Province of the EASTERN CAPE EDUCATION

Iphondo leMpuma Kapa: Isebe leMfundo
Provinsie van die Oos Kaap: Department van Onderwys
Porafensie Ya Kapa Botjahabela: Lefapha la Thuto

# NATIONAL SENIOR CERTIFICATE

# GRADE 12

## JUNE 2025

# PHYSICAL SCIENCES P1

**MARKS 150**

**TIME: 3 hours**

* J P H S C E 1 *

This question paper consists of 18 pages including 2 data sheets.

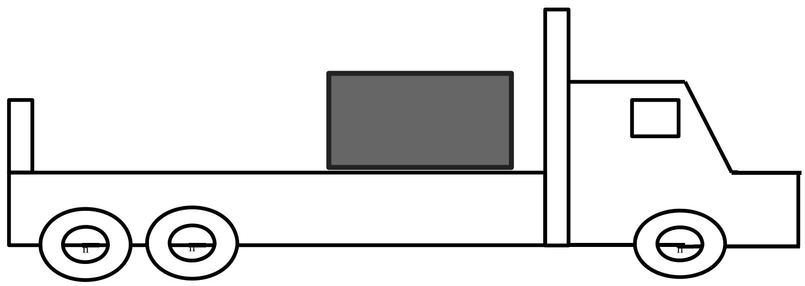
## INSTRUCTIONS AND INFORMATION

1. Write your full NAME and SURNAME in the appropriate space on the ANSWER BOOK.
2. Answer ALL the questions.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
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, et cetera 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.
12. Write neatly and legibly.

## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as answers to the following questions. Choose the answer and write ONLY the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 A box is placed on top of a truck while the truck is stationary. When the truck starts to move, which ONE of the following statements will CORRECTLY describe the motion of the box?



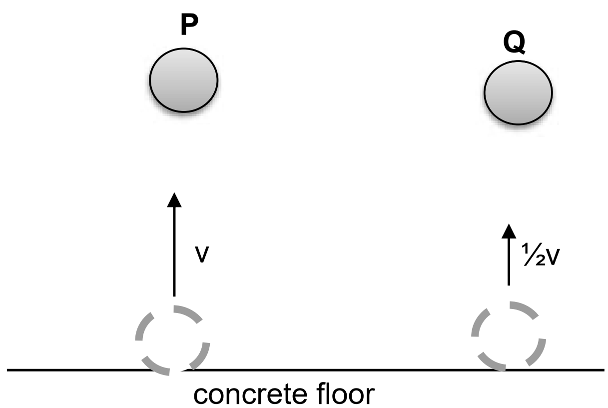
A It will remain stationary.

B It will move forward in the direction of the truck.

C It will move backwards as the truck is moving forward.

D It will first move forward and then backwards. (2)

1.2 Ball **P** and ball **Q**, of the same mass, are dropped from the same height onto a concrete floor. Both balls hit the concrete floor at the same speed, **v**. Ball **P** rebounds with the same vertical speed, **v**, but ball **Q** rebounds with speed **½v**.



Which ONE of the following statements regarding the collision of EACH ball with the concrete floor is CORRECT?

A Kinetic energy is conserved for both balls **P** and **Q**.

B The change in momentum of ball **P** is greater than that of ball **Q**.

C The contact time with the floor is the same for both balls **P** and **Q**.

D Momentum is conserved for the collision of ball **P**, but not for that of ball **Q**. (2)

1.3 A car of mass **m** travels along a straight road with a velocity of magnitude **v**. The driver sees the traffic lights turn red and immediately applies the brakes. The car stops uniformly in **t** seconds from the moment that the brakes were applied. Which ONE of the following represents the MAGNITUDE of the average force exerted on the car during the braking period of **t** seconds?

A $\frac{v}{t}$

B mv

C mvt

D $\frac{mv}{t}$ (2)

1.4 A ball is projected vertically upwards. Ignore air resistance. Which ONE of the following statements about the acceleration of the ball at its maximum height is CORRECT? The acceleration is equal to …

A zero.

B g and is directed downwards.

C g and is directed upwards.

D g and is directed horizontally. (2)

1.5 Consider the statements below:

I Work is done on an object when a force displaces the object in the direction of the force.

II Mechanical energy of a system is conserved when an external force does no work on the system.

III The work done on an object by a net force is equal to the kinetic energy of the object.

Which ONE of the above statement(s) is/are TRUE?

A I Only

B I and II only

C II and III only

D I, II and III (2)

1.6 If the net work done on a moving object is POSITIVE, then we can conclude that the kinetic energy of the object …

A has not changed.

B has increased.

C has decreased.

D is zero. (2)

1.7 An object moving with a velocity **v** has kinetic energy K. If the velocity of the object doubles to **2v,** the net work done will be …

A 2K.

B K.

C 3K.

D 4K. (2)

1.8 An observer stands at a distance **x** from a stationary ambulance blowing its siren at a certain frequency at an accident scene. The pitch of sound that the observer hears compared to the pitch of sound produced from the siren will be …

A equal to.

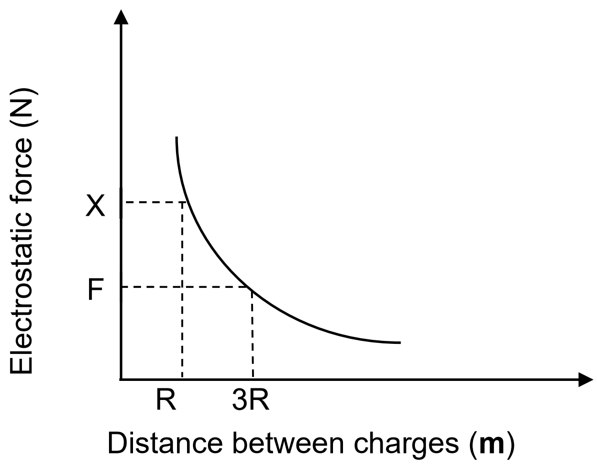
B greater than.

C less than.

D zero. (2)

1.9 The graph below, not drawn to scale, shows the relationship between the electrostatic force exerted by two point charges on each other and its distance between the charges.




Which ONE of the following is the CORRECT representation of the magnitude of force **X** shown on the graph?

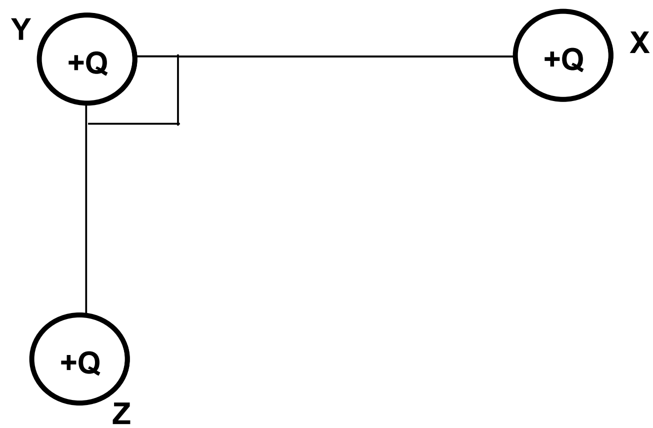
A 3F

B 9F

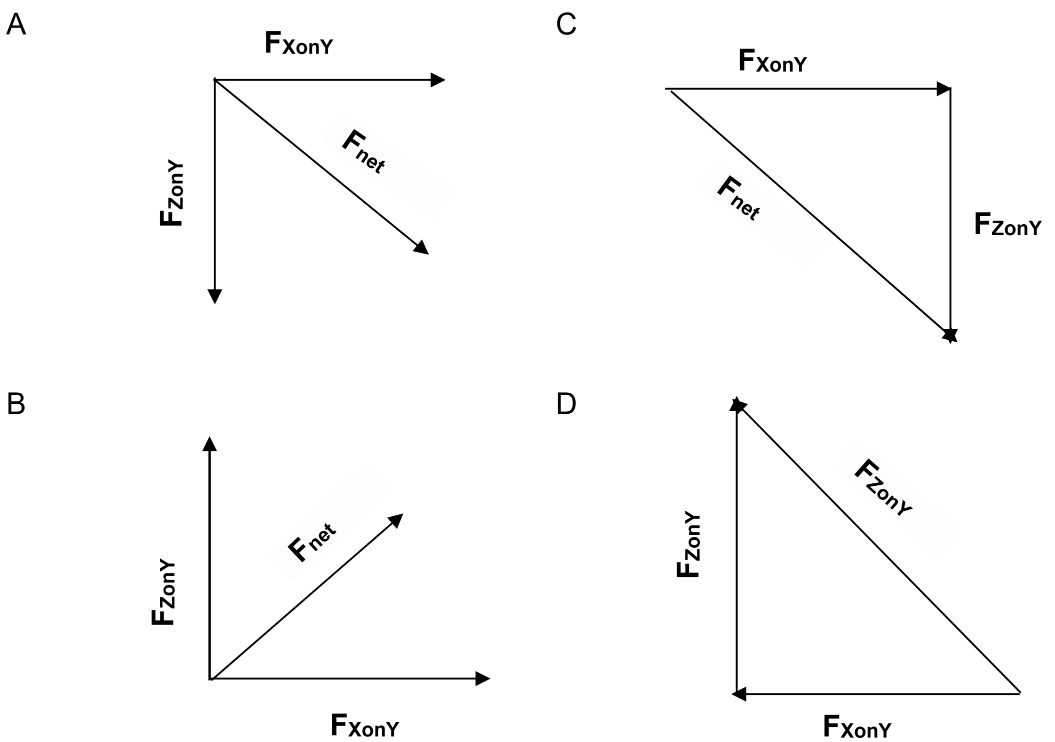
C ⅓F

D $\frac{1}{9}$F (2)

1.10 Three identical charges **X**, **Y** and **Z** are arranged in a vacuum as shown in the diagram below.



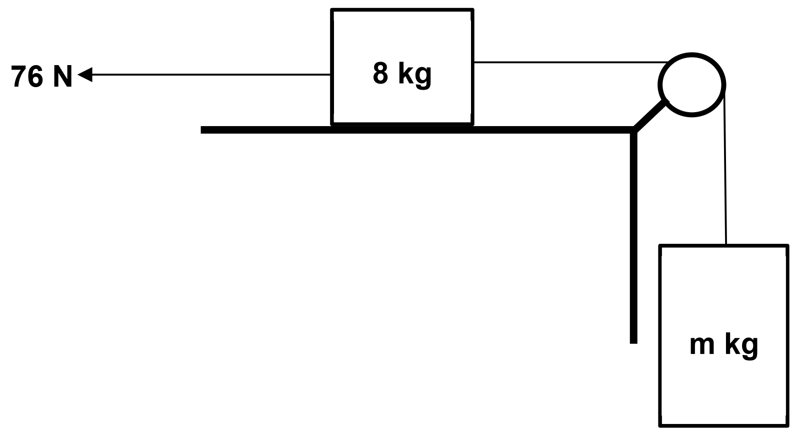

Which of the following vector diagrams NOT drawn to scale represent the forces acting on sphere **Y** and the net force on sphere **Y**?




(2)
**[20]**

## QUESTION 2

A block of mass 8 kg is placed on a horizontal surface and is connected to an **m** kg block which hangs vertically by means of an INEXTENSIBLE string that passes over a light frictionless pulley as shown in the diagram below. A force of 76 N is applied horizontally to keep the system sliding downwards at a CONSTANT VELOCITY.




2.1 State Newton's second law of motion in words. (2)

2.2 Draw a labelled free-body diagram of all forces acting on the 8 kg block. (5)

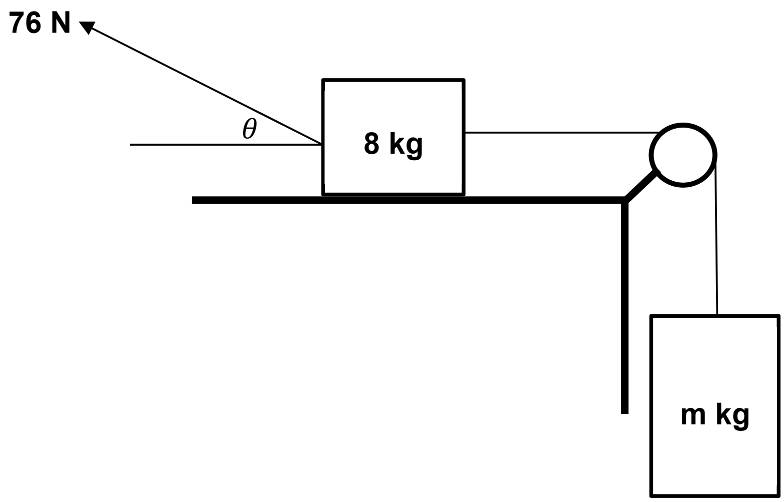
2.3 The coefficient of kinetic friction ($\mu_k$) between the block and the surface is 0,2.

Calculate:

2.3.1 The frictional force acting on the 8 kg block (3)

2.3.2 **m**, the mass of the hanging block (4)

2.4 The applied force now acts at an angle $\theta$ to the horizontal as shown in the diagram below.




What will be the effect on the following?

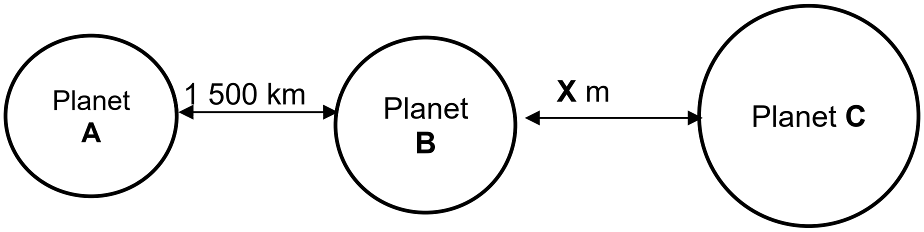
Choose from INCREASE, DECREASE or REMAIN THE SAME.

2.4.1 The coefficient of kinetic friction? (1)

2.4.2 The kinetic friction acting on the 8 kg block? Explain your answer. (3)
**[18]**

## QUESTION 3

Consider three planets **A**, **B** and **C** arranged in a straight line as shown in the diagram below.




| | MASS OF PLANET (kg) | RADIUS OF PLANET (m) |
|---|---|---|
| **A** | $6,42 \times 10^{23}$ | $3,93 \times 10^{6}$ |
| **B** | $5,98 \times 10^{24}$ | $6,38 \times 10^{6}$ |
| **C** | $1,92 \times 10^{25}$ | $7,20 \times 10^{6}$ |

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

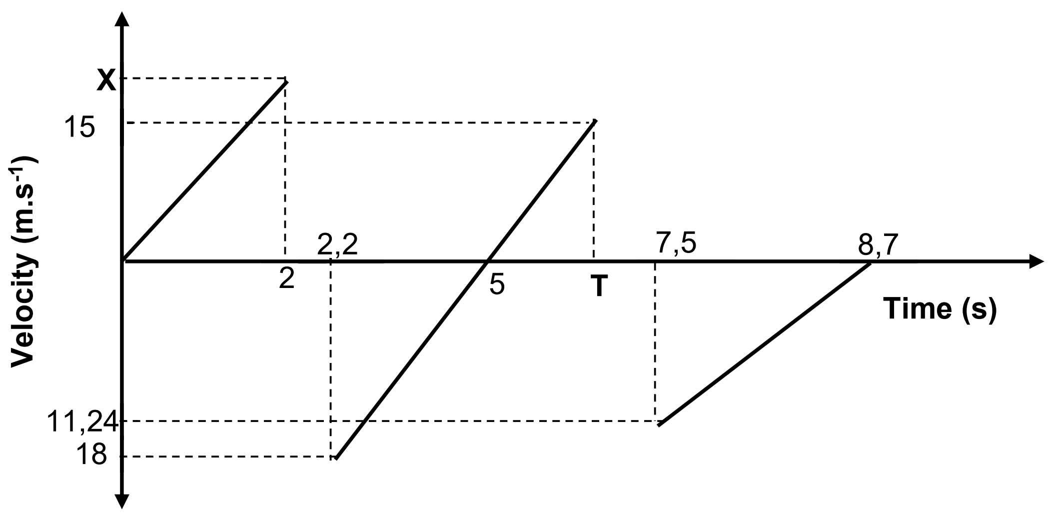
3.2 Calculate the gravitational force exerted by planet **A** on planet **B**. (4)

3.3 Planet **B** experiences a zero net force due to planet **A** and planet **C**. Calculate the distance **X** on the diagram above. (6)

**[12]**

## QUESTION 4

The velocity-time graph below, NOT drawn to scale, shows the motion of a ball from a certain height above the ground. The ball bounces a few times and all sections of the graph have the same gradient. Ignore the effect of air friction.




4.1 Give a reason why all sections of the graph have the same gradient. (1)

4.2 Is the downwards motion POSITIVE or NEGATIVE. (1)

4.3 How many times did the ball bounce. (1)

4.4 Calculate the:

4.4.1 Velocity **X** on the graph (3)

4.4.2 Time **T** on the graph (4)

4.4.3 Height above the ground where the ball was projected (3)

4.4.4 Maximum height reached after the second bounce (3)

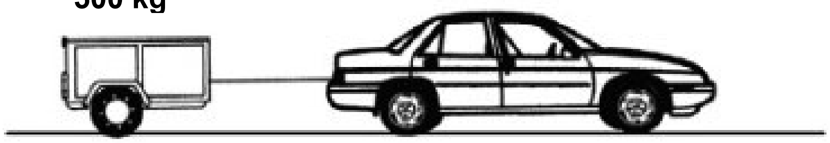
4.5 Sketch a position-time graph for the entire motion of the ball. Indicate the following on the graph:

- Height above the ground where the ball was projected
- Maximum height reached after the second bounce
- All the times indicated on the graph above (4)

**[20]**

## QUESTION 5

A car of mass 1 200 kg is moving at a constant velocity of 12 $m.s^{-1}$ to the right and pulls a trailer of mass 500 kg. Ignore the effect of all frictional forces.




5.1 State the law of conservation of linear momentum in words. (2)

5.2 Calculate the momentum of the car-trailer system. (3)

The rope connecting the trailer to the car suddenly breaks and the car and trailer are separated.

5.3 In which direction will the trailer move the instant the rope breaks. State a relevant PHYSICS LAW to support your answer. (3)

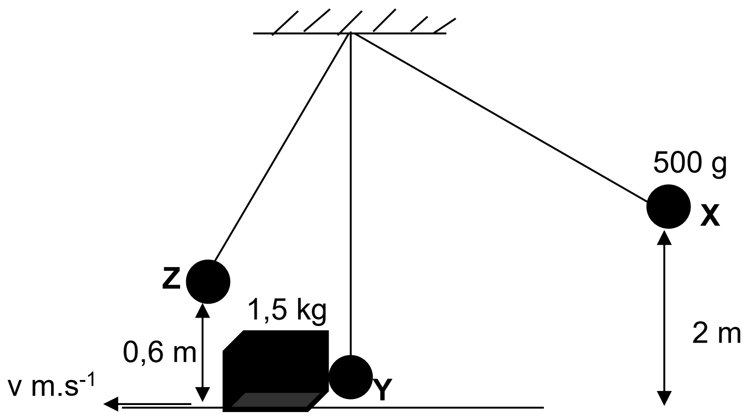
5.4 Calculate the velocity of the trailer after it separated from the car. (4)

5.5 Use a relevant calculation to determine whether the collision is ELASTIC or INELASTIC. (5)

**[17]**

## QUESTION 6

A steel ball of mass 500 g attached to an inextensible string, hangs from a ceiling. The ball is held at position **X**, a height of 2 m above a horizontal table with a 1,5 kg crate placed on it. When the ball is released, it collides with the crate at position **Y**. The crate moves to the left with a speed of **v** m.s$^{-1}$ while the ball continues its swing to position **Z**, and reaches a maximum height of 0,6 m above the table shown in the diagram below. A frictional force of 50 N acts on the crate as it moves to the left. Ignore the air friction.



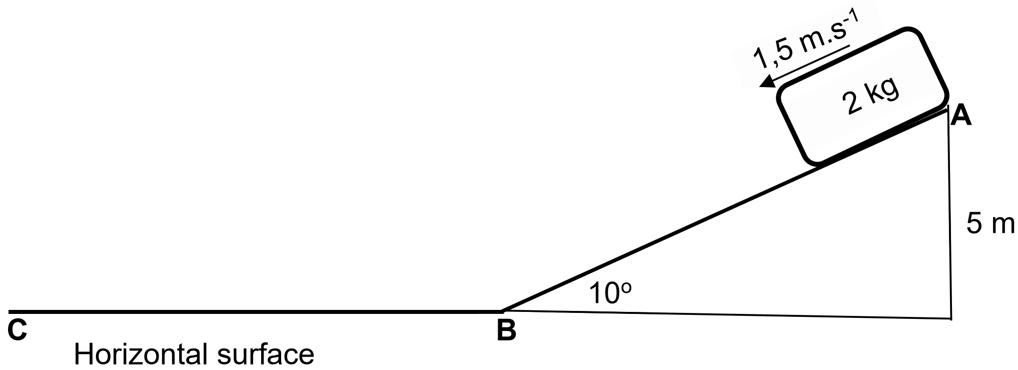

6.1 State the law of conservation of mechanical energy in words. (2)

6.2 Calculate the work done by the gravitation force in moving the steel ball from point **A** to **B**. (3)

6.4 Calculate the speed **v**, of the crate after the steel ball collides with it. (5)
**[10]**

## QUESTION 7

In the diagram below, a small object of mass 2 kg is sliding at velocity of 1,5 $m.s^{-1}$ down a rough plane inclined at 10° to the horizontal surface.




At the bottom of the plane, the object continues sliding onto the rough horizontal surface and eventually comes to a stop. The frictional force acting on the block while it slides along the inclined surface is 2,5 N.

The coefficient of kinetic friction between the object and the surface is the same for both the inclined surface and the horizontal surface.

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

7.2 Draw a labelled free-body diagram of all the forces acting on the block while it is on the inclined surface. (3)

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

7.4 Use ENERGY PRINCIPLES to calculate the:

7.4.1 Speed of the block at the bottom of the incline at point **B** (5)

7.4.2 Distance **BC** that the block moves before it comes to a stop (5)

**[17]**

## QUESTION 8

The siren of a fire truck moving at a constant speed 20 $m.s^{-1}$ along a straight horizontal road emits sound with a wavelength of 0,34 m. A detector on the same road records sound waves from the fire truck with a lower frequency than the sound emitted by the siren. Take the speed of sound in air as 340 $m.s^{-1}$ .

8.1 Define *Doppler effect* in words. (2)

8.2 Is the fire truck driving TOWARDS or AWAY FROM the detector? Give a reason for your answer. (2)

8.3 Explain in terms of wave motion why the detector records sound waves with lower frequency. (3)

8.4 Calculate the:

8.4.1 Frequency of the siren (3)

8.4.2 Frequency recorded by the detector (6)

8.5 The speed of the fire truck now increased to 25 $m.s^{-1}$. How will the increase in speed affect the following?

Choose from INCREASE, DECREASE or STAYS THE SAME.

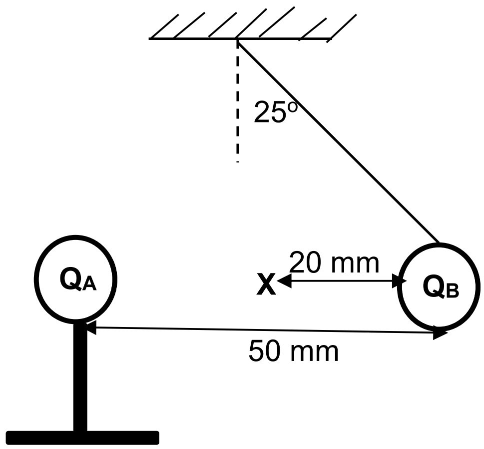
8.5.1 The frequency of the sound waves emitted by the siren. (1)

8.5.2 The frequency of the sound waves recorded by the detector. (1)

**[18]**

## QUESTION 9

**$Q_A$** and **$Q_B$** are metal charged spheres. **$Q_A$** is placed on an insulated stand while **$Q_B$** hangs from a ceiling by means of an inextensible string that makes an angle of 25° to the vertical as shown in the diagram below. **$Q_A$** carries a charge of +15 nC while **$Q_B$** has a mass of 6 x $10^{-5}$ kg and carries an unknown charge. **$Q_B$** is in equilibrium.




9.1 Is the charge on **$Q_B$** POSITIVE or NEGATIVE? Give a reason for your answer. (2)

9.2 State Coulomb's law in words. (2)

9.3 Calculate the:

9.3.1 Tension in the string. (4)

9.3.2 Magnitude of the charge on **$Q_B$** (5)

9.3.3 Net electric field at point **X** shown on the diagram above. (5)
**[18]**

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

| | |
|---|---|
| $F_{net} = ma$ | $p = mv$ |
| $f_s^{max} = \mu_s N$ | $f_k = \mu_k N$ |
| $F_{net}\Delta t = \Delta p$<br>$\Delta p = mv_f - mv_i$ | $w = mg$ |
| $F = \frac{Gm_1m_2}{d^2}$ | $g = G\frac{M}{d^2}$ |

**WORK, ENERGY AND POWER/*ARBEID, ENERGIE EN DRYWING***

| | |
|---|---|
| $W = F\Delta x\cos\theta$ | $U = mgh$ or/*of* $E_P = mgh$ |
| $K = \frac{1}{2}mv^2$ or/*of* $E_k = \frac{1}{2}mv^2$ | $W_{net} = \Delta K$ or/*of* $W_{net} = \Delta E_k$<br>$\Delta K = K_f - K_i$ or/*of* $\Delta E_k = E_{kf} - E_{ki}$ |
| $W_{nc} = \Delta K + \Delta U$ or/*of* $W_{nc} = \Delta E_k + \Delta E_p$ | $P = \frac{W}{\Delta t}$ |
| $P_{av} = Fv$ | |

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

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

## ELECTROSTATICS/*ELEKTROSTATIKA*

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

## ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

| | |
|---|---|
| $R = \frac{V}{I}$ | emf ($\varepsilon$) = I(R + r)<br>emk ($\varepsilon$) = I(R + r) |
| $R_s = R_1 + R_2 + ...$<br>$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$ | $q = I\Delta t$ |
| $W = Vq$<br>$W = VI\Delta t$<br>$W = I^2R\Delta t$<br>$W = \frac{V^2\Delta t}{R}$ | $P = \frac{W}{\Delta t}$<br>$P = VI$<br>$P = I^2R$<br>$P = \frac{V^2}{R}$ |

## ALTERNATING CURRENT/*WISSELSTROOM*

| | |
|---|---|
| $I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$<br>$V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$ | $P_{average} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$<br>$P_{average} = I^2_{rms}R$ / $P_{gemiddeld} = I^2_{wgk}R$<br>$P_{average} = \frac{V^2_{rms}}{R}$ / $P_{gemiddeld} = \frac{V^2_{wgk}}{R}$ |