**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

JUNE 2018

PHYSICAL SCIENCES P1

MARKS: 150

TIME: 3 hours

JPHSCE1

This question paper consists of 18 pages including 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your NAME and SURNAME in the appropriate spaces on the ANSWER BOOK.

2. Answer ALL the questions.

3. Non-programmable calculators may be used.

4. Appropriate mathematical instruments may be used.

5. Number the answers correctly according to the numbering system used in this question paper.

6. You are advised to use the attached DATA SHEETS.

7. Show ALL formulae and substitutions in ALL calculations.

8. Give brief motivations, discussions, etcetera where required.

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

10. Start EACH question on a NEW page.

11. All diagrams are not necessarily drawn according to scale.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four possible options are provided as answers to the following questions. Each question has only ONE correct answer. Choose the best answer and ONLY write down the letters (**A**, **B**, **C** or **D**) next to the question number (1.1–1.10) in your ANSWER BOOK, for example 1.11 E.

1.1   A flatbed truck carrying a 400 kg concrete block, near the back of its flatbed, is travelling to the right along a straight level road at 20 m.s^{-1}.
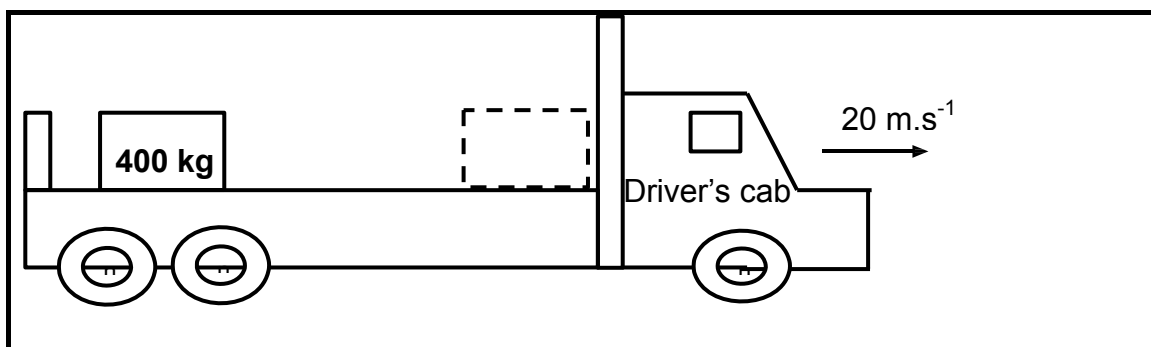
The truck collides head-on with a stationary truck and stops immediately. The concrete block slides to the front in the right. Which ONE of the following is the best explanation as to why the block slides forward?

A   The truck exerts a force on the block.

B   The inertia of the concrete block causes it to slide forward.

C   The velocity of the concrete block relative to the ground remains constant.

D   The concrete block experiences an acceleration due to a resultant force.   (2)

1.2   Two different masses exert a force **F** on each other when they are a distance **r** apart. What will the force be if the distance between them is **doubled**?

A   ¼ **F**

B   ½ **F**

C   2 **F**

D   4 **F**   (2)

1.3 The mass of an object, **M**, is twice the mass of another object **N**.

Both objects are released simultaneously from the same height. How does the velocity of **N** compare with the velocity of **M** just before they strike the ground? (Ignore the effects of air resistance.) The velocity of **N** is …

A half the velocity of **M**.

B twice the velocity of **M**.

C equal to the velocity of **M**.

D a quarter the velocity of **M**. (2)

1.4 Which ONE of the following physical quantities represents the **rate of change of momentum** of an object?

A Net force

B Kinetic energy

C Impulse

D Acceleration (2)

1.5 Two objects experience an INELASTIC collision in a closed system. Which ONE of the following combinations regarding the momentum and kinetic energy is correct?

	MOMENTUM	KINETIC ENERGY
A	Is not conserved	Is conserved
B	Is conserved	Is not conserved
C	Is not conserved	Is not conserved
D	Is conserved	Is conserved

(2)

1.6 A sound source is moving relative to a stationary observer. As the sound source moves away from the observer, its frequency appears to decrease because the …

A wavelength between the source and observer decreases.

B wavelength between the source and observer increases.

C wavelength between the source and observer remains unchanged.

D loudness between the source and observer increases. (2)

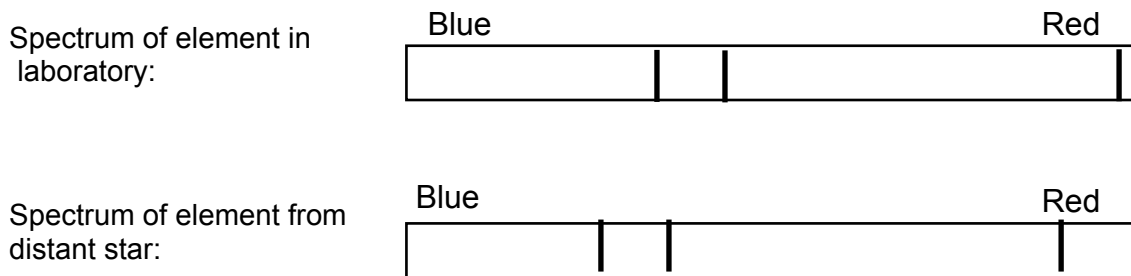1.7 An airbag **can protect a driver from serious injury** during a collision because as the contact time …

A increases, the net force will decrease.

B decreases, the net force will remain the same.

C increases, the net force will increase.

D decreases, the net force will decrease. (2)

1.8 The siren of a stationary train delivers sound waves of frequency 800 Hz. The train starts moving in such a way that the WAVELENGTH of the sound waves that reach a stationary listener, INCREASES. The frequency that the stationary listener hears, could possibly be …

    A   850 Hz

    B   800 Hz

    C   750 Hz

    D   1 000 Hz   (2)

1.9 Astronomers obtained the following spectral lines of an element:

Spectrum of element in laboratory:

Blue   Red

Spectrum of element from distant star:

Blue   Red

This observation confirms that the …

    A   star is moving towards the earth.

    B   star is moving away from the earth.

    C   universe enlarges.

    D   star is undergoing no relative movement.   (2)


1.10 A ball is dropped to the ground from a certain height and bounces back to the same height. Which ONE of the following velocity versus time graphs represents the motion of the ball if downwards is taken as positive?
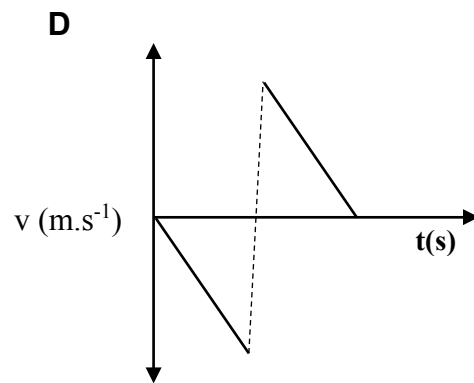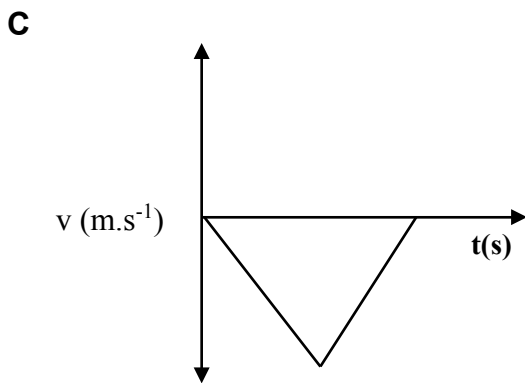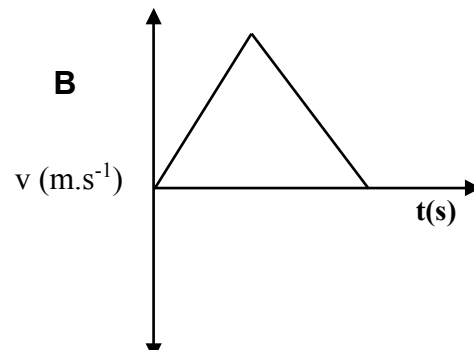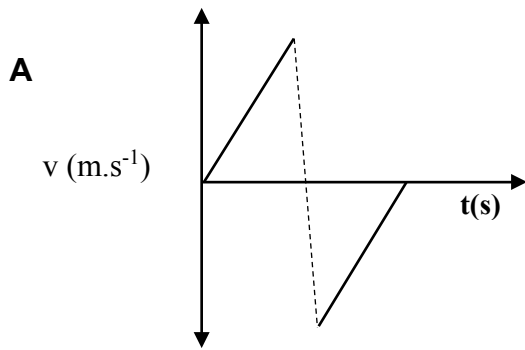
(2)
[20]

QUESTION 2 (Start on a NEW page.)

A block of mass 2 kg is at rest on a rough horizontal surface. The block is connected with a light inextensible string that is hanging over a frictionless pulley, to another block of mass **X** kg. The 2 kg block now accelerates at 4 m·s⁻² to the left.
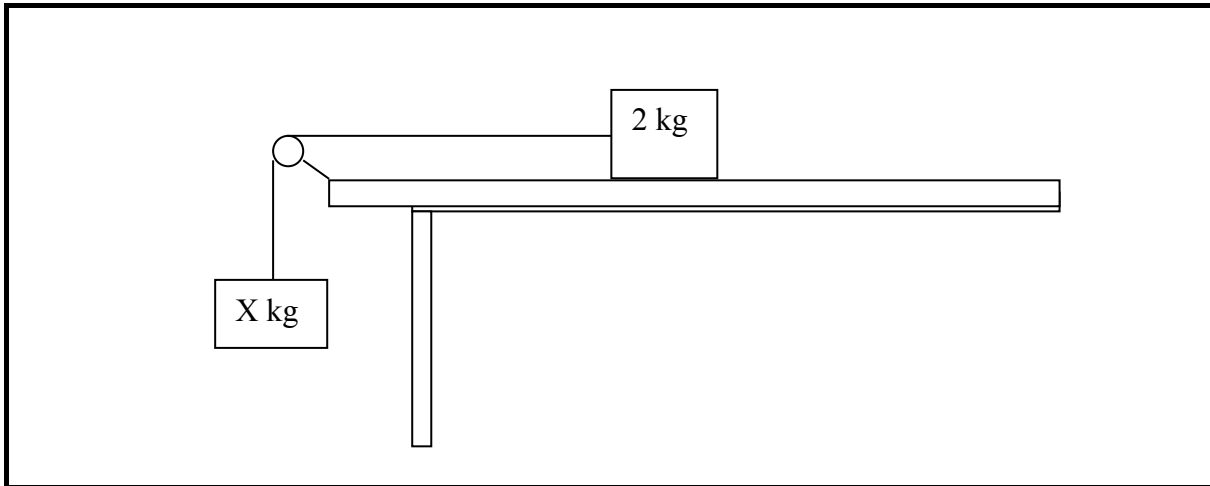

2.1 Write down Newton's Second Law of Motion in words. (2)

2.2 Draw a free-body diagram of all forces acting on the 2 kg block. (4)

2.3 The coefficient of kinetic friction (μ_k) between the block and the surface is 0,2. Calculate:

    2.3.1 The kinetic frictional force acting on the 2 kg block (3)

    2.3.2 **X**, the mass of the hanging block (5)

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QUESTION 3 (Start on a NEW page.)

Ball A is thrown vertically upwards from the ground with a speed of 12 m.s^{-1} and reach height **M**. After 0,72 s, **ball B** is also thrown upwards from the top of a building. Both balls undergo a **free fall** and reach the maximum height at point **M** at the **same time** as shown in the diagram below.
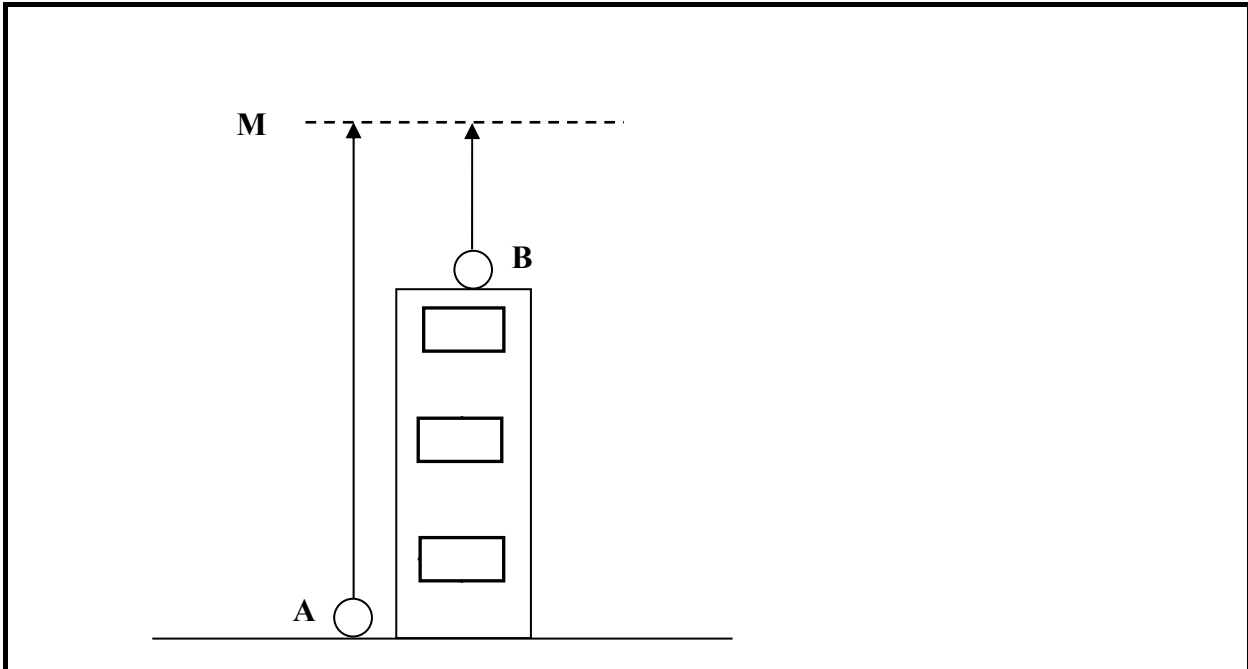
3.1 Define the term *free fall.* (2)

3.2 Calculate the:

3.2.1 Time taken by ball **A** to reach the maximum height at **M** (3)

3.2.2 Velocity at which ball **B** is thrown to reach point **M** (4)

3.2.3 Height of the building (6)

3.3 Sketch the velocity-time graph for the motion of ball **A** from the time it was projected until it reaches the maximum height.

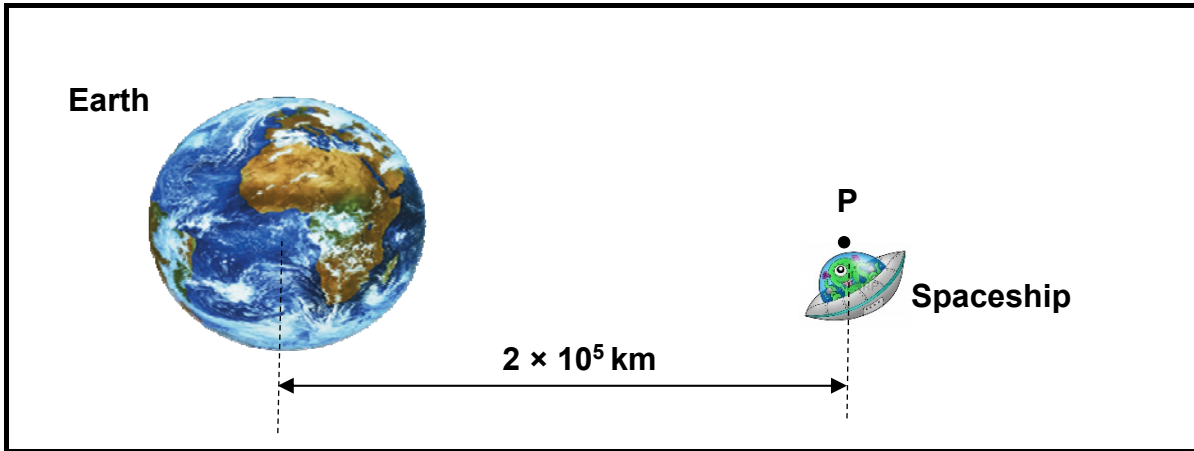Indicate the following on your graph:

(i) initial velocity and time of ball **A**

(ii) velocity and time of ball **A** at the maximum height, **M** (4)

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QUESTION 4 (Start on a NEW page.)

A space ship, mass **m** kg, is at rest at point **P**, 2×10^5 km from the centre of the earth. The gravitational force that the spaceship experiences at point **P** is 34,9 N.

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

4.2 Calculate the mass of the spaceship. (4)

Point **Q** is a point on a straight line between the moon and the earth's centres. Point **Q** is a distance **d** from the centre of the earth. The space ship experiences a ZERO net force when it is at rest at point **Q**. The mass of the moon is $7,35 \times 10^{22}$ kg. The distance between the centre point of the earth and the moon is $3,8 \times 10^5$ km.
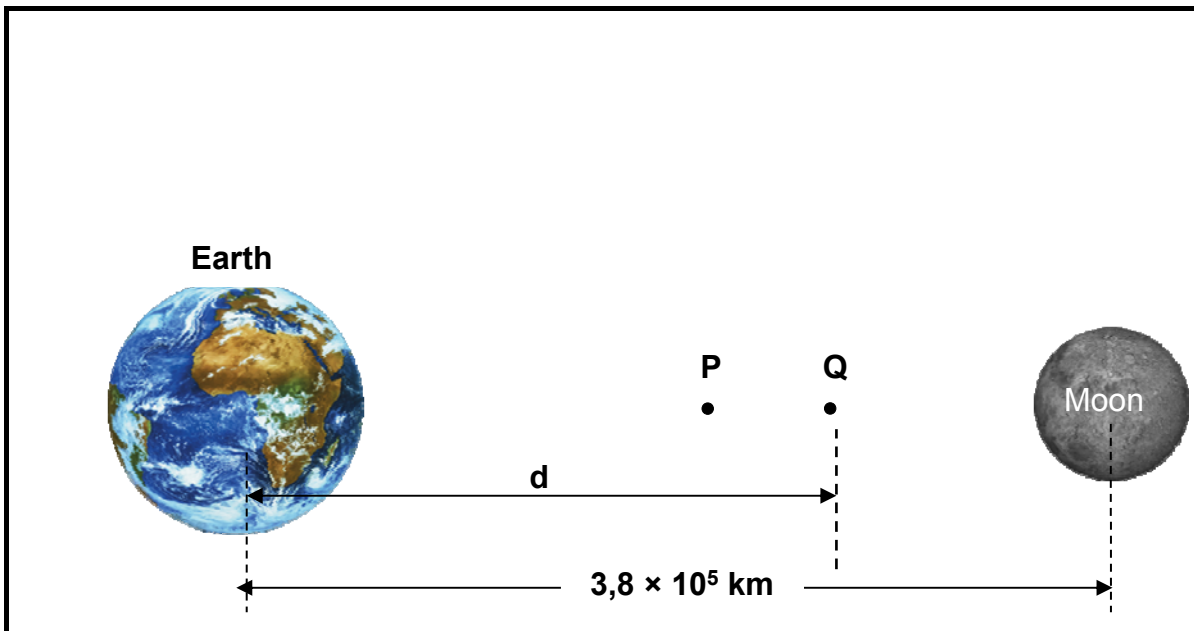
4.3 Calculate the distance between points **P** and **Q** . (5)

[11]

QUESTION 5 (Start on a NEW page.)

A man sitting in a stationary boat in the middle of a lake, wants to reach the shore, 60 m away. The man throws an object of mass 1 kg horizontally at a speed of 10 m·s^{-1} in the direction shown in the diagram below.
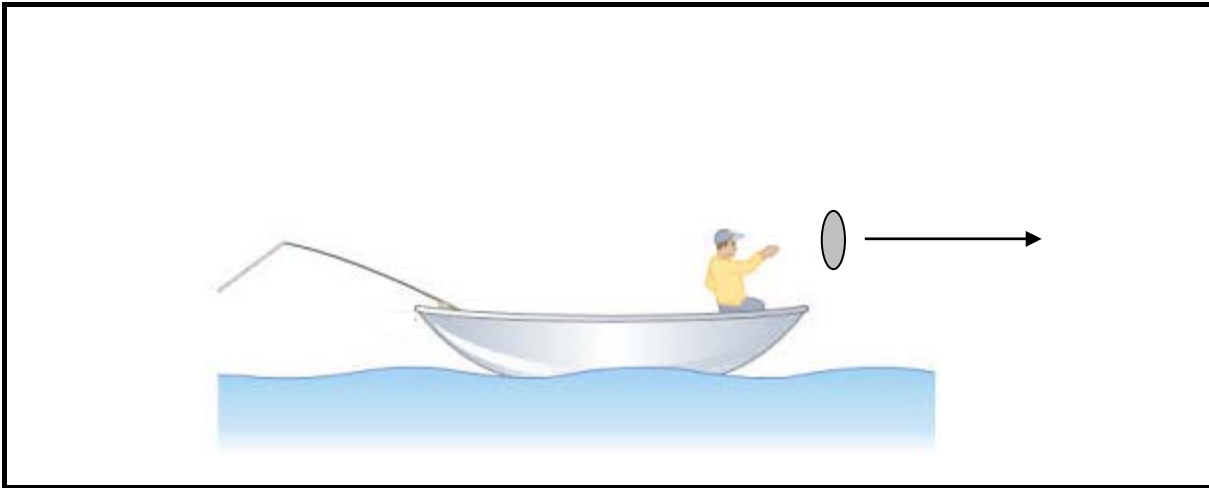
The mass of the man is 40 kg and the mass of the boat is 60 kg. The effects of air resistance and friction between the water and the boat can be ignored.

5.1 Write down the principle of conservation of linear momentum in words. (2)

5.2 In which direction will the man and-boat combination move? (1)

5.3 Calculate the momentum of the object after it has been thrown. (3)

The man's throwing action when he throws the object, takes 0,1 s.

5.4 Calculate the average force that the man exerts on the object. (4)

5.5 The man is expected to reach the shore in less than 15 minutes. Use calculations to find out how long it will take him to reach the shore after throwing the object if the boat is moving at a constant speed. (5)

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QUESTION 6 (Start on a NEW page.)

A constant force **F** is applied to a crate of mass 20 kg to move it upwards along a frictionless inclined plane as shown in the diagram. Its speed at **A** is 12 m·s^{-1} and at **B** are 10,8 m·s^{-1}. The distance **AB** is 4,0 m.
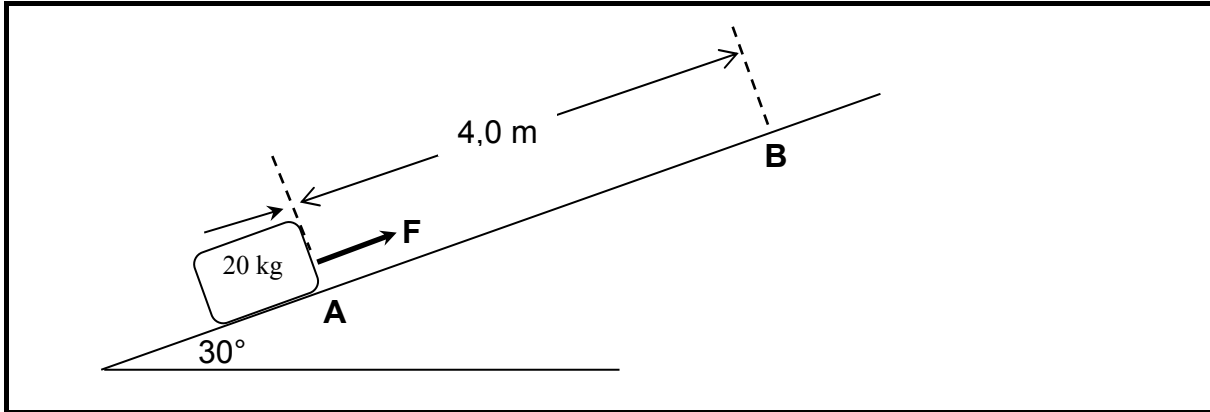
6.1 Draw a free-body diagram showing ALL the forces acting on the crate while it is moving up the incline. (3)

6.2 Define the term *conservative force*. (2)

6.3 Write down the NAME of the conservative force that acts on the crate. (1)

6.4 Calculate the magnitude of the normal force on the crate. (3)

6.5 In which direction does the net force act on the crate as it moves up the incline?
Write only **FROM A TO B** or **FROM B TO A**. (1)

6.6 Use ENERGY PRINCIPLES to calculate the magnitude of the force **F**. (5)

[15]

QUESTION 7 (Start on a NEW page.)

A helicopter hovers above the ground with a bale of wool of mass 65 kg connected to it by a cable as shown in the diagram below. The bale of wool is lowered vertically downwards with a constant acceleration. When the bale is 30 m above the ground, its velocity is 2,2 m.s^{-1} and it **comes to rest** on the ground. Air friction is NOT to be ignored.
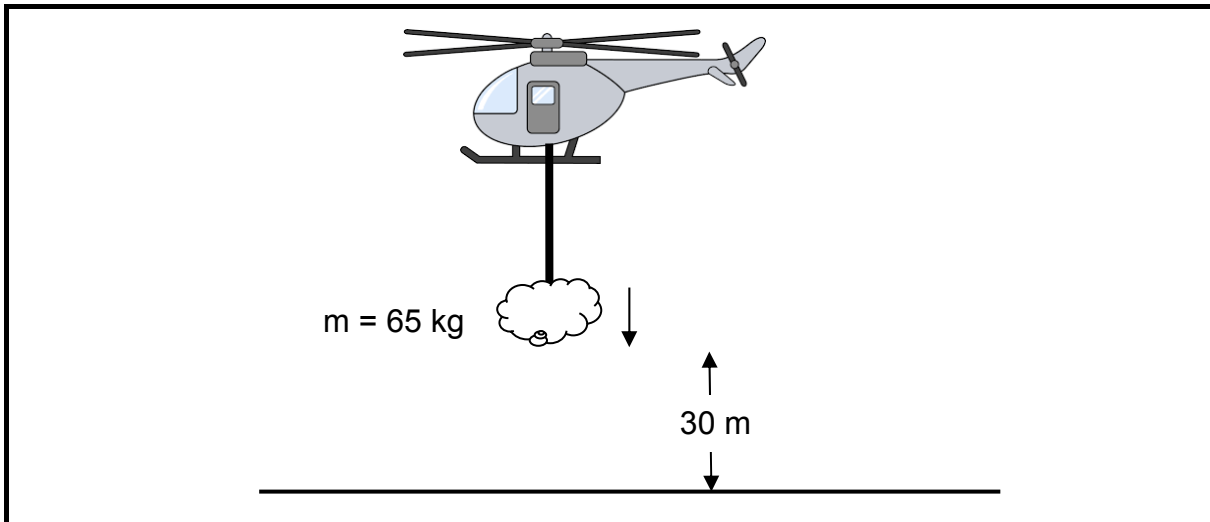
7.1 Identify TWO *non-conservative forces* acting on the bale during its downward motion. (2)

7.2 Draw a free-body diagram showing ALL the forces acting on the bale while it is being lowered to the ground. (3)

7.3 Write down the work-energy theorem in words. (2)

7.4 Use the work-energy theorem to calculate the acceleration of the bale as it is lowered to the ground. (5)

[12]

QUESTION 8 (Start on a NEW page.)

Benny is driving his speedboat at a constant speed towards a lighthouse. The fog horn from the lighthouse blows with a frequency of 180 Hz. The apparent frequency of sound heard by Benny is 188 Hz. Ruby, his friend, stands in front of the lighthouse, as shown in the diagram below. Use the speed of sound in the air as 340 m.s^{-1}.
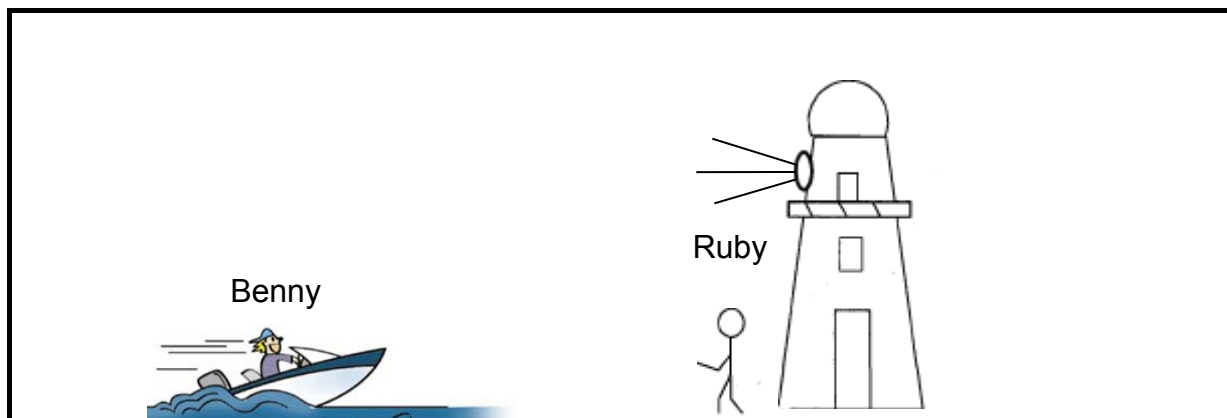
8.1   State the Doppler effect in words.   (2)

8.2   Explain why Ruby perceives the same frequency of 180 Hz.   (2)

8.3   How would the wavelength of the sound wave produced by the fog horn change if the frequency of the sound wave is lower than 180 Hz? Write down only INCREASES, DECREASES or STAYS THE SAME.   (1)

8.4   Give a reason for your answer in QUESTION 8.3.   (2)

8.5   Calculate the speed of the boat as it approaches the lighthouse.   (5)

8.6   Ruby runs in the direction of the boat at a constant speed of 5 m·s^{-1}. Show, by calculations, that the frequency Ruby now hears, is lower than 180 Hz.   (4)

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QUESTION 9 (Start on a NEW page.)

The diagram below represents a frictionless track. **B** and **X** are points on the horizontal section of the track.
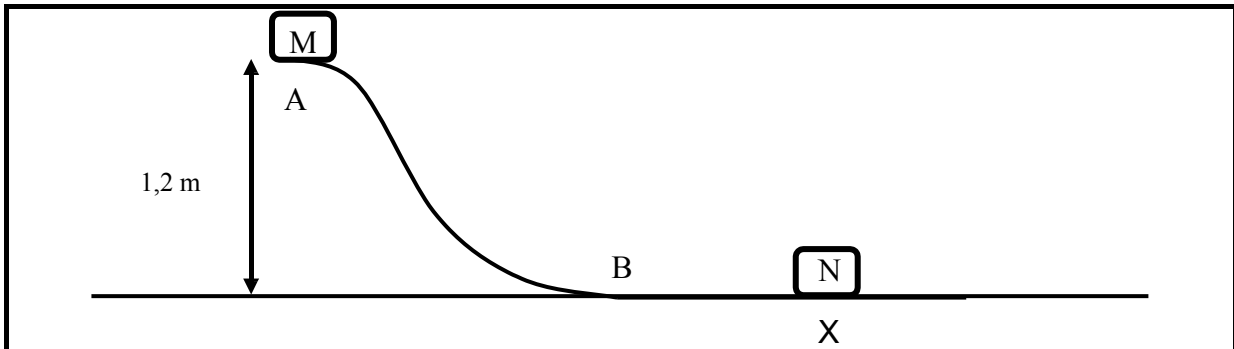
A block **M** of mass 0,40 kg is stationary at point **A** while a second block **N**, with mass 0,30 kg, is stationary at point **X**. Point **A** is 1,20 m higher than the horizontal section of the track. Ignore the effects of air resistance on the blocks. The block at **A** is now released from rest.

9.1   Calculate the speed of the block when it reaches point **B**.   (4)

9.2   Block **M** collides with the stationary block **N** at point **X**. The two blocks then move together after the collision.

     9.2.1   Calculate the speed of the attached blocks immediately after the collision.   (4)

     9.2.2   Calculate the amount of energy that was **lost** during the collision.   (6)

     9.2.3   Is the collision elastic or inelastic?   (1)

                                                                            [15]

QUESTION 10 (Start on a NEW page.)

A charge of -2 µC is positioned 10 cm from point **P,** as shown below.
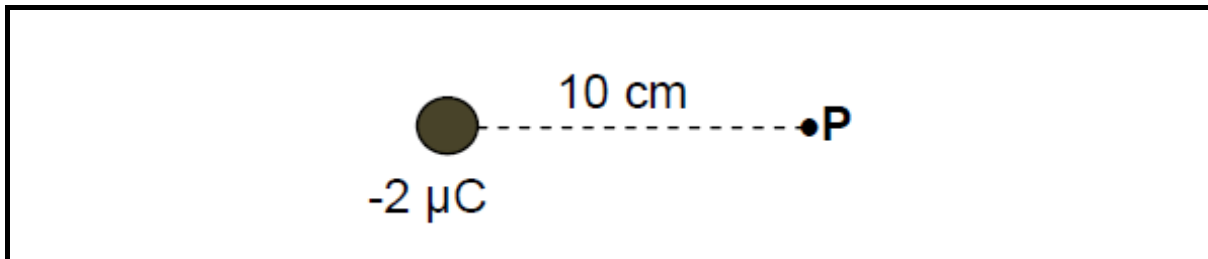
10.1 Define in words *electric field at a point*. (2)

10.2 Draw the electric field lines associated with this charge. (2)

10.3 Another charge of magnitude +3 µC is placed 6 cm on the right hand side of point **P** in line with the other charge as shown in the diagram below.
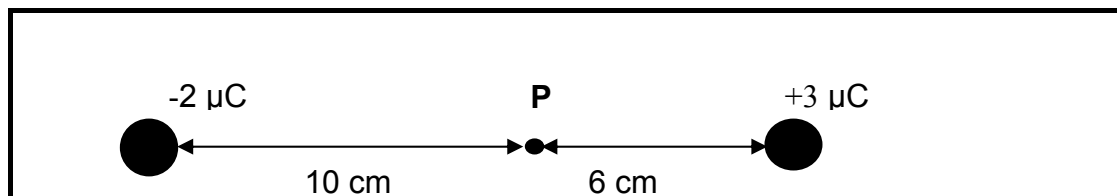
Calculate the:

10.3.1 Force that the -2 µC charge exerts on the +3 µC charge (4)

10.3.2 Net electric field strength experienced at point P as a result of the two charges (5)

[13]

TOTAL: 150

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

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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \dfrac{Gm_1 m_2}{d^2}$	$g = G\dfrac{M}{d^2}$

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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \dfrac{W}{\Delta t}$
$P_{av} = Fv$	

WAVES, SOUND AND LIGHT/*GOLWE, KLANK EN LIG*

$v = f\lambda$	$T = \dfrac{1}{f}$
$f_L = \dfrac{v \pm v_L}{v \pm v_s}f_s$ $f_L = \dfrac{v \pm v_L}{v \pm v_b}f_b$	$E = hf$ or/of $E = h\dfrac{c}{\lambda}$
$E = W_o + E_k$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_k = \dfrac{1}{2}mv^2$ or/of $K_{max} = \dfrac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \dfrac{kQ_1Q_2}{r^2}$	$E = \dfrac{kQ}{r^2}$
$E = \dfrac{V}{d}$	$E = \dfrac{F}{q}$
$V = \dfrac{W}{q}$	$n = \dfrac{Q}{q_e}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \dfrac{V}{I}$	$\text{emf}\,(\varepsilon) = I(R + r)$ $\text{emk}\,(\varepsilon) = I(R + r)$
$R_s = R_1 + R_2 + \ldots$ $\dfrac{1}{R_p} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \ldots$	$q = I\,\Delta t$
$W = Vq$ $W = VI\,\Delta t$ $W = I^2R\,\Delta t$ $W = \dfrac{V^2\Delta t}{R}$	$P = \dfrac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \dfrac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms} = \dfrac{I_{max}}{\sqrt{2}} \quad / \quad I_{wgk} = \dfrac{I_{maks}}{\sqrt{2}}$ $V_{rms} = \dfrac{V_{max}}{\sqrt{2}} \quad / \quad V_{wgk} = \dfrac{V_{maks}}{\sqrt{2}}$	$P_{average} = V_{rms}I_{rms} \quad / \quad P_{gemiddeld} = V_{wgk}I_{wgk}$ $P_{average} = I_{rms}^2R \quad / \quad P_{gemiddeld} = I_{wgk}^2R$ $P_{average} = \dfrac{V_{rms}^2}{R} \quad / \quad P_{gemiddeld} = \dfrac{V_{wgk}^2}{R}$