
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$v_f^2 = 0 + 2(9,8)(9,50)$ ✓	$v_f^2 = 0 + 2(–9,8)(–9,50)$ ✓
$v_f = 13,65\ m{\cdot}s^{-1}$ ✓	$v_f = -13,65\ m{\cdot}s^{-1}$ ✓

(3)

3.2.2

TAKING DOWNWARD AS POSITIVE	TAKING DOWNWARD AS NEGATIVE
$v_f^2 = v_i^2 + 2a\Delta y$ ✓	$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$0 = v_i^2 + 2(9,8)(–4,70)$ ✓	$0 = v_i^2 + 2(–9,8)(4,70)$ ✓
$v_i = 9,60\ m{\cdot}s^{-1}$ ✓	$v_i = 9,60\ m{\cdot}s^{-1}$ ✓

(3)

3.2.3

OPTION 1 (POSITIVE MARKING FROM QUESTION 3.2.2)

TAKING DOWNWARD AS POSITIVE	TAKING DOWNWARD AS NEGATIVE
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$9,50$ ✓ $= 0 + ½(9,8)\Delta t^2$ ✓	$–9,50$ ✓ $= 0 + ½(-9,8)\Delta t^2$ ✓
$\Delta t = 1,39$ s	$\Delta t = 1,39$ s
Either formula ✓	Either formula ✓
$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$–2,20$ ✓ $= \underline{-9,60\Delta t + ½(9,8)\Delta t^2}$ ✓	$2,20$ ✓ $= \underline{9,60\Delta t + ½(–9,8)\Delta t^2}$ ✓
$\Delta t = 1,69$ s	$\Delta t = 1,69$ s
$\therefore \Delta t = \underline{1,39 +}$ ✓ 1,69	$\therefore \Delta t = \underline{1,39 +}$ ✓ 1,69
$= 3.08$ s ✓	$= 3.08$ s ✓

OPTION 2 (POSITIVE MARKING FROM QUESTION 3.2.2)

TAKING DOWNWARD AS POSITIVE	TAKING DOWNWARD AS NEGATIVE
$v_f = v_i + a\Delta t$ 13,65✓ = 0 + (9,8)Δt✓ Δt = 1,39 s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ Either formula✓ –2,20✓ = -9,60Δt + ½(9,8)Δt²✓ Δt = 1,69 s ∴ Δt = 1,39 + ✓ 1,69 = 3.08 s✓	$v_f = v_i + a\Delta t$ -13,65✓ = 0 + (-9,8)Δt✓ Δt = 1,39 s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ Either formula✓ 2,20✓ = 9,60Δt + ½(–9,8)Δt²✓ Δt = 1,69 s ∴ Δt = 1,39 + ✓ 1,69 = 3.08 s✓

OPTION 3: (POSITIVE MARKING FROM QUESTION 3.2.1)

TAKING DOWNWARD AS POSITIVE	TAKING DOWNWARD AS NEGATIVE
$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ 9,50✓ = $(\frac{0+13,65}{2})\Delta t$✓ Δt = 1,39 s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ Either formula✓ –2,20✓ = -9,60Δt + ½(9,8)Δt²✓ Δt = 1,69 s ∴ Δt = 1,39 + ✓ 1,69 = 3.08 s✓	$\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$ -9,50✓ = $(\frac{0+(-13,65)}{2})\Delta t$✓ Δt = 1,39 s $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ Either formula✓ 2,20✓ = 9,60Δt + ½(–9,8)Δt²✓ Δt = 1,69 s ∴ Δt = 1,39 + ✓ 1,69 = 3.08 s✓

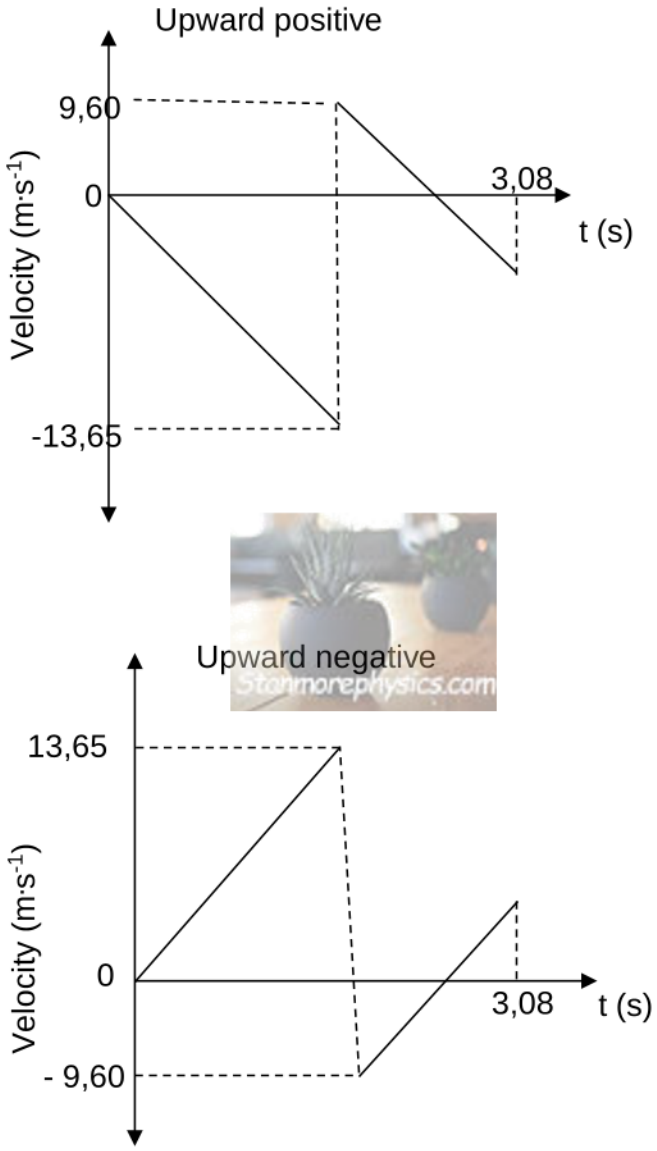
(7)

3.3

3.3.1 Less than. ✓ (1)

3.3.2 Equal to.✓ (1)

3.4 **POSITIVE MARKING FROM Q 3.2.1 & Q 3.2.2**



Criteria for marking the graph	Marks
Correct shape (two parallel straight lines) as shown. Second segment must cut the x-axis	✓
First segment starts at v = 0 m·s^{-1} at t = 0 s.	✓
First segment ends at -13,65 m·s^{-1}/ 13,65 m·s^{-1}	✓
Second segment starts at - 9,60 m·s^{-1}/9,60 m·s^{-1}	✓

(4)

[21]

QUESTION 4

4.1 The work done on an object by a net force is equal to the change in the object's kinetic energy. ✓✓

OR

The net work done on an object is equal to the change in the object's kinetic energy✓✓. (2)

NOTE: If any one of the underlined key words in the **correct context** is omitted deduct 1 mark.

4.2 $W_{net} = \Delta K$

$W_f = \Delta K$

$W_{nc} = \Delta U + \Delta K$ ✓

$f\cos\theta\Delta x = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$(10)(\cos 180^o)(2)$ ✓ $= \frac{1}{2}(7{,}02)(0) - \frac{1}{2}(7{,}02)v_i^2$ ✓

$v_i = 2{,}39\ m\cdot s^{-1}$✓ (4)

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

ACCEPT: In an isolated system total linear momentum before collision is equal to the total linear momentum after the collision✓✓

NOTE: If any one of the underlined key words in the **correct context** is omitted deduct 1 mark. (2)

4.4 **POSITIVE MARKING FROM Q4.2**

$\Sigma p_i = \Sigma p_f$

$m_1v_{i1} + m_2v_{i2} = (m_1 + m_2)v$ ✓

$0{,}02v_{i1} + 7(0)$ ✓ $= (7{,}02)(2{,}39)$ ✓

$v_{i1} = 838{,}89\ m\cdot s^{-1}$✓ (4)

[12]

QUESTION 5

5.1 $E_{M(A)} = E_{M(P)}$

$(K + U)_A = (K+U)_P$

$W_{nc} = \Delta U + \Delta K$ ✓

$(½ mv^2 + mgh)_A = (½mv^2 + mgh)_P$

$\underline{½(5)(4)^2}$ ✓ $\underline{+ (5)(9,8)h}$ ✓ = $\underline{285 + 0}$ ✓

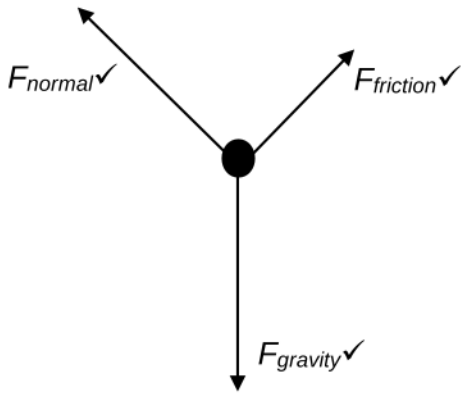
h = 5 m ✓ (5)

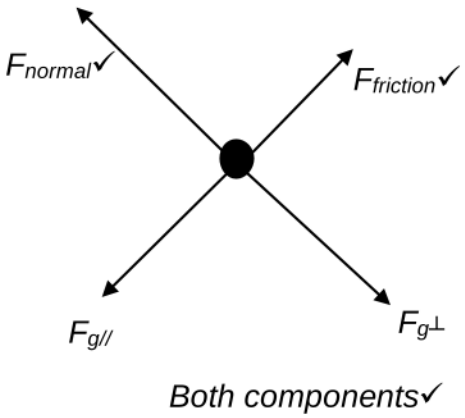
5.2 The path PQ is frictionless (smooth) and horizontal, ✓ (no energy is lost to friction or gained or lost as potential energy) (1)

5.3 Force for which the work done in moving an object between two points depends on the path taken. ✓✓

NOTE: If any one of the underlined key words in the **correct context** is omitted deduct 1 mark. (2)

5.4





Both components✓

Notes

- Mark is awarded for label and arrow.
- Do not penalise for length of arrows.
- Deduct 1 mark for any additional force.
- If force(s) do not make contact with body / dot: *Max:2/3*
- If arrows missing but labels are there: *Max:2/3*

Accept the following symbols	
F_{normal}	N; Normal
$F_{friction}$	f_s/f/friction/F_r
$F_{gravity}$	W/F_g/mg/98N

(3)

5.5 $W_{net} = \Delta K$
$W_g + W_f = \Delta K$ ✓

mg sinα Δx cos180 + 18 Δx cos180 = 0 – 285

$-\frac{(5)(9,8)(3)}{\Delta x}\Delta x + 18\ \Delta x \cos 180$ ✓ = -285 ✓

Δx = 7,67

$\sin \alpha = \frac{3}{7,67}$ ✓

α = 23,03° ✓

OR

$W_{nc} = \Delta E_p + \Delta E_k$ ✓

$f\Delta x \cos 180^o = mgh_2 - mgh_1 + Ek_f - Ek_i$

18Δx(–1) ✓ = (5 x 9,8 x 3) – 0 + 0 – 285✓

Δx = 7,67

$\sin \alpha = \frac{3}{7,67}$ ✓

α = 23,03° ✓

(5)

[16]

QUESTION 6

6.1 Doppler effect is the (apparent) 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 Doppler effect is the (apparent) change in frequency (or pitch) of the sound detected by a listener, because there is relative motion between the sound source and the listener✓✓ (2)

6.2 As the car is moving away from the observer, the observed frequency will be lower than the source frequency. ✓ As the car slows down the observed frequency increases until it is equal to the original source frequency. ✓ (2)

6.3 The speed of sound is very much lower than the speed of light. ✓ Doppler is only noticeable if the speed of source of sound is relatively close to the speed of the wave✓, hence the effect is noticeable with sound but not light. (2)

6.4 $f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ ✓

$f_L = (\frac{340 \pm 0}{340 - 15})(265)$ ✓✓

f_L = 277,23 Hz ✓ (5)

6.5 ANY THREE:

Medicine

- Measures blood flow rate.✓
- Observation of foetus heart rate.✓

Maritime

- SONAR positioning underwater.✓

Law enforcement

- Radar monitoring of speeding cars. ✓

Astronomy

- To observe the motion of celestial bodies / stars / galaxies (3)

[13]