Province of the
EASTERN CAPE
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

JUNE 2016

PHYSICAL SCIENCES P1

MARKS: 150

TIME: 3 hours

PHSCE1

This question paper consists of 14 pages, including a 2-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.

2. This 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. Write neatly and legibly.

7. You may use a non-programmable calculator.

8. You may use appropriate mathematical instruments.

9. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.

10. Show ALL formulae and substitutions in ALL calculations.

11. Round off your FINAL numerical answers to a minimum of TWO decimal places.

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

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A–D), corresponding to the correct answer of your choice, next to the question number (1.1–1.10) in the ANSWER BOOK, for example 1.11 D.

1.1 The diagram below shows a compressed spring between two trolleys initially at rest on a horizontal, frictionless surface. Trolley A has a mass of 2 kg and trolley B has a mass of 1 kg. A string holds the trollies together.
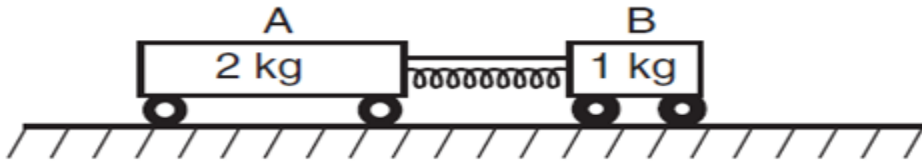
The string is cut and the trollies move apart. Compared to the magnitude of the force the spring exerts on trolley A, the magnitude of the force the spring exerts on trolley B is …

A   half as great.
B   the same.
C   twice as great.
D   four times as great.   (2)

1.2 A net force acts on each of the isolated objects, **R** and **S**, as shown below.

The mass of **S** is three times that of **R**. When effects of friction are ignored, the rate of change of momentum of **S** is X. What is the rate of change of momentum of **R** under the same conditions?

A $\frac{1}{9}$ X
B $\frac{1}{3}$ X
C   X
D   3 X   (2)

1.3 An object moving with a constant velocity **v** has a kinetic energy **E**. Which one of the following will be true for the kinetic energy if the object has a constant velocity of **2v**?

A   ½ E
B   E
C   2E
D   4E   (2)

1.4   A sphere is attached to a string, which is suspended from a fixed horizontal bar as shown in the sketch.
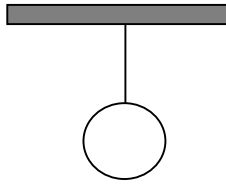
The reaction force to the gravitational force exerted by the earth on the sphere is the force of the …

A   bar on the sphere.
B   string on the sphere.
C   sphere on the earth.
D   bar on the string.   (2)

1.5   A ball is dropped from height **h** above the ground and reaches the ground with kinetic energy **E**. From which height must the ball be dropped to reach the ground with kinetic energy **2E**? (Ignore all effects of friction.)

A   2**h**
B   3**h**
C   4**h**
D   8**h**   (2)

1.6   The velocity versus time graph below represents the movement of an object under the influence of gravitational force ONLY.
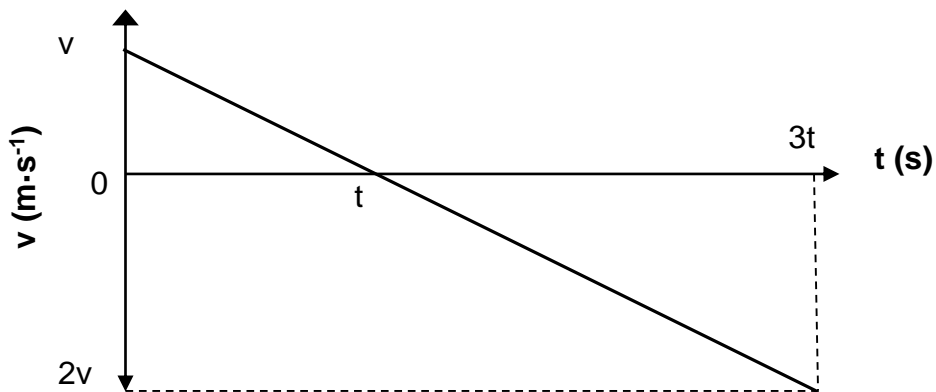
The displacement of the object in time **3t** is …

A $\frac{5}{2}$ **vt**.
B   7**vt**.
C $\frac{7}{2}$ **vt**.
D $-\frac{3}{2}$ **vt**.   (2)

1.7 A net force *F* accelerates two isolated objects, **P** and **Q**, from rest on a straight line for time **t** as shown below. Object **P** experiences an acceleration of **a** and object **Q** an acceleration of **2a**.


If the amount of work done by net force *F* on object **P** equals **W**, the amount of work done on **Q** will be …

A   W.
B   ½ W.
C   2 W.
D   4 W.   (2)

1.8 Which ONE of the following can be **explained by** the *Doppler Effect*?

A   A source of sound moves closer to a listener, the sound observed by the listener becomes louder.
B   If light shining on a metal has a frequency that is high enough, electrons will be emitted from the metal.
C   A spectrum will be shifted towards shorter wavelengths than expected if the light comes from distant celestial objects moving towards the observer.
D   A spectrum of frequencies of electromagnetic radiation is emitted when an atom makes a transition from high energy to a lower energy state.   (2)

1.9 The red shift can be used to estimate the speed of a galaxy relative to earth. Which ONE of the following statements is CORRECT? Distant galaxies are moving …

A   faster than closer galaxies and the universe is expanding.
B   faster than closer galaxies and the universe is contracting.
C   slower than closer galaxies and the universe is contracting.
D   moving at the same speed as closer galaxies and the universe remains unchanged.   (2)

1.10 A ball is dropped onto a concrete floor and bounces off the floor to the same height from which it was dropped. Which ONE of the following laws best explains why the ball experiences an upward force? Newton's …

A   first law of motion.
B   second law of motion.
C   third law of motion.
D   law of universal gravitation.   (2)

[20]

                                          Please turn over

QUESTION 2

A girl stands on a platform in a classroom. She throws a ball vertically downwards to the floor hoping that the ball, after it bounced on the floor, will hit the ceiling of the classroom. She throws the ball with a velocity of 8 m·s^{-1} from the height of 1,8 m above the floor. Ignore the effects of friction.
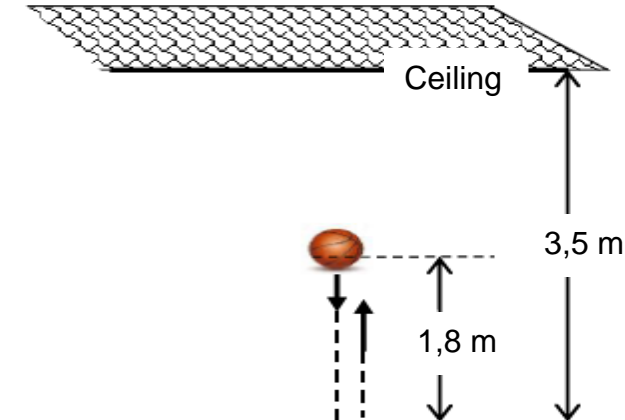
2.1   Write down the magnitude and direction of the acceleration of the ball immediately after the ball left her hand. (2)

2.2   Is the motion of the ball while moving downwards towards the floor a free fall? Answer YES or NO. Explain your answer. (2)

2.3   Calculate the magnitude of the velocity with which the ball hits the floor. (4)

2.4   How long does it take the ball to hit the floor? (3)

The ball bounces INELASTICALLY on the floor where the velocity of the ball DECREASES by 20%. The ball is in contact with the floor for 0,01 s.

2.5   Determine by means of calculations, whether the ball will reach the ceiling after its first bounce on the floor. (5)

2.6   Sketch a velocity-time graph for the motion of the ball, from the time the ball is thrown until it reaches the maximum height after the bounce.
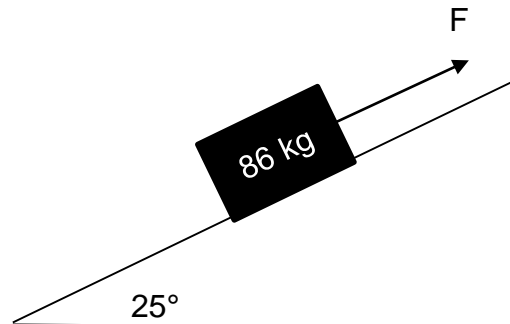
Clearly show the following on the graph:
- The initial velocity of the ball
- The velocity and time when the ball hits the floor
- The velocity and time when the ball leaves the floor (4)

[20]

QUESTION 3

A crate of mass 86 kg is accelerating down a surface inclined at an angle of 25° to the horizontal.


A man applies a force F upwards parallel to the plane in an attempt to prevent the crate from sliding down the inclined plane. In spite of the man's efforts the crate is accelerating down the incline.

3.1 The applied force is a <u>non-conservative force</u>. What is meant by a non-conservative force? (2)

3.2 The coefficient of kinetic friction (μ_k) between the crate and the surface of the plane is 0,22. Prove that the magnitude of the kinetic frictional force is 168,04 N. (2)

3.3 State work-energy theorem in words. (2)

3.4 Draw a labelled free-body diagram of all the forces acting on the crate. (4)

3.5 The crate accelerates parallel down the inclined plane for a distance of 0,9 m at 1,54 m·s^{-2}. Use the work-energy theorem and calculate the work done by the man on the crate. (5)

[15]

QUESTION 4

A 5 kg rigid crate moves from rest down path ABC as shown in the diagram below (diagram not drawn to scale). Section AB of the path is frictionless whilst section BC is a rough surface. Assume that the crate moves in a straight line down the path.
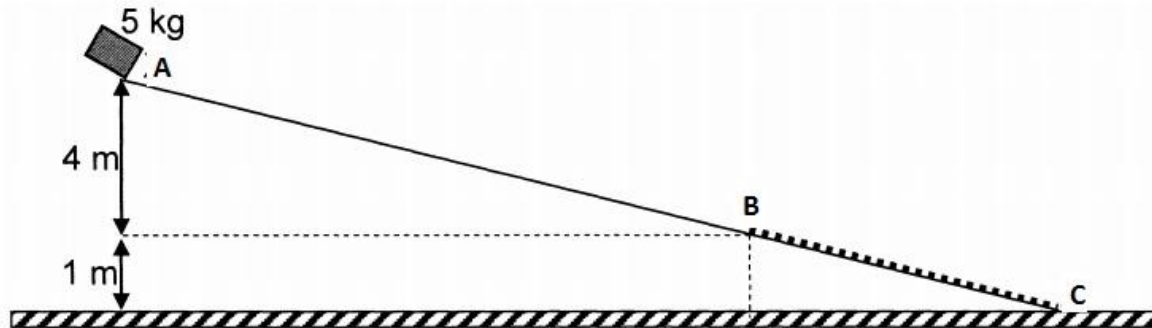
4.1   State, in words, the principle of the conservation of mechanical energy.   (2)

4.2   Use the principle of the conservation of mechanical energy to calculate the velocity of the crate when it reaches point B.   (4)

On reaching point B, the crate continues to move down the section BC of the path. It experiences an average frictional force of 10 N and reaches point C at a velocity of 4 m·s⁻¹.

4.3   Apart from friction, write down the names of TWO other forces that act on the crate as it moves down section BC.   (2)

4.4   In which direction does the net force act on the crate as it moves down section BC? Write down only <u>B to C</u> or <u>C to B</u>.   (1)

Another crate of mass 10 kg now moves from point A down path ABC.

4.5   How will the velocity of this 10 kg crate at point B compare to that of the 5 kg crate at B? Write down only GREATER, SMALLER or EQUAL TO.   (1)

[10]

QUESTION 5

5.1 A submarine can use the Doppler effect to detect the speed of the ship. A submarine at rest and just below the surface of the water, detects the frequency of a moving ship as 437 Hz, which is 0,985 times the actual frequency of the sound emitted by the ship. The speed of sound in water is 1 470 m·s^{-1}.

    5.1.1 State Doppler effect in words. (2)

    5.1.2 Is the ship moving away from or towards the submarine? Give a reason for your answer. (2)

    5.1.3 Calculate the speed of the ship. (5)

5.2 Light emitted from distant stars demonstrates the phenomenon known as red shift.

Explain how the phenomenon known as red shift can be used to explain an expanding universe. (2)

5.3 Absorption spectra from the Sun and another galaxy is shown below:

Study the atomic absorption spectra and answer the question that follows:

Spectrum from the Sun

Blue   Red

Spectrum from the other galaxy

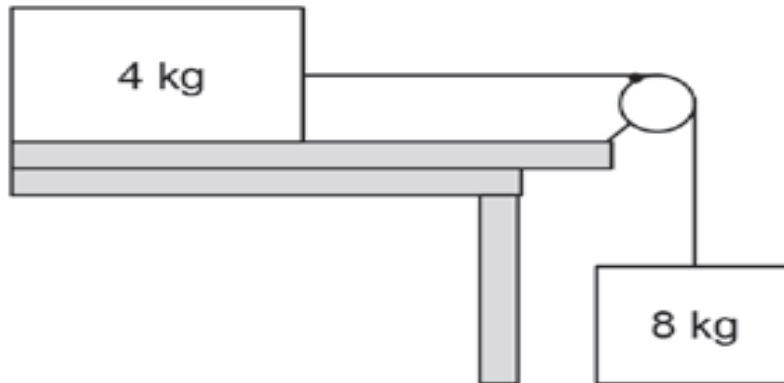Blue   Red

Does the spectrum of the other galaxy constitute a RED SHIFT or BLUE SHIFT? (1)

[12]

QUESTION 6

A 4 kg block on a horizontal, rough surface is connected to an 8 kg block by a light, inelastic string that passes over a frictionless pulley as shown below. The coefficient of kinetic friction between the block of 4 kg and the surface is 0,6.

6.1   Draw a free-body diagram showing the forces acting horizontally on the 4 kg block.   (2)

6.2   Calculate the acceleration of the system.   (7)

6.3   Calculate the magnitude of the tension in the string.   (3)

6.4   Calculate the magnitude of the frictional force that acts on the 4 kg block.   (4)

[16]

QUESTION 7

Collisions between vehicles take place on the roads in our country daily. In one of these collisions, a car of mass 1 650 kg, travelling at a velocity of 25 m·s^{-1} to the left, collides head-on with a minibus of mass 3 050 kg, travelling at 15 m·s^{-1} to the right. The two vehicles move together as unit in a straight line after collision.


7.1   Calculate the velocity of the two vehicles after the collision.   (5)

7.2   Prove by means of calculations that the collision was inelastic.   (9)

7.3   New cars have crumple zones to help minimise injuries during accidents. Airbags and padded interiors can also help to reduce the chances of fatal injury or serious injury. Use a principle in Physics to explain how **crumple zones** can reduce the chances of fatal or serious injury.   (3)

[17]

QUESTION 8

The diagram below shows a spaceship, with a mass of 3 500 kg, travelling in the vacuum of space in an orbit around the earth, with a mass of $5,98 \times 10^{24}$ kg at a constant speed. There is a distance of $8,53 \times 10^6$ m between the earth and the spaceship centres.
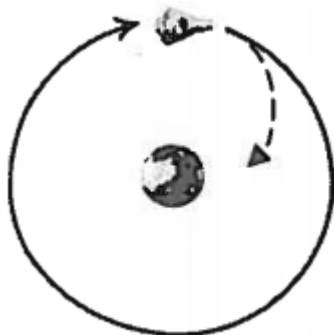

8.1   Define the Newton's law of Universal Gravitation.   (2)

8.2   Calculate the gravitational force that the earth exerts on the spaceship.   (4)

8.3   How does the force exerted by the spaceship on the earth compare to the force calculated in QUESTION 8.2 above?

        Write ONLY **greater than**, **smaller than** or **equal to**.   (1)

8.4   Name and state the Newton's Law of motion used to make a choice in QUESTION 8.3 above.   (3)

8.5   Due to the change in the distance between the earth and the spaceship centres, the force increased by a factor of 4. Calculate the new distance between the earth and the spaceship centres.   (4)

[14]

QUESTION 9

Two identical objects P and Q with a mass of 10 kg each, are moving side by side with an initial velocity of 5,5 m·s⁻¹ east on a horizontal surface. The following graphs show the net force experienced by each object respectively during the same time interval.
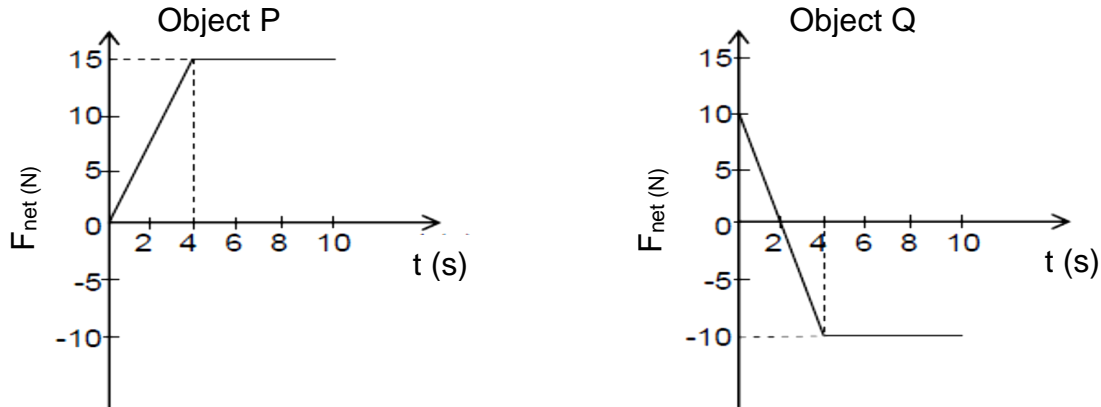
9.1   Calculate the total impulse experienced by object Q in 10 s.   (5)

9.2   Compare without using any calculations the total impulse for object P with that of object Q. Write down only GREATER THAN, LESS THAN or EQUAL TO.   (2)

9.3   Calculate the final velocity of object Q.   (4)

                                                     [11]

QUESTION 10

Two point charges of magnitudes +4 nC and -6 nC are placed at points A and C respectively. These charges are respectively 20 mm and 25 mm away from point R as shown in the diagram below:
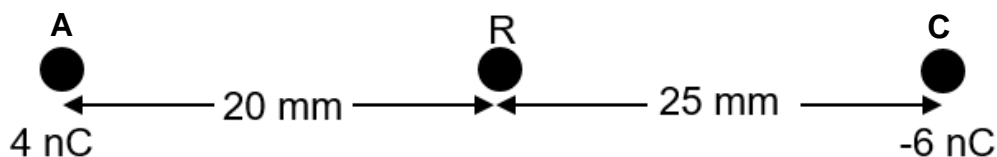
10.1   Draw the electric field pattern formed between the two point charges (A and C).   (3)

10.2   Calculate the net electric field at R due to the two point charges.   (7)

10.3   If the distance between the two charges (A and C) is reduced by 15 mm, calculate the electrostatic force that charge A exerts on charge C.   (5)

                                                     [15]

                                                   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	$9,8 \text{ m·s}^{-2}$
Universal gravitational constant *Universele gravitasie konstante*	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 elektron*	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	$6,38 \times 10^3 \text{ km}$

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*

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

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

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

$f_L = \dfrac{v \pm v_L}{v \pm v_s} f_s$ or/*of* $f_L = \dfrac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ $E = h\dfrac{c}{\lambda}$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \dfrac{kQ_1Q_2}{r^2}$	$E = \dfrac{kQ}{r^2}$
$E = \dfrac{F}{q}$	$V = \dfrac{W}{q}$
$n = \dfrac{Q}{e}$ or/of $n = \dfrac{Q}{q_e}$	