education

Department:
Education
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

PROVINCIAL ASSESSMENT

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)
JUNE 2024

MARKS: 150

TIME: 3 hours

This question paper consists of 16 pages and 3 data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your name on the ANSWER BOOK.

2. This question paper consists of 10 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 open between two subquestions, e.g. 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, etc. where required.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g.1.11 E.

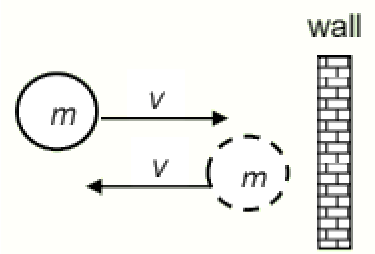
1.1 Inertia is a property of an object whereby the object …

A has kinetic energy.
B is not able to move.
C needs a force to accelerate.
D comes to rest when the force that has set it in motion is removed. (2)

1.2 A satellite orbits Earth at a height where it experiences a gravitational force four times less than that on the surface of the Earth. If Earth's radius is R, then the height of the satellite above Earth's surface is …

A 4R.
B 3R.
C 2R.
D R. (2)

1.3 A ball of mass m strikes a wall perpendicularly at a speed v. The ball bounces back with the same speed v, as shown in the diagram below.



The magnitude of the change in momentum of the ball is …

A 0.
B mv.
C 2mv.
D 3mv. (2)

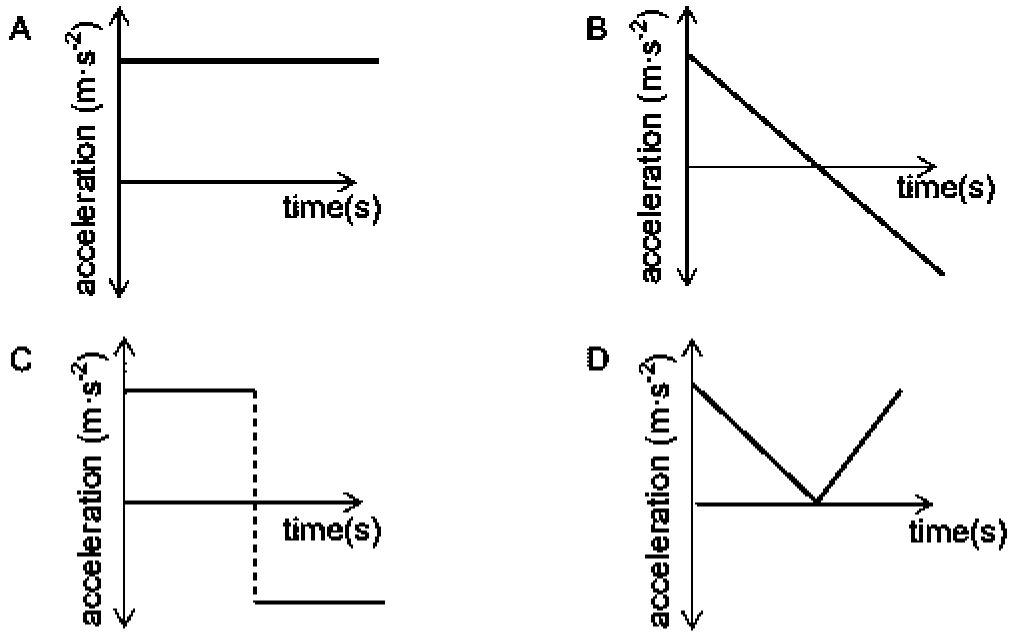
1.4 The same force of magnitude F, is applied to trolley **A** and **B** respectively, as shown in the sketch below.

The mass of trolley **A** is twice that of trolley **B** and the trolleys are on the same frictionless surface. If the rate of change in momentum of trolley **A** is “x”, then the rate of change of momentum of trolley **B** will be:

A 4x
B 2x
C x
D ½x (2)

1.5 A stone is thrown vertically upwards and returns to the thrower's hand after a while. Which ONE of the following acceleration-versus-time graphs best represents the complete motion of the stone?

Ignore the effects of air resistance.



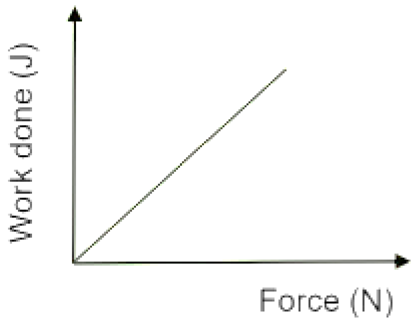
(2)

1.6 Which ONE of the following is an example of *conservative force*?

A Gravitational force
B Tension in a cord
C Frictional force
D Normal force (2)

1.7 A horizontal force F_A is applied on an object placed on a smooth surface as shown below.

The graph below represents the relationship between the applied force and the work done on the object.



The gradient of the graph represents the …

A time taken by the object.
B distance moved by the object.
C velocity of the object.
D acceleration of the object. (2)

1.8 A sound source approaches a stationary observer at constant velocity. Which ONE of the following describes how the observed frequency and wavelength differ from that of the sound source?

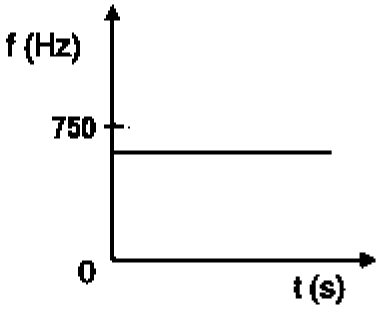
	Observed frequency	Observed wavelength
A	Greater than	Greater than
B	Less than	Less than
C	Greater than	Less than
D	Less than	Greater than

(2)

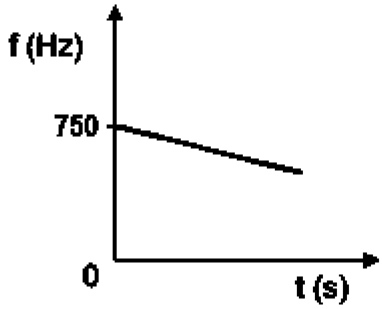
1.9 A police car approaches an accident scene at a constant speed of 80 $km.h^{-1}$. The siren of the police car emits sound waves at a frequency of 750 Hz. A stationary detector at the scene measures the frequency of the emitted sound waves.

Which ONE of the following frequency-time graphs shows the frequency measured by the detector?

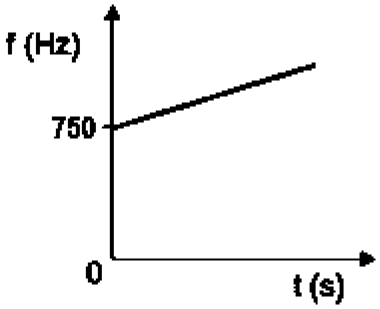
A



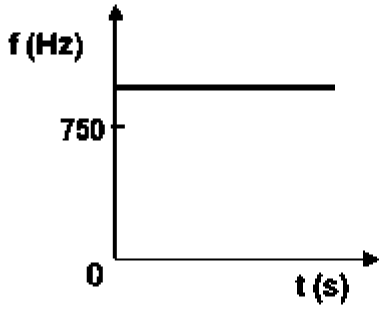
B



C



D

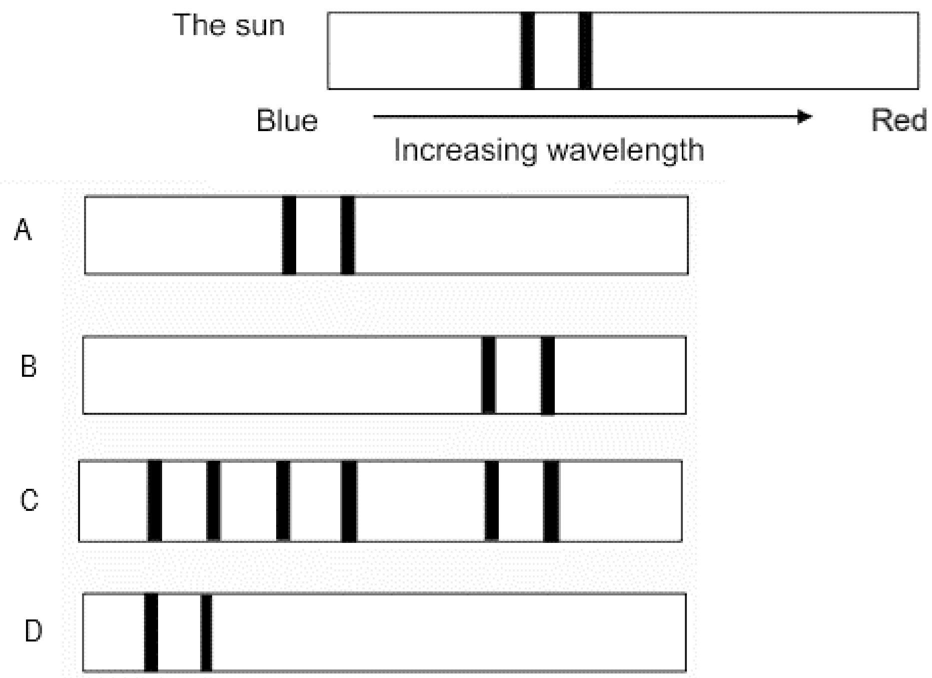


(2)

1.10 Scientists can use the absorption spectrum from distant stars to determine whether the stars are moving towards the Earth or away from the Earth.

The diagrams below show the absorption spectrum of a gas from the sun and from four other stars, **A**, **B**, **C** and **D** as observed from the Earth.

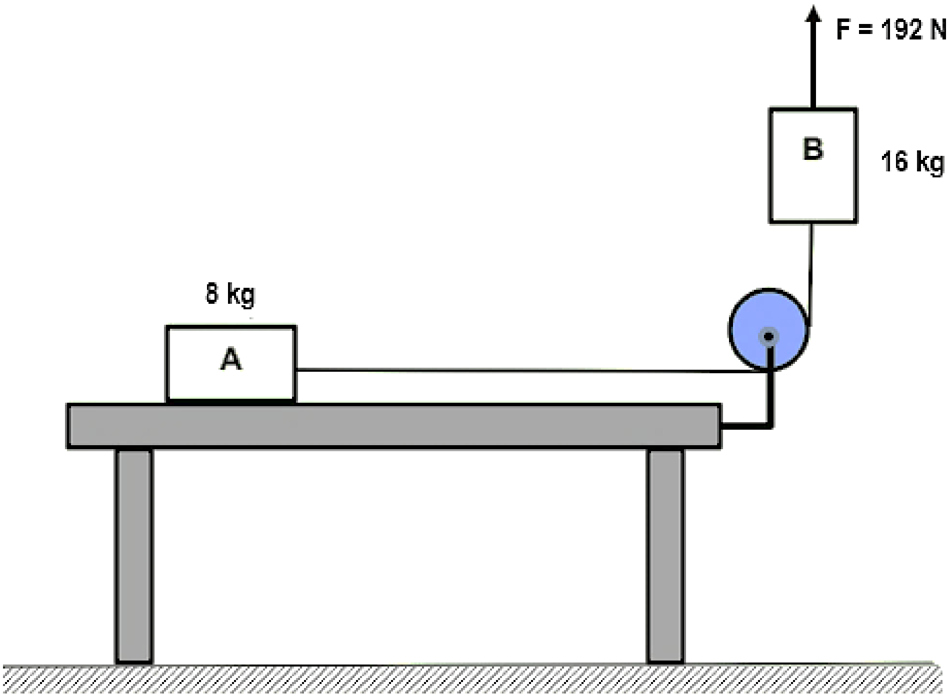
Which star, **A**, **B**, **C** or **D** is moving away from the Earth?



(2)
[20]

QUESTION 2 (Start on a new page)

A block **A** of mass 8 kg, resting on a rough horizontal table, is connected to another block **B** of mass 16 kg by a light inextensible string which passes over a light frictionless pulley. A force of magnitude 192 N is applied vertically upwards on block **B**,as shown in the diagram below.



The kinetic frictional force acting on block **A** is 23,52 N. Ignore the effects of air friction.

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

2.2 Draw a labelled free-body diagram for block **A**. (4)

2.3 Calculate the magnitude of the:

2.3.1 Normal force acting on block **A** (3)

2.3.2 Tension force acting on block **A** (5)

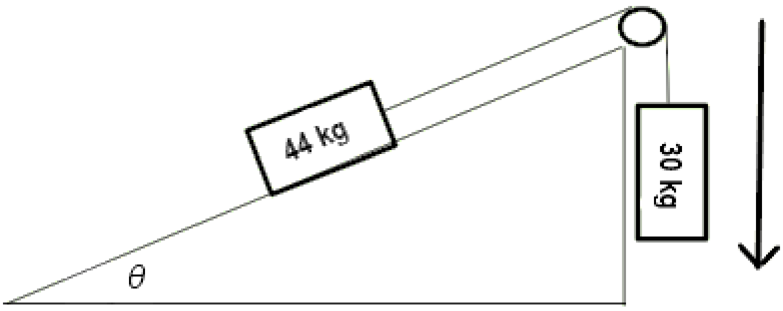
The string connecting **A** and **B** suddenly breaks while force F is still being applied.

2.4 Is the direction of the acceleration of block **A** now towards LEFT or RIGHT? Explain your answer. (2)

2.5 How will the net force acting on the block **B** be affected. Choose from INCREASES, DECREASES or REMAINS THE SAME. (1)
[17]

QUESTION 3 (Start on a new page)

A block of mass 44 kg is placed on a rough inclined surface and is connected to a 30 kg block which hangs vertically by means of a light inextensible string passing over a frictionless pulley, as shown in the diagram below. When the inclined surface is at an angle θ to the horizontal, the 30 kg block moves downwards (as shown by the arrow alongside the diagram) at a CONSTANT VELOCITY.



3.1 Define *normal force*. (2)

3.2 Draw a labelled force diagram of all the forces acting on the 44 kg block. (4)

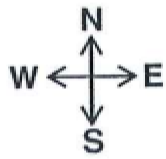
3.3 A constant frictional force of 87,72 N acts on the 44 kg block. Calculate the tension in the string that keeps this system moving at a CONSTANT VELOCITY. (3)

3.4 Calculate the magnitude of the angle θ that will keep the system moving at a CONSTANT VELOCITY. (2)

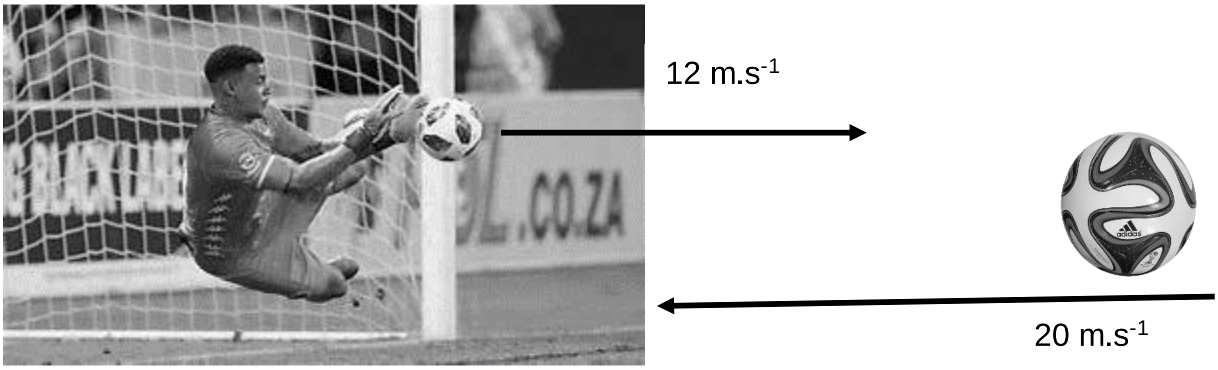
[11]

QUESTION 4 (Start on a new page)

During the African Cup of Nations (AFCON), a standard soccer ball, of mass 0,41 kg, was kicked at a velocity of 15 $m.s^{-1}$ west. Ronwen Williams, South African captain and star goalkeeper with mass 79 kg, moves at a velocity of 8 $m.s^{-1}$ south and deflects the ball after contact at a velocity of 12 $m.s^{-1}$ east. The ball was in contact with Ronwen's gloves for 2 s.



Ignore the effects of friction.



4.1 State Newton's Second Law of motion in terms of momentum. (2)

4.2 Calculate the magnitude and direction of:

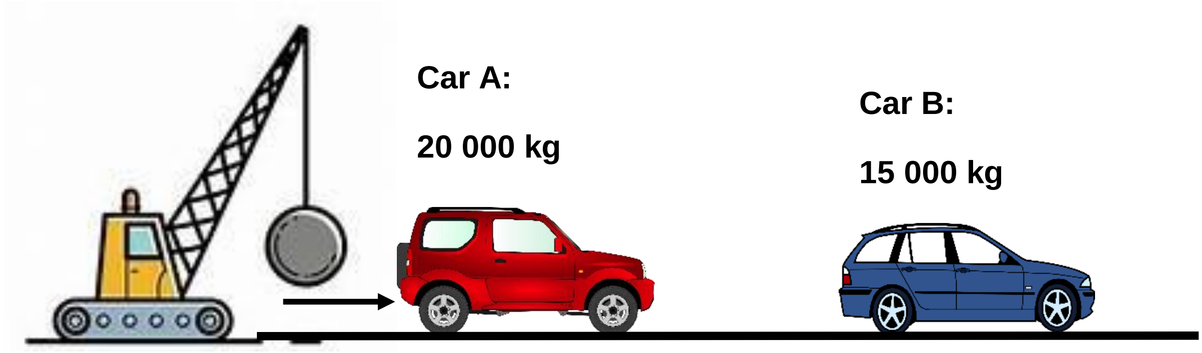
4.2.1 Ronwen's velocity after the collision (4)

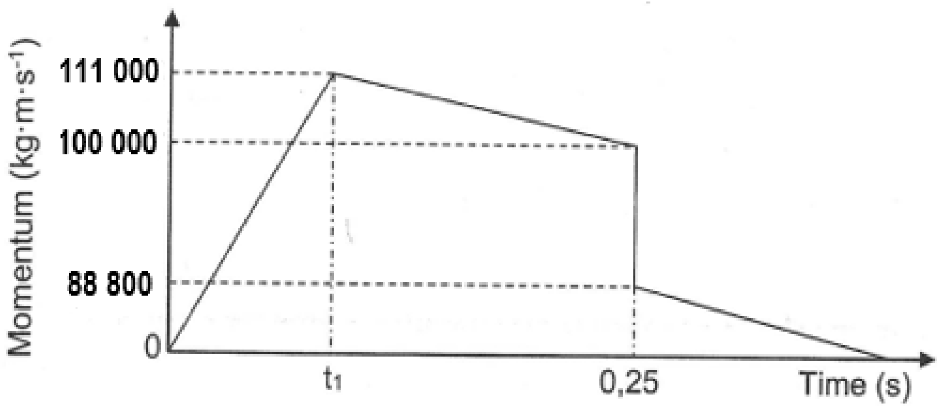
4.2.2 Average net force exerted by Ronwen on the soccer ball (3)

4.2.3 Average net force exerted by the soccer ball on Ronwen (1)
[10]

QUESTION 5 (Start on a new page)

A wrecking ball strikes a car **A** of mass 20 000 kg, as shown in the diagram below. Car **A** moves across the road and collides with car **B** of mass 15 000 kg.





The momentum versus time sketch graph is drawn, as shown above, for car **A**. From the moment it is struck by the wrecking ball (t = 0 s), as it leaves the wrecking ball (t = t_1) and as it collides with car **B** (t = 0,25 s).

5.1 State the principle of conservation of linear momentum. (2)

5.2 Use the information on the graph to:

5.2.1 Calculate the value of the time t_1 if the force exerted by the wrecking ball is 7,4 x 10^5 N. (4)

5.2.2 Explain why we can assume that the road surface was rough. (2)

5.2.3 Calculate the velocity of car **B** immediately after the collision. (4)

5.3 Crumple zones serves as a safety feature during collisions.

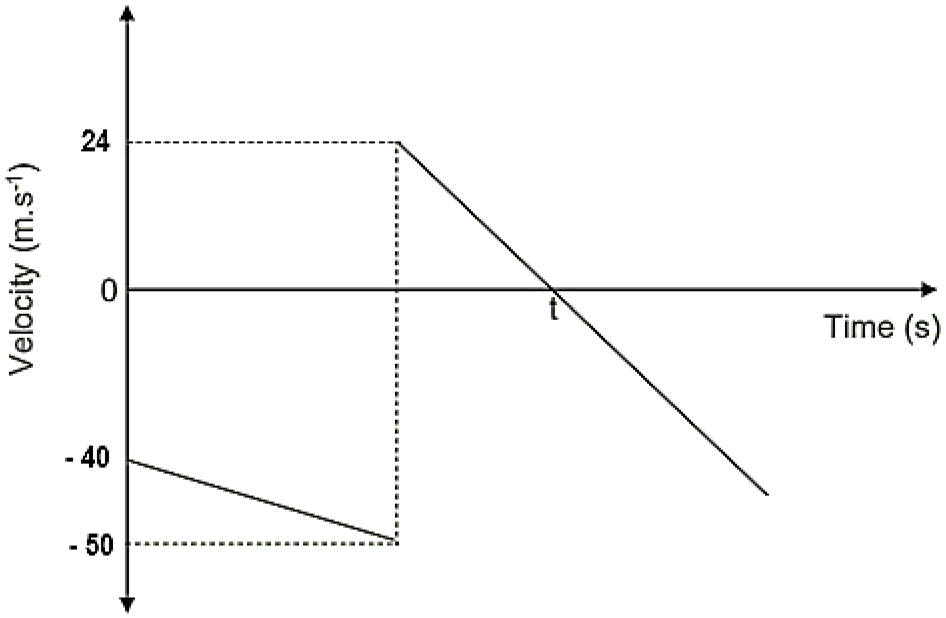
Use the relevant laws of physics to explain the purpose of crumple zones in cars. (3)
[15]

QUESTION 6 (start on a new page)

The velocity versus time graph below shows the motion of a ball thrown vertically downwards from the top of a building and bouncing off the floor as it hits the ground.

Ignore the effects of air friction.

UPWARD MOTION IS TAKEN AS POSITIVE.



6.1 Define the term *projectile*. (2)

6.2 Using EQUATIONS OF MOTION ONLY, calculate the:

6.2.1 Height from which the ball is thrown (3)

6.2.2 Time t on the graph (4)

6.2.3 Magnitude of the displacement of the ball from the moment it is thrown until time t (3)

6.3 Sketch a position versus time graph for the motion of the ball from the moment it is thrown until it reaches its maximum height after the bounce.

USE THE GROUND AS THE ZERO POSITION.

Indicate the following on the graph:

- The height from which the ball is thrown
- Time t (3)

[15]

QUESTION 7 (Start on a new page)

A drone is ascending vertically at a constant speed of 16 $m{\cdot}s^{-1}$. When reaching a height of 25 m above the ground, a package is dropped.The package undergoes <u>motion under the influence of gravitational force only</u>.

Ignore the effects of air resistance.

7.1 Give ONE word for the underlined phrase in the scenario above. (1)

7.2 Name and define in words the law that explains why the package first moves upwards immediately after it is dropped. (3)

7.3 Calculate:

7.3.1 The maximum height above the earth reached by the package (4)

7.3.2 The height above the ground when the package was in the air for 3,5 s after it was dropped (5)

7.3.3 The time it takes the package to reach the ground (4)

7.4 Draw the velocity-time graph for the motion of the package from the moment it is dropped, till it reaches the ground. Use the ground as a ZERO position.

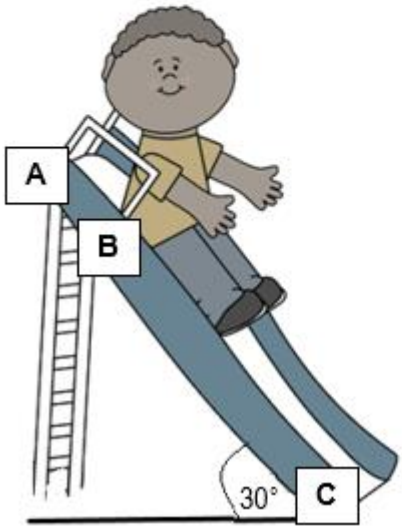
Indicate:

- The initial velocity of the package.
- The time the package strikes the ground. (3)

[20]

QUESTION 8 (Start on a new page)

Thabo of mass 70 kg slides down a playground slide that makes an angle of 30˚ with the horizontal. When he reaches point **B**, he is a height of 2,8 m above the ground and has a speed of 0,35 m.s^{-1}.



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

A constant frictional force acts on Thabo as he moves down the slide.

8.2 Name a non-conservative force acting on Thabo. (1)

The coefficient of kinetic friction of the surface of the slide is 0,112.

8.3 Calculate the frictional force that Thabo experiences as he slides down the slide from point **B** to **C**. (3)

8.4 Using ONLY ENERGY PRINCIPLES, calculate the velocity of Thabo at the lowest point of the slide (point **C**). (5)

8.5 If the angle between the horizontal and the slide is increased.
How will the change influence the frictional force acting on Thabo?

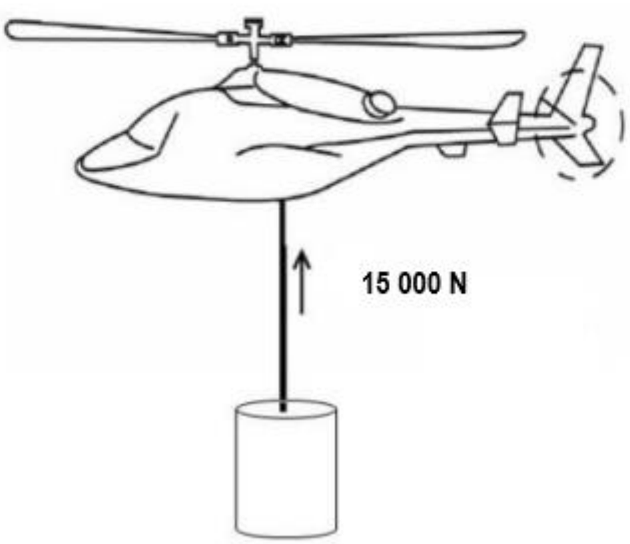
Write only INCREASES, DECREASES or STAYS THE SAME.

Explain the answer. (3)
[14]

QUESTION 9 (Start on a new page)

In order to extinguish a large veld fire, a large bucket of mass 100 kg is filled with 2 400 kg of water. It is lifted vertically upwards by a helicopter, through a height of 50 m, at CONSTANT SPEED of 2 $m \cdot s^{-1}$. The tension in the cable is 15 000 N.

Assume there is no sideways movement.



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

9.2 Draw a labelled free-body diagram showing ALL the forces acting on the bucket, while being lifted upwards. (3)

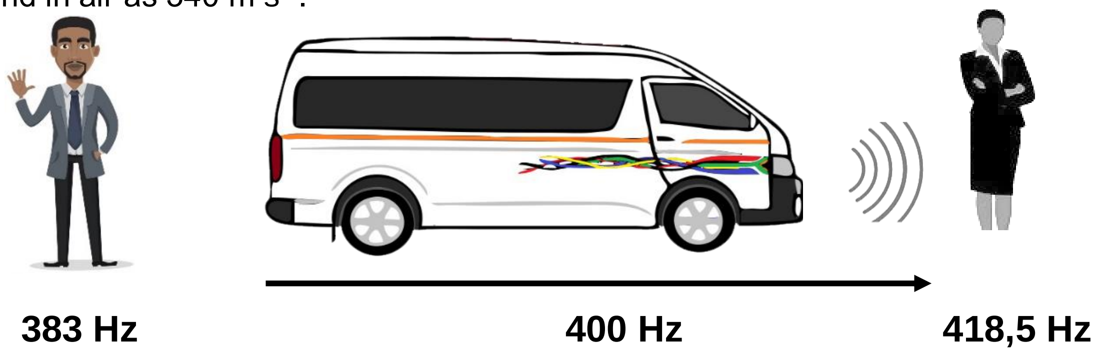
9.3 Use energy principles ONLY to calculate the work done by air friction on the bucket of water after moving through a height of 50 m. (5)

9.4 If it takes 30 minutes to get to the fire, calculate the amount of power expended by air friction on the bucket of water after moving through a height of 50 m. (3)

[13]

QUESTION 10 (Start on a new page)

A taxi driver presses his hooter, the taxi is moving at a constant speed and emits a sound wave of 400 Hz. A man that stands on the side of the road hears a sound of frequency 383 Hz when the taxi moves away from him. A girl that stands further away detects a sound of frequency 418,5 Hz when the taxi approaches her.Use the speed of sound in air as 340 m·s^{-1}.



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

10.2 Will the frequency detected by the driver of the taxi be GREATER THAN, EQUAL TO or SMALLER THAN 400 Hz? Give a reason for the answer. (2)

10.3 Calculate the speed of the taxi. (5)

10.4 Write down TWO applications of Doppler Effect in medicine. (2)

A helium line from the spectrum of the sun has a frequency of 6,20 x 10^{14} Hz.
The frequencies of the same helium line from the Earth, which are observed in the line emission spectrum of two stars, are:

Star **X**: 6,24 x 10^{14} Hz
Star **Y**: 6,04 x 10^{14} Hz

10.5 Name the phenomenon that is observed. (1)

10.6 Choose the diagram that best fits Star **Y** and explain your answer.

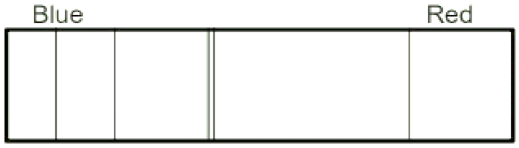


DIAGRAM 1

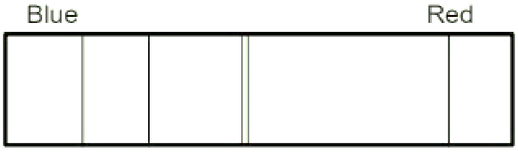


DIAGRAM 2

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

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

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

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

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

ALTERNATING CURRENT/*WISSELSTROOM*

$I_{rms}=\frac{I_{max}}{\sqrt{2}}$ / $I_{wgk}=\frac{I_{maks}}{\sqrt{2}}$ $V_{rms}=\frac{V_{max}}{\sqrt{2}}$ / $V_{wgk}=\frac{V_{maks}}{\sqrt{2}}$	$P_{ave}=V_{rms}I_{rms}$ / $P_{gemiddeld}=V_{wgk}I_{wgk}$ $P_{ave}=I_{rms}^2R$ / $P_{gemiddeld}=I_{wgk}^2R$ $P_{ave}=\frac{V_{rms}^2}{R}$ / $P_{gemiddeld}=\frac{V_{wgk}^2}{R}$