education

Department:
Education
PROVINCE OF KWAZULU-NATAL

NATIONAL
SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

COMMON TEST

JUNE 2019

Marks: 100

TIME: 3 hours

This question paper consists of 11 pages and 2 data sheets.

INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name and other information in the appropriate spaces on the ANSWER BOOK.
2. The question paper consists of TEN 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 pocket 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 where applicable.
11. Give brief motivations, discussions, et cetera where required.
12. Write neatly and legibly.

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 In Newton's third Law, the "reaction" force DOES NOT cancel the "action" force because …

A the action force is greater than the reaction force.

B the action force is equal to the reaction force.

C the action force and reaction force act on different bodies.

D the reaction force exists only after the action force is removed. (2)

1.2 Which ONE of the following statements is INCORRECT regarding "g", the acceleration due gravity on the Earth?

A Its value is independent of the mass of the object.

B It is also called the gravitational field strength.

C It is the same everywhere on the surface of the Earth.

D It depends on the distance an object is from the surface of the Earth. (2)

1.3 An object of mass $\boldsymbol{m}$ moves to the right with a speed $\boldsymbol{v}$. It collides head-on with an object of mass $\mathbf{3}\boldsymbol{m}$ moving with speed $\boldsymbol{v}/\mathbf{3}$ in the opposite direction. If the two objects stick together, what is the speed of the combined object, of mass $\mathbf{4}\boldsymbol{m}$, after the collision?

A 0

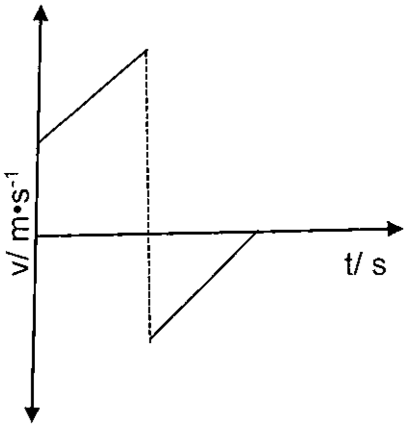
B $\frac{1}{2}\mathbf{v}$

C $\boldsymbol{v}$

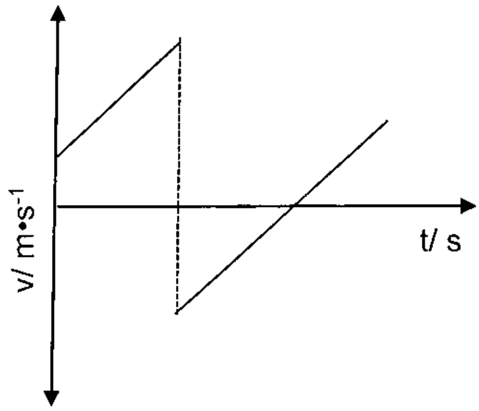
D $2\boldsymbol{v}$ (2)

1.4 A ball is thrown VERTICALLY DOWNWARDS from height **h** with a velocity **v**. The ball strikes the ground and bounces upwards. It is caught when it reaches its maximum height after the bounce.
Which ONE of the following velocity versus time graphs best represents the motion of the ball?

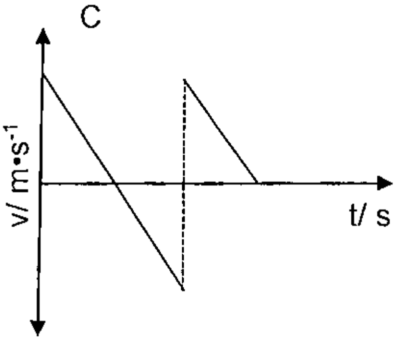
A



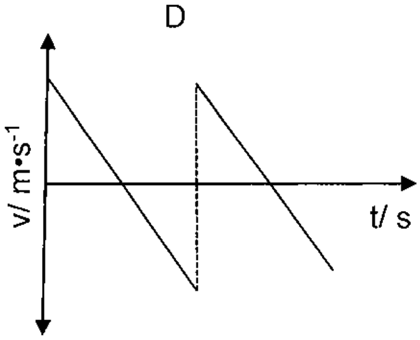
B



C

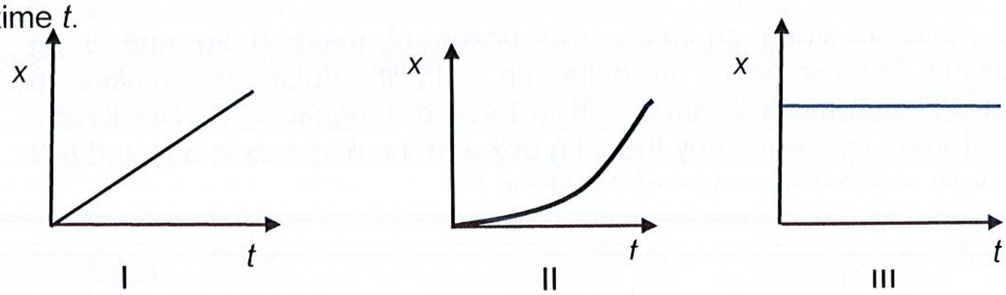


D



(2)

1.5 Three objects can only move along a straight, level path. The graphs below show the position x of each of the objects plotted as a function of time t.



For which of the three objects is the net work done on the object equal zero?

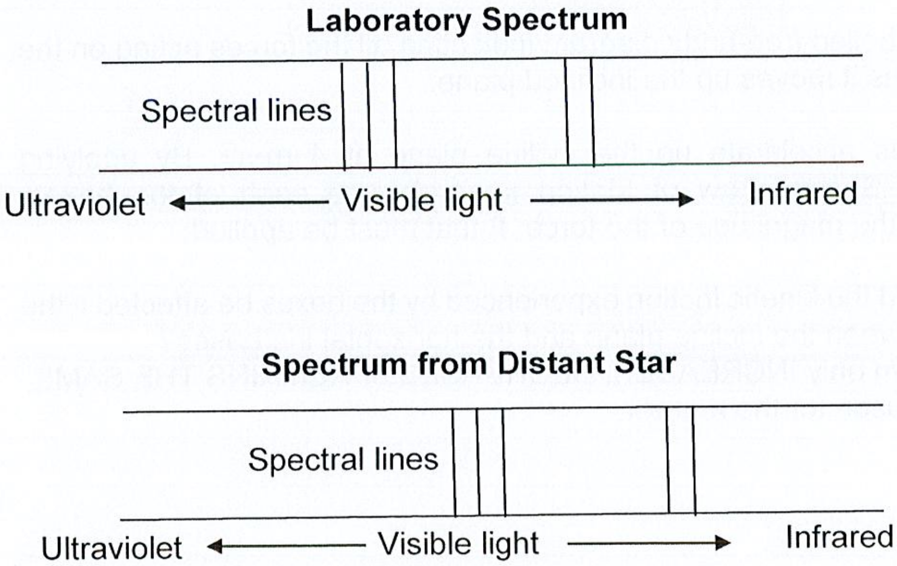
A I and II

B II only

C III only

D I and III (2)

1.6 The diagrams below show a laboratory spectrum of light and a spectrum of light produced from a distant star.



When comparing these two spectra, it can be concluded that:

A The star's spectral lines have shifted toward the UV end of the spectrum and the star is moving towards Earth.

B The star's spectral lines have shifted toward the UV end of the spectrum and the star is moving away from Earth.

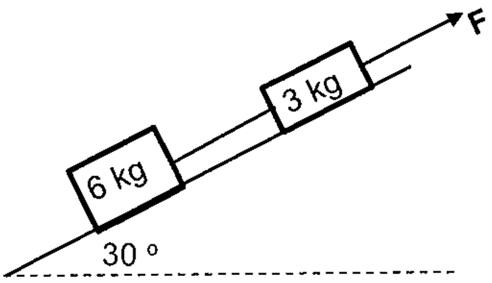
C The star's spectral lines have shifted toward the infrared end of the spectrum and the star is moving towards Earth.

D The star's spectral lines have shifted toward the infrared end of the spectrum and the star is moving away from the Earth. (2)

[12]

QUESTION 2 (Start on a new page)

A light inelastic string connects two boxes of mass 6 kg and 3 kg respectively. The two boxes are pulled up an inclined plane that makes an angle of 30° with the horizontal, with a force of magnitude **F**. The kinetic frictional force experienced by the 3 kg box and the 6 kg box is 5 N and 8 N respectively. (Ignore the mass of the string.)



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

2.2 Draw a labelled free-body diagram indicating all the forces acting on the 6 kg box as it moves up the inclined plane. (4)

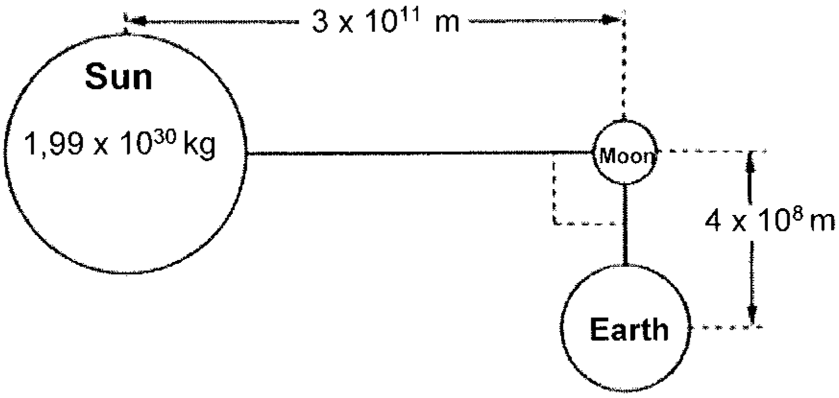
2.3 The boxes accelerate up the incline plane at 4 $m \cdot s^{-2}$. By applying Newton's Second Law of Motion <u>separately to each of the boxes</u>, calculate the magnitude of the force, **F** that must be applied. (6)

2.4 How would the kinetic friction experienced by the boxes be affected if the angle between the incline plane and the horizontal increases?
Write down only INCREASES, DECREASES or REMAINS THE SAME.
Give a reason for the answer. (3)

[15]

QUESTION 3 (Start on a new page)

Consider the following sketch of the **Sun**, the **Earth** and the **Moon**. The mass of the Moon is $7{,}35 \times 10^{22}$ kg.



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

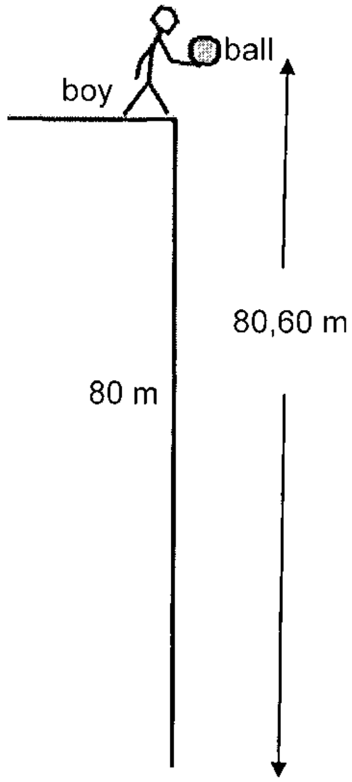
3.2 Calculate the magnitude of the gravitational force that the **Earth** exerts on the **Sun** at the position indicated in the diagram. (6)

3.3 Calculate the acceleration due to gravity on the surface of the **Moon** if the radius of the **Moon** is $1{,}6 \times 10^{6}$ m. (3)

[11]

QUESTION 4 (Start on a new page)

A boy standing on top of a 80 m high building, throws a ball vertically upwards. The ball is thrown from the boy's midriff (half – way his height) position. It takes the ball 6 s to land on the ground bellow. (Ignore air resistance)



4.1 What is the velocity of the ball at the maximum height of its motion? (1)

4.2 Calculate the magnitude of the initial velocity of the ball. (4)

4.3 Calculate the magnitude of the final velocity with which the ball strikes the ground. (4)

4.4 Draw a position versus time graph for the entire motion of the ball. Indicate the following in your graph:
- Height from where it was initially dropped.
- Time for the entire motion. (4)

4.5 If the ball was thrown from a building of lower height , how would this affect each of the following :
(Choose from: INCREASES, DECREASES, REMAINS THE SAME)

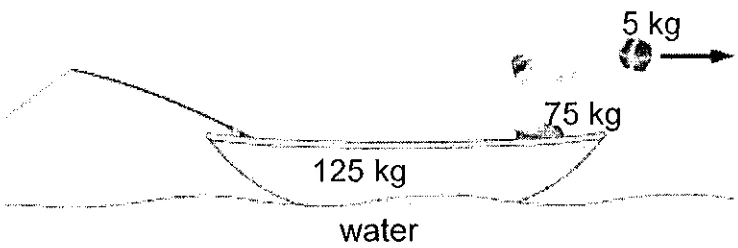
4.5.1 The MAXIMUM HEIGHT ABOVE THE BUILDING reached by the ball? Write down a reason for the answer. (3)

4.6.2 Velocity of the ball on hitting the ground? (1)

[17]

QUESTION 5 (Start on a new page)

A 75 kg fisherman in a 125 kg boat throws a package of mass 5 kg horizontally toward the right with a speed of 4 m•s^{-1}. The boat is at rest before the package is thrown.



5.1 State the principle of conservation of momentum, in words. (2)

5.2 Calculate the velocity of the boat IMMEDIATELY after the package is thrown. (5)

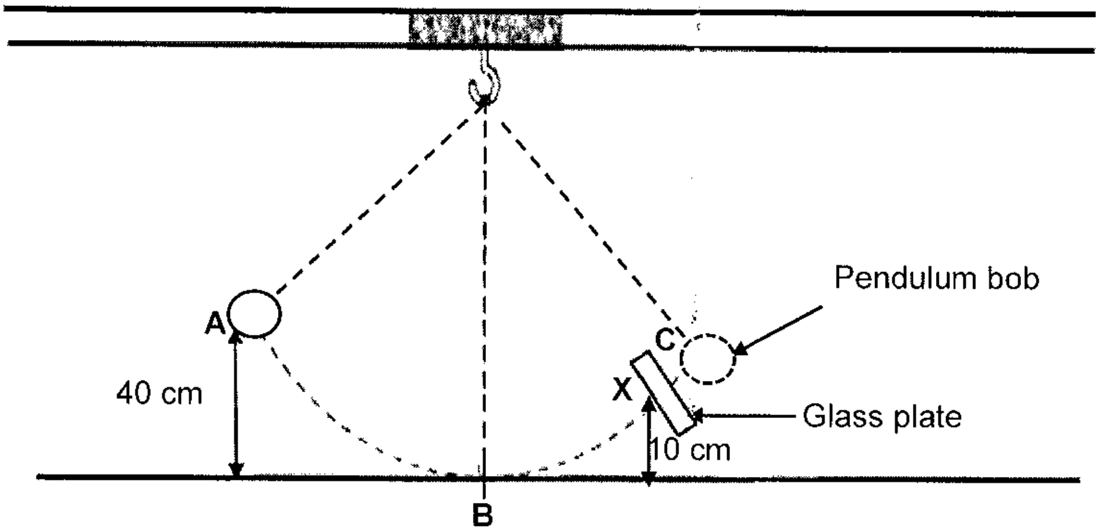
5.3 Prove, by means of a calculation, that the whole scenario represents an inelastic collision. (4)

5.4 Calculate impulse of the boat – fisherman system. (4)

[15]

QUESTION 6 (Start on a new page)

A pendulum bob of mass 300 g, is suspended by an inextensible piece of string that is 2,00 m long. The bob is pulled sideways to a vertical height of 40.0 cm (position A) and then released.
(Ignore the mass of the string and the effects of air resistance)



6.1 State the Principle of Conservation of Mechanical Energy in words (2)

6.2 Calculate the mechanical energy of the pendulum when the bob is at its highest point? (4)

6.3 How will the speed of the pendulum bob at position B be affected if the mass of the bob was now increased? (Choose from: INCREASES, DECREASES, REMAINS THE SAME)
Write down a reason for the answer. (3)

On its way up from position B towards position C, the pendulum bob (mass 300 g) smashes into a glass plate that is placed at position X. The bob then reaches a maximum height of 25 cm (position C). Point X is 10 cm above the ground,

6.4 Using energy principles, calculate the magnitude of the velocity of the pendulum bob immediately after it smashes the glass plate.
(Ignore the width of the glass plate) (6)

6.5 Explain why the bob reaches a height lower than that at position A, after smashing the glass plate. (1)

[16]

QUESTION 7 (Start on a new page)

A girl stands beside a train platform and observes a train moving slowly past her. She notes two frequencies of the train's whistle that are 465 Hz and 441 Hz. Take the speed of sound to be 343 m•s^{-1}.

7.1 State the Doppler Effect in words. (2)

7.2 Calculate the speed of the train. (6)

7.3 Calculate the ORIGINAL FREQUENCY of the whistle. (3)

7.4 If the SPEED of the train (calculated in question 7.2 above) INCREASES, how would this affect the frequency of the whistle heard as the train approaches the girl?
(Choose from: HIGHER THAN, LOWER THAN, REMAIN THE SAME) (1)

7.5 Write down two applications of the Doppler Effect in real life. (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	$9,8\ m\cdot s^{-2}$
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

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

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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GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

MARKING GUIDELINE

COMMON TEST

JUNE 2019

MARKS: 100

This marking guideline consists of 10 pages.

SECTION A

QUESTION 1: Multiple Choice Questions

1.1 C ✓✓ (2)

1.2 C ✓✓ (2)

1.3 A ✓✓ (2)

1.4 A ✓✓ (2)

1.5 D ✓✓ (2)

1.6 D ✓✓ (2)

[12]

SECTION B

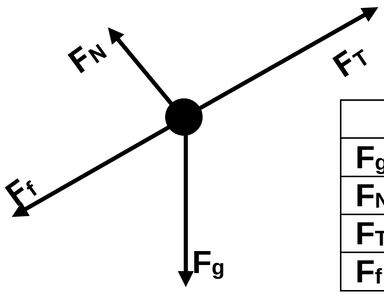
QUESTION 2 (Start on a new page)

2.1 If the resultant/net force acts on an object, the object will accelerate in the direction of the resultant/net force with an acceleration that is directly proportional to the resultant/net force ✓ and inversely proportional to the mass of the object. ✓

OR

The net force is equal to the rate of change of momentum. ✓✓ (2)

2.2



Accepted Labels	
F_g	F_W, W, 58,8 N, Weight, mg, gravitation force
F_N	N, Normal force, 50,92 N
F_T	Tension, T
F_f	f, friction force, f_k

Notes

- Accept components for gravitational force
- Mark awarded for label and arrow
- Do not penalise for length of arrows since drawing is not to scale
- Any other additional forces (*Max* ¾
- If force(s) do not make contact with body Max*:* ¾

(4)

2.3

Consider the motion along the plane

<u>For the 6 kg block</u>
F_{net} = ma✓
T – F_f – $F_{g//}$ = ma
<u>T – 8 – 6 x 9,8 Sin 30°</u>✓ = 6 x 4✓
T = 61,40 N

<u>For the 3 kg block</u>
F_{net} = ma
F – T – F_f - $F_{g//}$ = ma
<u>F – 61,4 – 5 – (3)(9,8) Sin 30°</u>✓ = 3 x 4✓
F = 93,10 N✓

NB: If a systems approach is used: Max 4/6 (6)

2.4 DECREASES. ✓ Normal force decreases✓✓ (3)

[15]

QUESTION 3 (Start on a new page)

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

If they mention charges: 0/2 (2)

3.2 **<u>Distance between the Earth and the Sun</u>**

$x = \sqrt{(3\times10^{11})^2 + (4\times10^{8})^2}$ ✓

x = 3 x 10^{11} m✓

<u>Force of Sun on Earth</u>

$F = G\frac{m_1 m_2}{r^2}$ ✓

$F = 6{,}67 \times 10^{-11} \frac{1{,}99 \times 10^{30} \times 5{,}98 \times 10^{24}}{(3{,}00 \times 10^{11})^2 ✓}$ ✓

F = 8,82 x 10^{21} N✓ (6)

3.3 $g = G\frac{M}{r^2}$ ✓

$g = 6{,}67 \times 10^{-11} \frac{7{,}35 \times 10^{22}}{(1{,}60 \times 10^{6})^2}$✓

g = 1,92 m•s^{-2}✓ (3)

[11]

QUESTION 4 (Start on a new page)

4.1 0 ($m \cdot s^{-1}$)✓ (1)

4.2

Choose up to be positive	**Choose down to be positive**
$\Delta y = v_i \Delta t + \frac{1}{2}(-9{,}8)\Delta t^2$✓	$\Delta y = v_i \Delta t + \frac{1}{2}(-9{,}8)\Delta t^2$✓
$-80{,}60$✓ $= v_i(6) + \frac{1}{2}(-9{,}8)(6)^2$✓	$80{,}60$✓ $= v_i(6) + \frac{1}{2}(9{,}8)(6)^2$✓
$v_i = 15{,}97\ m \cdot s^{-1}$	$v_i = 15{,}97\ m \cdot s^{-1}$
The initial velocity is $15{,}97\ m \cdot s^{-1}$✓	The initial velocity is $15{,}97\ m \cdot s^{-1}$✓

OR

Choose up to be positive

✓ $v_f = v_i + a\Delta t$

$v_f = v_i + (-9{,}8)(6)$

$v_f = v_i - 58{,}80$✓ ---------- 1

$v_f^2 = v_i^2 + 2a\Delta y$

$v_f^2 = v_i^2 + 2(-9{,}8)(-80{,}60)$

$v_f^2 = v_i^2 + 1579{,}76$ ✓---------- 2

Substitute 1 into 2

$(v_i - 58{,}80)^2 = v_i^2 + 1579{,}76$

$v_i = 15{,}97\ m \cdot s^{-1}$

The initial velocity is $15{,}97\ m \cdot s^{-1}$✓

(4)

If the answer is negative, the candidate must say therefore initial velocity is $15{,}97\ m \cdot s^{-1}$✓

4.3 **POSITIVE MARKING FROM 4.2**
Choosing up to be positive

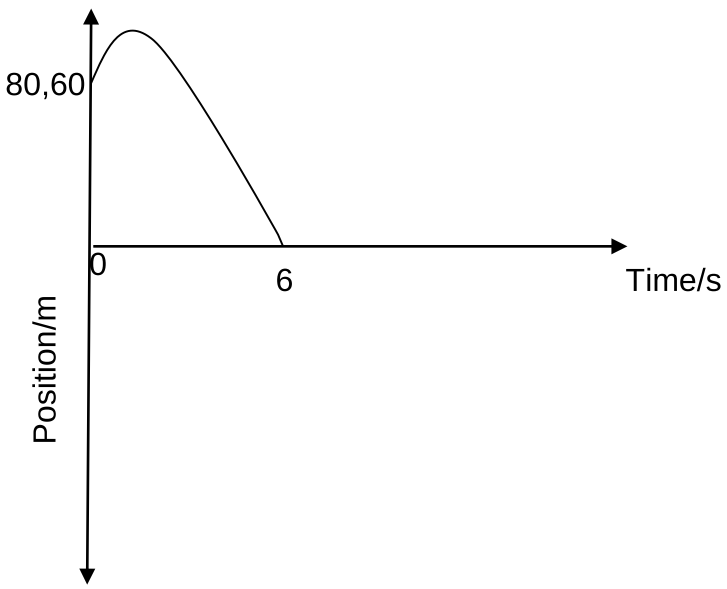
$v_f = v_i + a\Delta t$ ✓
$v_f = 15,97$ ✓ $+ (-9,8)(6)$ ✓
$v_f = - 42,83\ m{\bullet}s^{-1}$

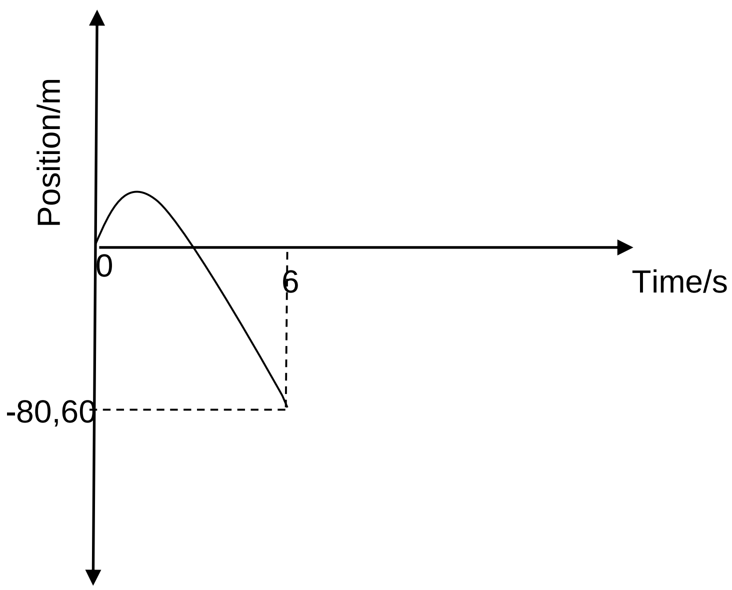
The final velocity of the ball is $42,83\ m{\bullet}s^{-1}$ ✓

OR

$v_f^2 = v_i^2 + 2a\Delta y$ ✓
$= (15,97)^2$ ✓ $+ 2(–9,8)(–80,60)$ ✓
$\therefore\ v_f = 42,83\ m{\bullet}s^{-1}$ ✓ (4)

4.4





Accept the other options where downwards is taken as positive

Criteria	Marks
Correct height of 80,60 m	✓
Correct shape	✓
End time of 6 s	✓
Correct labels on the axes	✓

(4)

4.5

4.5.1 Remain the same✓

Negative marking

The maximum height reached above the point of projection depends on the initial velocity only. ✓✓

Accept all the options with a correct reason. (3)

4.5.2 Decreases✓ **Mark in relation to the answer in question 4.5.1** (1)

[17]

QUESTION 5 (Start on a new page)

5.1 The total linear momentum of a closed (isolated) system remains constant (is conserved). ✓✓

OR

In an isolated system, the total linear momentum before collision is equal to the total linear momentum after collision ✓✓ (2)

5.2

$\Sigma p_i = \Sigma p_f$

$\left.m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}\right\}$ ✓

$\underline{(125 + 75)(0) + (5)(0)}$ ✓ $= (125 + 75)\,v_{1f} + (5)(4)$ ✓

$v_{1f} = -0{,}10\ \text{m}\cdot\text{s}^{-1}$

$\therefore$ the velocity of the boat is $0{,}10\ \text{m}\cdot\text{s}^{-1}$ ✓ to the left. ✓

(5)

5.3

Total E_k before $= \frac{1}{2}(125 + 75)(0)^2 + \frac{1}{2}(5)(0)^2 = 0$ J ✓

Total E_k after $= \underline{\frac{1}{2}(125 + 75)(0{,}1)^2 + \frac{1}{2}(5)(4)^2}$ ✓

$= 41{,}00$ J ✓

Total E_k before $\neq$ Total E_k after ✓

$\therefore$ the scenario represents an inelastic collision

Note:

- If momentum formula is used then 0/4
- If $E_{kf} = E_{ki}$ is used then 3/4 max

(4)

5.4 **POSITIVE MARKING FROM 5.2**

$F_{net}\Delta t = \Delta p = mv_f - mv_i$ ✓

$= (125 + 75)(0{,}1)$ ✓ $- (125 + 75)(0)$ ✓

$= 20$ N.s ✓

(4)

[15]

QUESTION 6 (Start on a new page)

6.1 The total mechanical energy/sum of kinetic and gravitational potential energy in a closed/isolated system is constant (conserved).✓✓ (2)

6.2

$E_{m\ top} = (E_k + E_p)_{top}$✓
$= ½mv^2 + mgh$
$= ½\,(0{,}3)\,(0)^2$✓$+ (0{,}3)\,(9{,}8)\,(0{,}4)$ ✓
$= 1{,}18$ J✓

(4)

6.3 Remain the same✓.

Negative marking

The speed of the pendulum bob at the bottom of its swing only depends on the height from where it is initially released. ✓✓

Or

The speed is independent of the mass. (3)

6.4

E_T at C $= mgh + ½\,mv^2$ ✓

$= 0{,}3 \times 9.8 \times .25 + 0$ ✓

$= 0{,}735$ J

Total energy after breaking glass = 0,735 J

At X : $E_T = mgh + ½\,mv^2$

$0{,}735$ ✓ $= \underline{(0{,}3 \times 9.8 \times 0.1)}$ ✓ $+ ½\,(0{,}3 \times v^2)$ ✓

$v = 1{,}71\ m.s^{-1}$✓

(6)

6.5 Mechanical Energy is converted to other forms during the collision of the bob and glass plate.✓ **(1)**

[16]

QUESTION 7 (Start on a new page)

7.1 An (apparent) change in the observed frequency (pitch), (wavelength)✓ as a result of the relative motion between a source and an observer ✓ (listener) (2)

7.2

$$f_L = f_S\left(\frac{v \pm v_L}{v \pm v_S}\right) ✓$$

✓ $465 = f_S\left(\frac{343}{343 - v_S}\right)$ ✓----------------------------1

✓ $441 = f_S\left(\frac{343}{343 + v_S}\right)$✓ ----------------------------2

Equation 1 ÷ Equation 2

$$\frac{465}{441} = \frac{(343 + v_S)}{(343 - v_S)}$$

159495 - 465 v_S = 151263 + 441v_S

v_S = 9,09 m•s^{-1}✓ (9,02 m.s^{-1})

(6)

7.3 **Positive marking from 7.2**

$$465 = f_S\left(\frac{343}{343 - v_S}\right)$$

$$465 = f_S\left(\frac{343}{343 - 9{,}09}\right) ✓✓$$

f_S = 452,67 Hz✓(452,77 Hz)

OR

$$441 = f_S\left(\frac{343}{343 + v_S}\right)$$

$$441 = f_S\left(\frac{343}{343 + 9{,}09}\right)$$

f_S = 452,67 Hz✓(452,77 Hz) (3)

7.4 HIGHER THAN✓ (1)

7.5 **ANY TWO**
Doppler flow meter (*Measure speed of blood flow)*;✓ Measuring foetal heartbeat *;*✓*;* Ultra sound*;* Sonar; Radar (for speeding) .
(2)
[14]

TOTAL MARKS [100]