Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2014

PHYSICAL SCIENCES P1

MARKS: **150**

TIME: **3 hours**

PHSCE1

This question paper consists of 17 pages including a 3 page data sheet.

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space 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 questions correctly according to the numbering system used in this question paper.
6. You are advised to use the attached DATA SHEETS.
7. The formulae and substitutions must be shown in ALL calculations.
8. Give brief motivations, discussions, etc. 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. Give brief motivations, discussions, etc. where required.

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 write down **A**, **B**, **C** or **D** next to the question number (1.1–1.10) on your ANSWER BOOK.

1.1 A builder throws a brick vertically upwards with an initial velocity of 7,35 m•s^{-1}. When the brick reaches its maximum height, then the …

A acceleration of the brick is 7,35 m•s^{-2} and its potential energy is a maximum.

B velocity of the brick is 0 m•s^{-1} and its potential energy is a minimum.

C velocity of the brick is 9,8 m•s^{-1} and its potential energy is a maximum.

D acceleration of the brick is 9,8 m•s^{-2} and its kinetic energy is a minimum. (2)

1.2 A vehicle with mass *m* is moving horizontally at a constant velocity on a frictionless path. The kinetic energy of the vehicle is K and the momentum is p. The velocity of the vehicle can be given as:

A $\frac{K}{2p}$

B $\frac{2K}{p}$

C $\frac{K}{P}$

D $\frac{p}{K}$ (2)

1.3 When an airbag inflates in a car during a collision, the chances of serious injury to a passenger is reduced because the …

A passenger is brought to rest in a shorter period of time.

B net force acting on the passenger is reduced.

C passenger's change in momentum is reduced.

D passenger's change in momentum is increased. (2)

1.4 A spaceship experiences a weight of X on earth. It is sent into space and lands on a planet which has a mass twice that of the earth and a radius ½ that of the earth. The weight of the spaceship will be ...

A 8X

B ½X

C X

D ¼X (2)

1.5 Astronomers observe that the emitted light of a star shifts to the red part of the visible spectrum. The observation confirms that the ...

A star is moving closer towards earth.

B earth is moving towards the star.

C temperature of earth is increasing.

D universe is expanding. (2)

1.6 A girl stands next to the road as a fire engine approaches her with its sirens blaring and the red flashlights on. She makes the following observations:

	Frequency of sound heard	**Colour of flashlight**
A	Higher	Red
B	Lower	Red
C	Higher	Orange
D	Lower	Orange

(2)

1.7 Which statement below is CORRECT for resistors connected in parallel in a circuit?

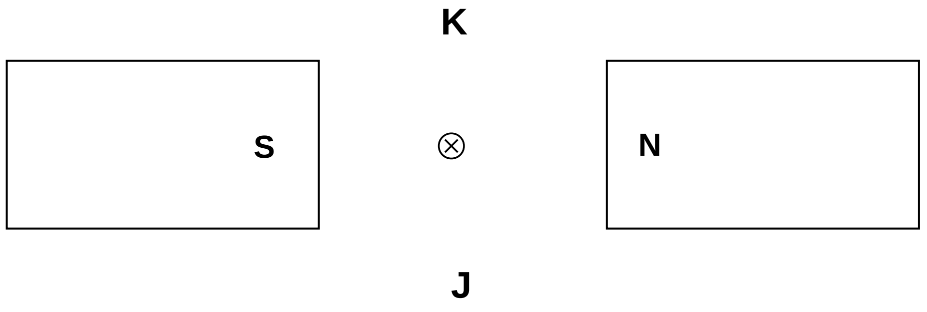
A The voltage (V) across the combination is divided but the resistors each have the same current (I).

B The current (I) across the combination is divided but the resistors each have the same voltage (V).

C The current (I) and the voltage (V) across the combination is divided.

D The current (I) and the voltage (V) across the combination is the same across each resistor. (2)

1.8 Two strong bar magnets are arranged with the north and south poles facing each other as shown in the diagram below. A current-carrying conductor placed between the two magnetic poles carries conventional current into the plane of the page.



The conductor would experience a force towards …

A N.

B S.

C K.

D J. (2)

1.9 If a light is passed through a cold, diluted gas, the atoms of the gas absorb photons at a certain …

A velocity and form an absorption spectrum.

B velocity and form a continuous spectrum.

C frequency and form an absorption spectrum.

D frequency and form a line emission spectrum. (2)

1.10 An atom in the ground state absorbs energy, E, and is excited to a higher energy state. When the atom returns to the ground state, a photon with energy …

A E is absorbed.

B E is released.

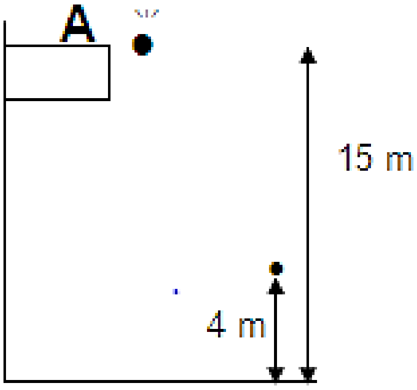
C ½E is absorbed.

D ½E is released. (2)

[20]

QUESTION 2 (Start on a new page.)

A cricket ball, mass 156 g, is dropped from point **A** on a tall building, 15 m high. It strikes the concrete pavement and it then bounces to a maximum height of 4 m.



2.1 Calculate the velocity with which the cricket ball strikes the pavement. (3)

2.2 If the effects of air friction are NOT ignored during the fall of the cricket ball, how would the value you calculated in QUESTION 2.1 change? Write down HIGHER, LOWER or STAYS THE SAME. (1)

2.3 The cricket ball is in contact with the concrete pavement of 0,8 s. Ignore the effects of air friction. Take DOWNWARD motion as POSITIVE.

2.3.1 Calculate the impulse of the cricket ball on the pavement. (8)

2.3.2 Calculate the (net) average force exerted by the pavement on the cricket ball. (4)

2.4 Sketch the **position versus time** graph for the motion of the cricket ball from the moment it is dropped until it reaches its maximum height after the bounce.

USE POINT **A** AS THE ZERO POSITION.

Indicate the following on the graph:

- The height from which the cricket ball is dropped
- The height reached by the cricket ball after the bounce
- Time with which the cricket ball is in contact with the concrete pavement (4)

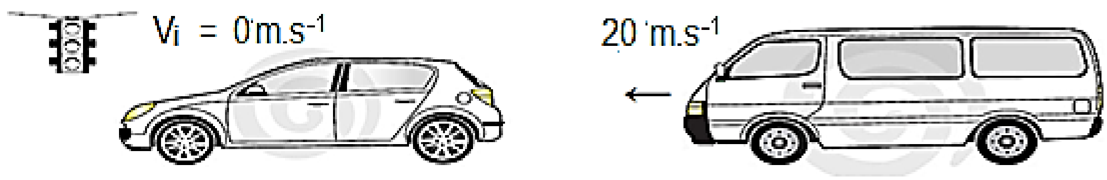
2.5 The cricket ball is now replaced with a softer ball of similar mass. State how the (net) average force exerted by the concrete pavement on the softer ball compares with your answer in QUESTION 2.3.2. (Write down only GREATER, SMALLER or STAYS THE SAME). Use physics principles to explain your answer. (3)

[23]

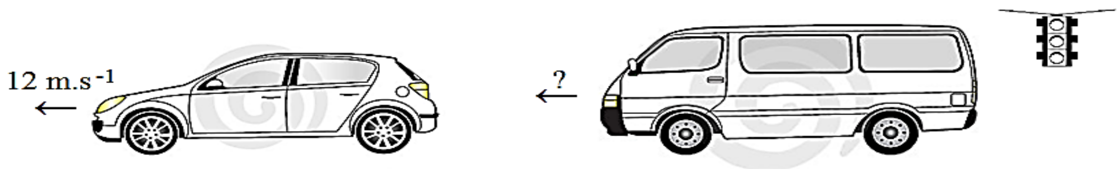
QUESTION 3 (Start on a new page.)

A car of mass 1 500 kg is stationary at a traffic light. It is hit from behind by a minibus of mass 2 000 kg travelling at a speed of 20 m•s^{-1}. Immediately after the collision the car moves forward at 12 m•s^{-1}.

BEFORE



AFTER



3.1 State the LAW OF CONSERVATION OF LINEAR MOMENTUM in words. (2)

3.2 Calculate the speed of the minibus immediately after the collision. (4)

3.3 The driver of the minibus is NOT wearing a seatbelt.

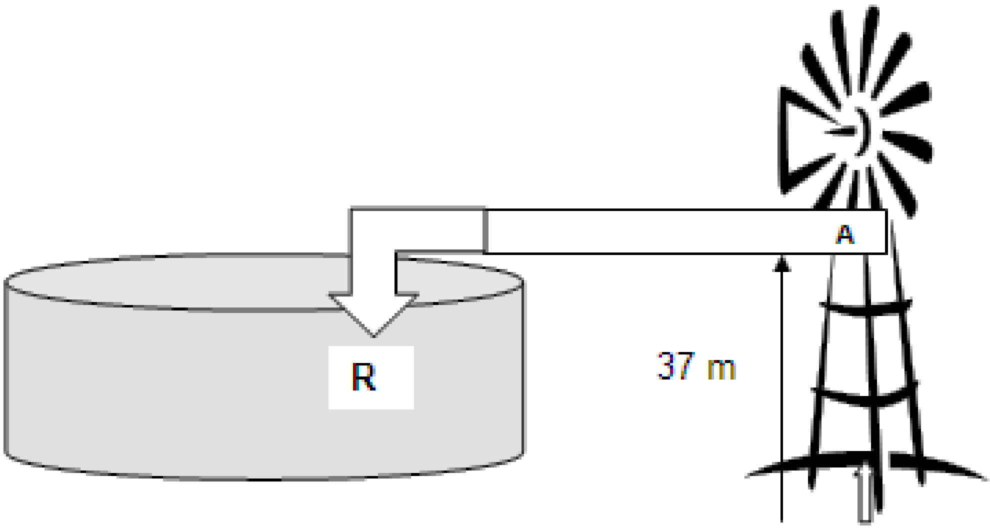
Describe the motion that the driver undergoes immediately after the collision. (1)

3.4 State the law of physics which can be used to explain your answer about the motion of the driver in QUESTION 3.3. (2)

[9]

QUESTION 4 (Start on a new page.)

A windmill is used on a farm to pump water out of a well that is 37 m deep. The water flows past point A, 37 m above the well to the dam with a constant velocity of 2 m•s^{-1}.



4.1 Calculate how much energy is necessary to pump 90 kg of water out of the well to point **A**. (4)

4.2 It is necessary to pump 90 kg of water per minute. What is the maximum power that the windmill must produce? (3)

4.3 The farmer wants to modernise the farm. The farmer decides to buy a 0,5 kW petrol water pump.

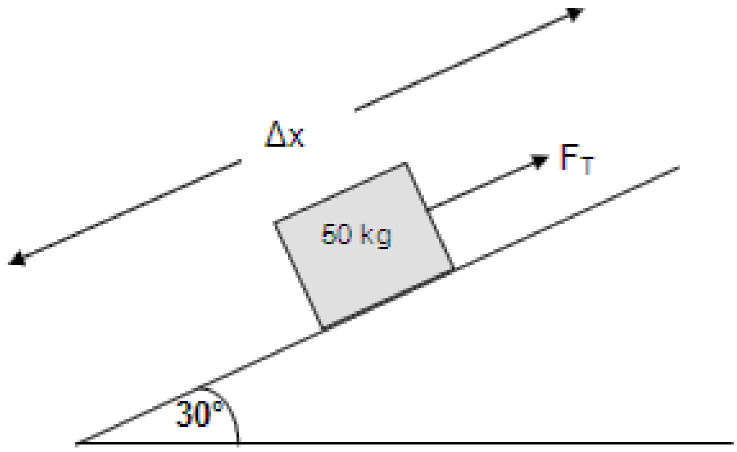
4.3.1 Will the petrol water pump be able to produce the required power? (YES or NO) (1)

4.3.2 Why would you advise the farmer to rather use a windmill instead of a petrol water pump? (1)

[9]

QUESTION 5 (Start on a new page.)

The diagram below shows a crate of mass 50 kg sliding down a steep slope. The slope makes an angle of 30° with the horizontal. The motion of the crate as it moves down the slope is controlled by a worker using a rope attached to the crate. The rope is held parallel to the slope. The tension in the rope, F_T, is 300 N and a constant frictional force of 50 N acts on the crate as it slides down the slope.



5.1 Draw a **labelled free-body diagram** showing the forces parallel to the slope acting on the crate as it moves down the slope. (3)

5.2 State the WORK-ENERGY THEOREM in words. (2)

5.3 The change in kinetic energy of the crate is 450 J as it slides from the top to the bottom of the slope.

Use the **work-energy theorem** to calculate the length of the slope, Δx. (5)

5.4 Calculate the coefficient of kinetic friction on the crate as it moves down the slope. (4)

[14]

QUESTION 6 (Start on a new page.)

An ambulance approaches an accident scene at a constant velocity. The siren of the ambulance emits sound waves with a constant, unknown frequency. A detector at the scene measures the frequency as 1,07 times the frequency of the siren.

6.1 State the DOPPLER EFFECT for sound in words. (2)

6.2 Calculate the speed at which the ambulance approaches the accident scene. Use the speed of sound in air as 340 $m{\bullet}s^{-1}$. (5)

6.3 Explain, in terms of wave motion, why the frequency detected by the detector is higher than the frequency of the source. (2)

6.4 State TWO uses of the Doppler flow meter in humans. (2)

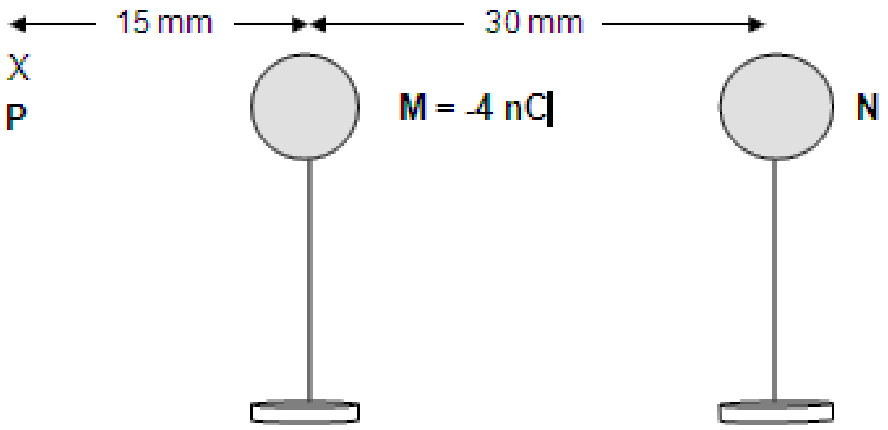
6.5 A line in a hydrogen spectrum has a frequency of $7,55 \times 10^{14}$ Hz when measured in a laboratory. The same line in the light of a star has a frequency of $7,23 \times 10^{14}$ Hz.

Is this star moving TOWARDS or AWAY from the Earth? Explain your answer. (2)

[13]

QUESTION 7 (Start on a new page.)

Two metal spheres, **M** and **N,** are on insulated stands. **M** with charge of -4 nC is placed 30 mm away from **N**. **P** is a point at a distance 15 mm from sphere **M** as shown below. The NET ELECTRIC FIELD STRENGTH at point **P** due to presence of **M** and **N** is 2×10^5 $N \cdot C^{-1}$ eastwards.



7.1 Define the term *ELECTRIC FIELD* at a point. (2)

7.2 Calculate the magnitude and direction of the electric field at point **P** due to the presence of sphere **M**. (5)

7.3 Calculate the magnitude of the charge on sphere **N**. (5)

7.4 Is the charge on sphere **N,** POSITIVE or NEGATIVE? (1)

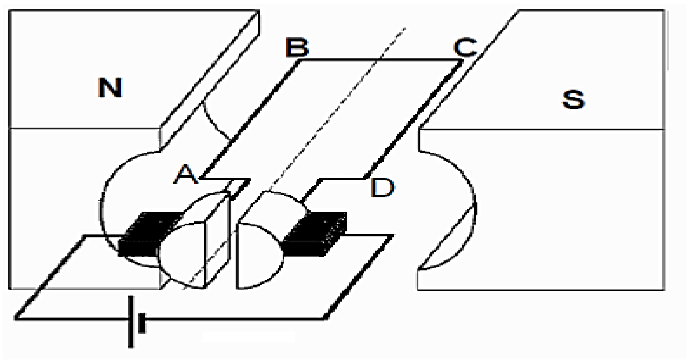
7.5 Sketch the net electric field pattern due to the two spheres, **M** and **N**. (3)

7.6 Calculate the magnitude of the electric force that an electron will experience when placed at point **P**. (3)

[19]

QUESTION 8 (Start on a new page.)

The simplified sketch below represents a DC motor.



8.1 Name the principle on which the motor operates. (1)

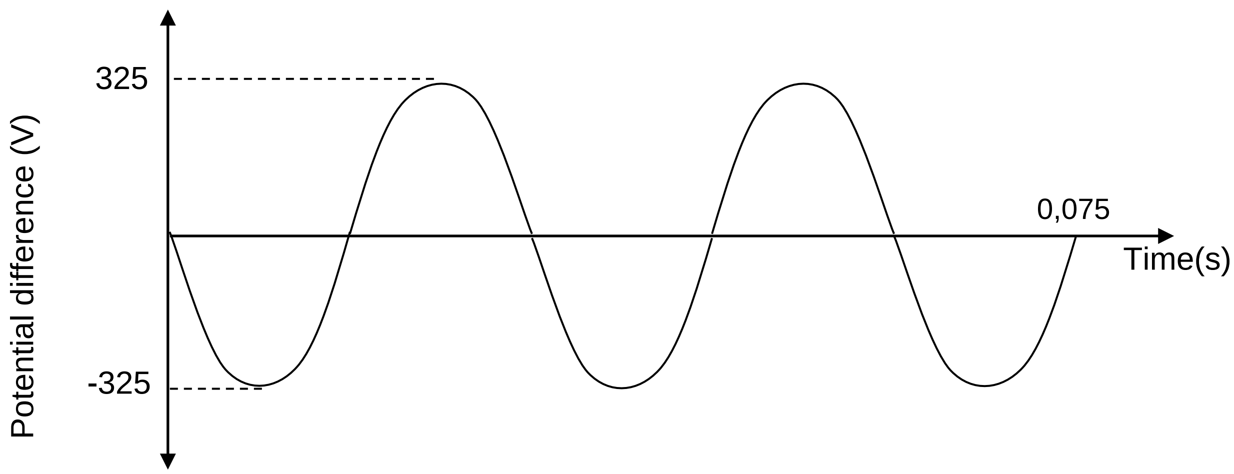
8.2 State the energy conversion which takes place in a DC motor. (1)

8.3 Give a reason why section BC in the above diagram does NOT experience a magnetic force whilst the coil is in the position as shown. (2)

8.4 In which direction will the coil rotate, CLOCKWISE or ANTI-CLOCKWISE? (1)

8.5 Write down ONE way in which the turning effect (torque) can be increased. (1)

8.6 The graph below shows how the alternating voltage, produced by the AC generator, varies with time.



8.6.1 Calculate the frequency of the alternating voltage. (3)

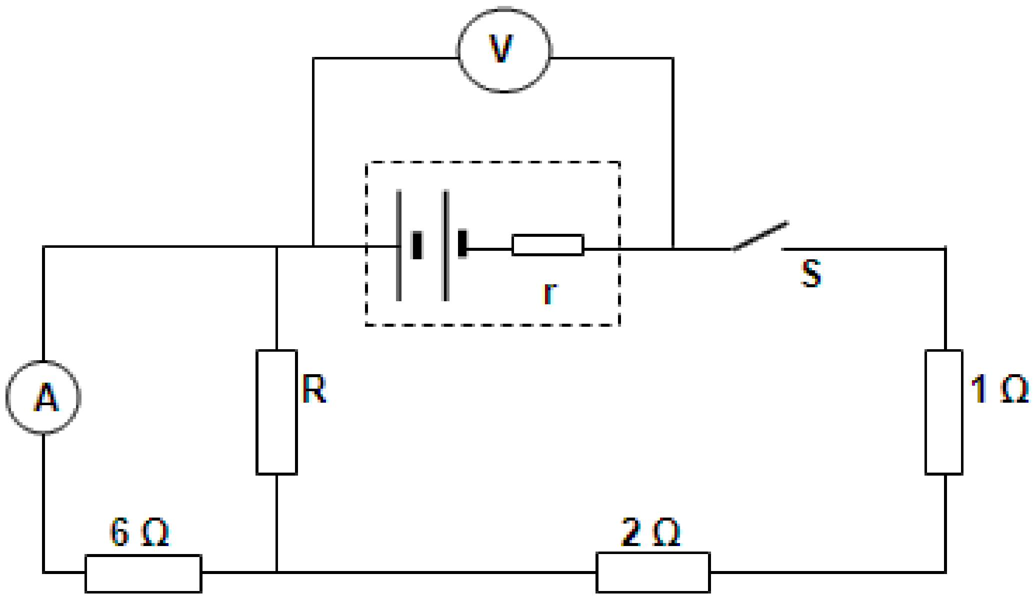
8.6.2 The generator's average power output is 2,7 kW. Calculate the maximum current that the generator produces. (5)

[14]

QUESTION 9 (Start on a new page.)

A learner wants to use a battery with an emf of 13 V to operate a walking doll. The battery has an unknown internal resistance of **r**. The walking doll has a resistance of 6 Ω. The learner uses the circuit below to obtain the potential difference required for the walking doll to function.

When switch **S** is closed, the reading on the voltmeter drops to 12 V and the walking doll functions at its maximum power of 6 W.



9.1 Explain briefly why the reading on the voltmeter drops when switch **S** is closed. (2)

9.2 Calculate the internal resistance, **r**, of the battery. Show all the steps in your calculations. (9)

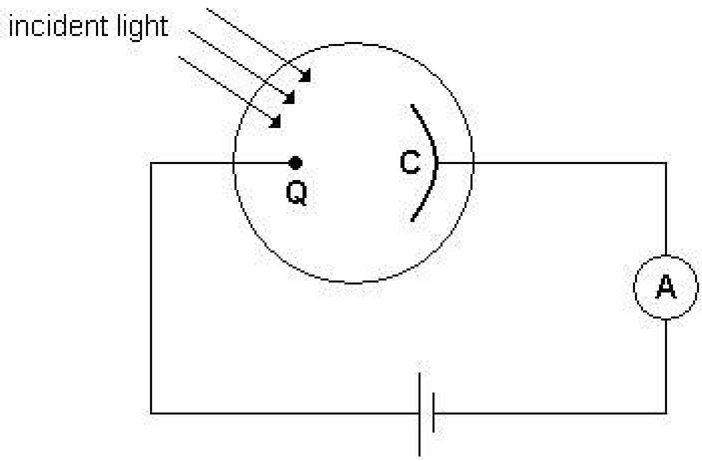
9.3 Calculate the magnitude of the unknown resistor, **R**. (3)

9.4 The resistor **R** is replaced with a conducting wire of negligible resistance. What effect will this have on the "lost volts"? Fully explain your answer. (4)

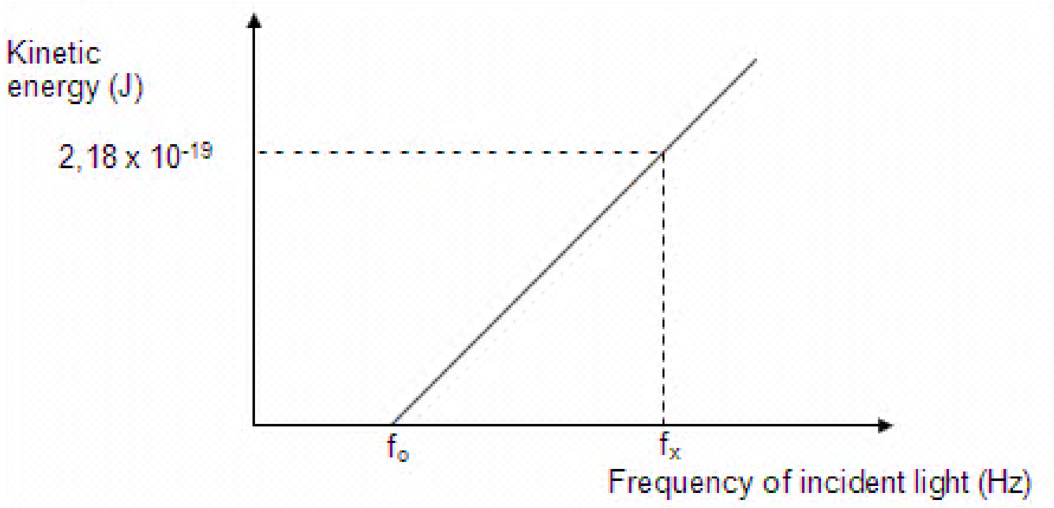
[18]

QUESTION 10 (Start on a new page.)

Learners in a physics class perform an experiment using a photo cell to investigate the relationship between photo electrons emitted and the frequency of the incident light.



A graph is plotted of the maximum kinetic energy (E_K) against the frequency of the incident light. When the straight line graph is extrapolated, it intercepts the x-axis at $f_o = 4,29 \times 10^{14}$ Hz.



10.1 Write an investigative question for this investigation. (2)

10.2 What is the frequency, f, in the graph called? (1)

10.3 Calculate the frequency, $f_{x,}$ in the graph. (5)

10.4 Draw a sketch-graph of the **kinetic energy** of the photo-electrons (on the y-axis) **versus** the **intensity** of the incident light. (No values needed on the graph.) (3)
[11]

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 *Universele gravitasiekonstant*	G	6,67 x 10^{-11} N•m^{2}•kg^{-2}
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^{8} m•s^{-1}
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} J•s
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^{9} N•m^{2}•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 earth *Massa op aarde*	M	5,98 x 10^{24} kg
Radius of earth *Radius van aarde*	R_E	6,38 x 10^{3} 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* $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_i + v_f}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_i + v_f}{2}\right)\Delta t$

FORCE/*KRAG*

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

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* $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ 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* $E = hf$ 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 (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*

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