



HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 1- Physics



SEPTEMBER 2014
TIME: 3 HRS

Total 150

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (20)
SECTION B (130)

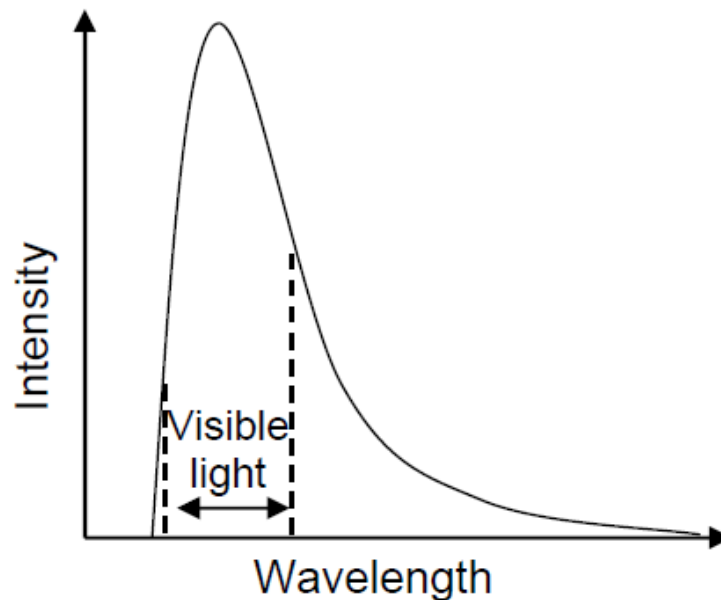
Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets and a periodic table are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places.

SECTION A

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) next to the question number (1.1 – 1.10) in the ANSWER BOOK.

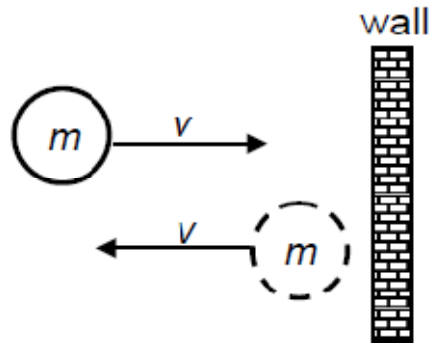
- 1.1 Sunlight is composed of various intensities of the different wavelengths of light. The graph below represents the relationship between the intensity and wavelength of sunlight. The region between the dashed lines indicates the range of wavelengths of the visible portion of the spectrum.



Which colour of the visible part of sunlight has the lowest intensity?

- A. Red
- B. Green
- C. Blue
- D. Violet

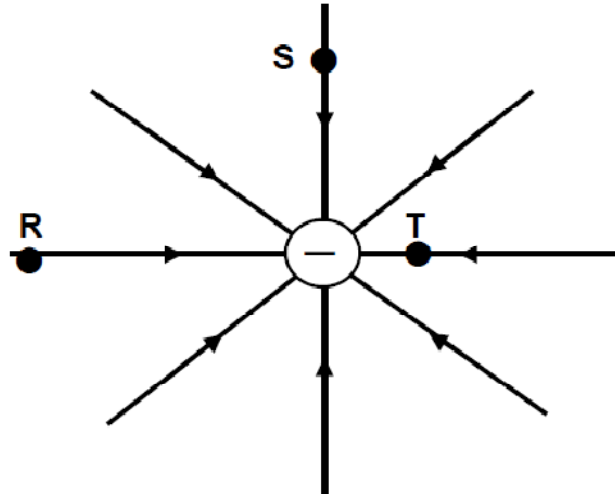
- 1.2 A ball of mass m strikes a wall perpendicularly at a speed v . Immediately after the collision the ball moves in the opposite direction at the same speed v , as shown in the diagram below.



Which ONE of the following represents the magnitude of the change in momentum of the ball?

- A. 0
 - B. mv
 - C. $2mv$
 - D. $3mv$
- 1.3 Which ONE of the following correctly represents the given types of electromagnetic radiation in order of **INCREASING WAVELENGTH**?
- A. Microwaves; infrared; ultraviolet
 - B. Infrared; ultraviolet; X-rays
 - C. Radio waves; infrared; gamma rays
 - D. Ultraviolet; infrared; microwaves

- 1.4 The diagram below represents the electric field pattern around a negative point charge. R, S and T are points at different distances from the negative point charge.



The magnitude of the electric field of the point charge is ...

- A. Greatest at point R
 - B. Greatest at point S
 - C. Greatest at point T
 - D. The same at points R, S and T.
- 1.5 A car of mass m moves along a straight line with a velocity of magnitude v . The driver sees an obstruction and immediately applies the brakes. The car stops uniformly in t seconds from the moment that the brakes are applied. The car does not hit the obstruction.



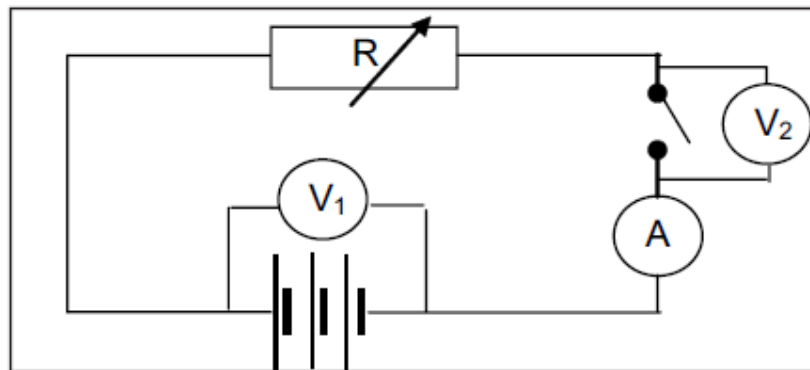
Which ONE of the following represents the MAGNITUDE of the average force exerted on the car during the braking period of t seconds?

- A. $\frac{mv}{t}$
- B. mv
- C. $\frac{v}{t}$
- D. mvt

- 1.6 The engine of a car does work, W , to increase the velocity of the car from 0 to v . The work done by the engine to increase the velocity from v to $2v$, is:
- A. $4W$
 - B. $3W$
 - C. $2W$
 - D. W

- 1.7 If a star gazer on earth noticed a red shift in the light emitted from a star, this would mean
- A. The star is moving away from earth
 - B. The star is moving toward the earth
 - C. The star is at rest
 - D. The earth is expanding

- 1.8 A variable resistor, an ammeter, a battery of emf 12 V and voltmeters V_1 and V_2 are connected as shown in the diagram below. When the switch is **open**, what are the readings on voltmeters V_1 and V_2 respectively?



- A. 12V and 12V
- B. 12V and 0V
- C. 0V and 12V
- D. 0V and 0V

1.9 Which colour has the lowest energy?

- A. red
- B. blue
- C. green
- D. yellow

1.10 The work function of Platinum is twice that of the work function of Calcium. If the minimum photon energy required to emit photoelectrons from the surface of Platinum is E , then that for the surface of Calcium would be

- A. $\frac{2E}{3}$
- B. $\frac{3E}{2}$
- C. $\frac{E}{2}$
- D. $2E$

[2 x 10 = 20]

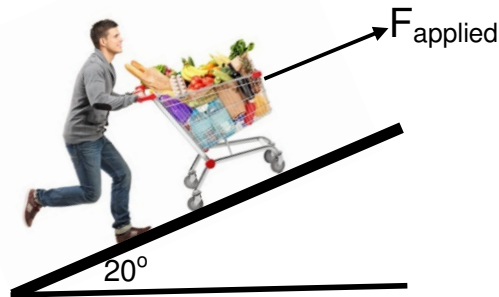
SECTION B

INSTRUCTIONS AND INFORMATION

1. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
2. Show the formulae and substitutions in ALL calculations.
3. Round off your numerical answers to **TWO** decimal places.

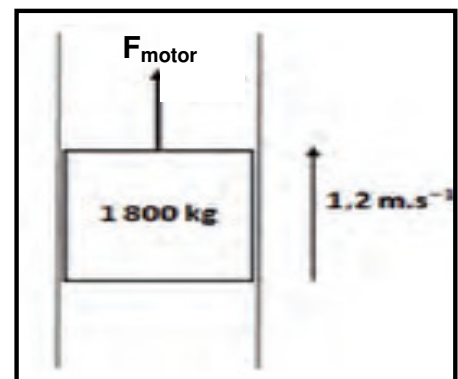
Question 2

- 2.1 State Newton's second law in words. (3)
- 2.2 At the supermarket there is a ramp for customers to push their trolleys so that they can get to their cars on the roof top parking. The average trolley has a mass of 20kg. The surface of the ramp has a coefficient of static friction of 0.7 and is inclined at 20° .



- 2.2.1 Draw a **labelled force diagram** of all the forces acting on the trolley. (3)
- 2.2.2 Calculate the **frictional force** experienced by the trolley when the trolley is stationary. (4)
- 2.2.3 Calculate the **minimum applied force** to move the trolley up the hill at a constant velocity. (5)
- 2.3 A lift with a total mass of 1800kg moves upwards with a constant speed of $1,2\text{m}\cdot\text{s}^{-1}$. The friction between the lift and the guide rails exert a constant force of 1050N on the movement.

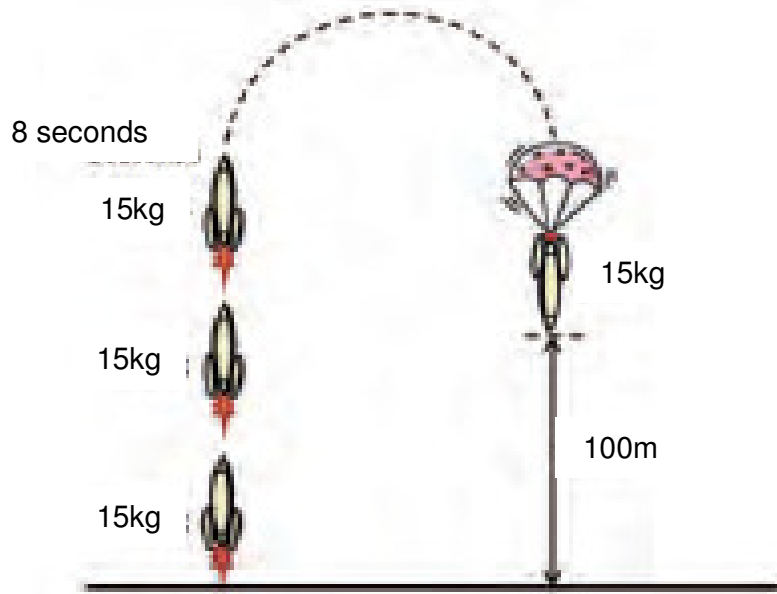
Calculate the **force of the motor** acting on the lift. (3)



[18]

Question 3

A rocket equipped with meteorological instruments is launched vertically upwards. The total mass of the rocket and instruments is 15kg. The jet engine of the rocket is able to produce power P Watts and it accelerates the rocket at a **constant acceleration** of $5\text{m}\cdot\text{s}^{-2}$ for 8 seconds at which time the fuel is finished. The rocket then **free falls** until it reaches a point exactly 100m above the ground when a parachute opens and the rocket falls with a velocity of $3\text{m}\cdot\text{s}^{-1}$ to the ground. **Ignore air resistance** for the motion of the rocket, **except for the last 100m** where the parachute is of course using air resistance to reduce the velocity to $3\text{m}\cdot\text{s}^{-1}$.



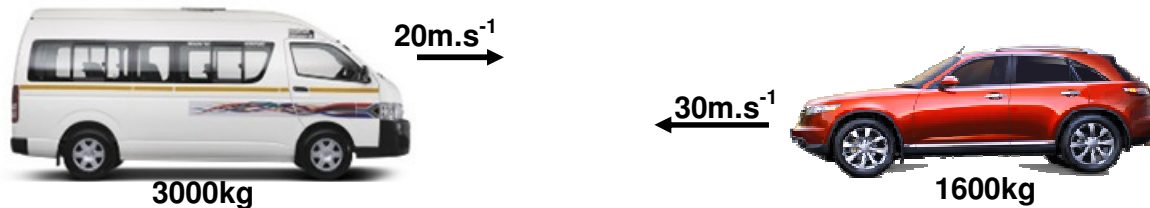
While the rocket was accelerating it reaches a height of 160m above the ground. The velocity of the rocket when the jet engine stopped working is $40\text{m}\cdot\text{s}^{-1}$ up.

- 3.1 Calculate the total time that the rocket was in the air from the launch until it landed on the ground? (7)
- 3.2 What was the velocity of the rocket at the moment the parachute was opened? (3)
- 3.3 Draw a velocity-time graph of the movement of the rocket from launch until it landed on the ground. (5)

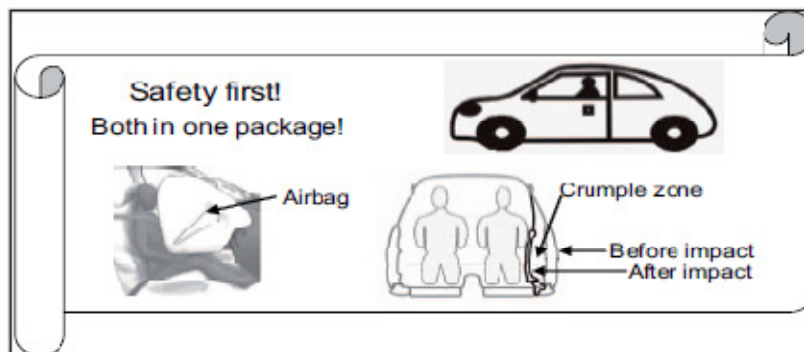
[15]

Question 4

The head on collision illustrated below takes place between a car of mass 1600kg travelling at a speed of $30\text{m}\cdot\text{s}^{-1}$ to the left and a minibus of mass 3000kg travelling at $20\text{m}\cdot\text{s}^{-1}$ to the right. The two vehicles move in a straight line as a single unit after the collision.



- 4.1 Calculate the velocity of the two vehicles after the collision. (4)
- 4.2 Using a calculation show that the collision was inelastic. (5)
- 4.3 The billboard advertises a car from a certain manufacturer.



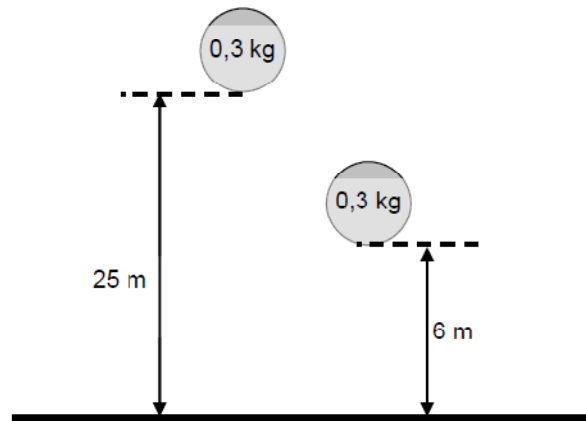
Use your knowledge of momentum and impulse to justify how the safety features mentioned in the advertisement contribute to the safety of the passengers.

(3)

[12]

Question 5

The roof of a tall building is 25m above the ground. A rigid ball of mass 0.3kg falls freely when dropped from the roof. It strikes the concrete floor on the ground with a velocity of $22.13\text{m}\cdot\text{s}^{-1}$. It bounces to a maximum vertical height of 6m. The ball was in contact with the floor for 0.9s. **Ignore the effects of friction.**

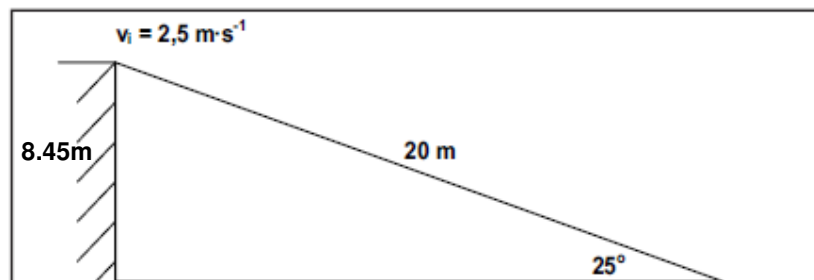


- 5.1 Calculate the impulse on the ball as a result of the collision. (5)
- 5.2 Using the ground as zero reference, draw a sketch graph of displacement vs time for the motion of the ball from its original height until it reaches its second maximum height. Indicate the relevant position values on the y-axis. Also indicate the time lapse of the ball making contact with the ground. (**HINT: represent the time the ball hits ground as x on the time axis**). (4)

[9]

Question 6

A person skis down a 20m long slope which makes an angle of 25° with the horizontal. The total mass of the skier and the skis is 50kg. There is a constant frictional force of 60N opposing the skier's motion. The speed of the skiers as she descends from the top of the slope is $2.5\text{m}\cdot\text{s}^{-1}$.



- 6.1 Calculate the magnitude of the net force parallel to the slope which is experienced by the person. (3)
- 6.2 Calculate the maximum speed of the skier at the bottom of the 20m slope. (5)

[8]

Question 7

The siren of a burglar alarm system has a frequency of 960Hz. During a patrol a security officer, travelling in his car, hears the siren of the alarm of a house and approaches the house at a constant velocity. A detector in his car registers the frequency of the sound as 1000Hz.

7.1 Name the phenomenon that explains the change in the observed frequency. (1)

7.2 Calculate the speed, in $\text{m}\cdot\text{s}^{-1}$, at which the patrol car approaches the house. Use the speed of sound in air as $340\text{m}\cdot\text{s}^{-1}$. (4)

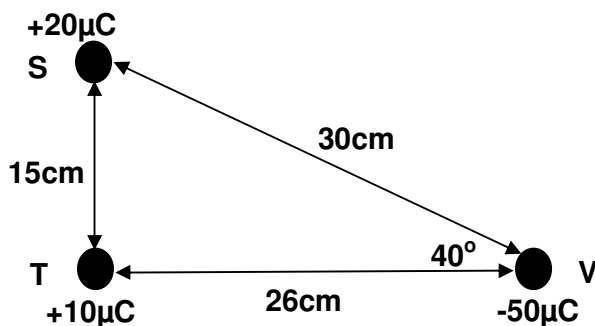
7.3 If the patrol car had approached the house at a higher speed how would the detected frequency have compared to the first observed frequency of 1000Hz? Write down only **HIGHER THAN, LOWER THAN** or **EQUAL TO**. (1)

[6]

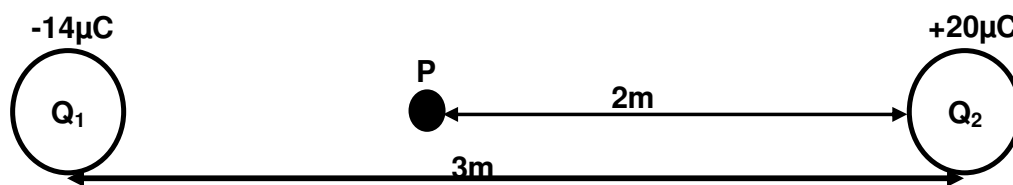
Question 8

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

8.2 Determine the net electrostatic force on charge S due to charges T and V. (8)



8.3 Two point charges Q_1 and Q_2 are 3m apart. The charge on Q_1 is $-14\mu\text{C}$ and the charge on Q_2 is $+20\mu\text{C}$.



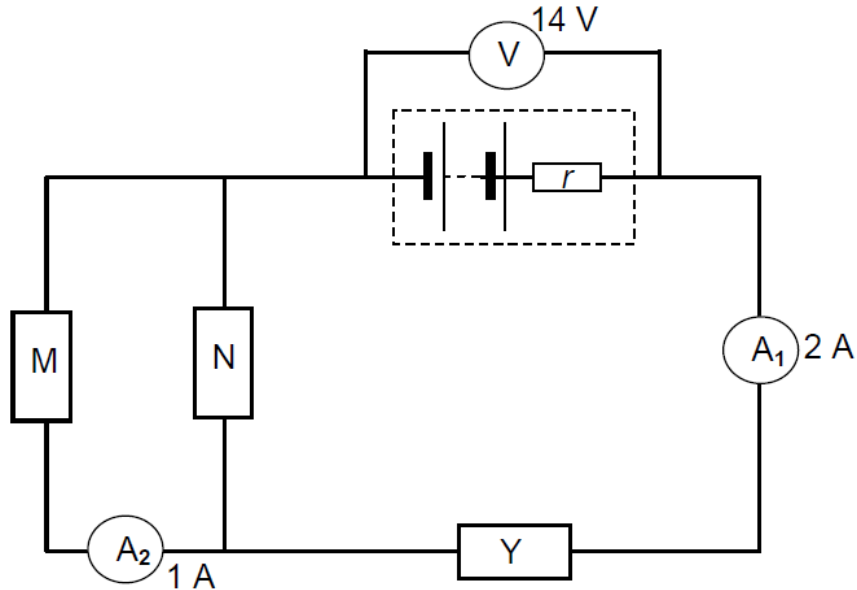
8.3.1 Define the term electric field at a point in space. (2)

8.3.2 Calculate the net electric field at point P situated 2 m from Q_2 . (5)

[17]

Question 9

The circuit diagram below shows a battery, with an internal resistance r , connected to three resistors, M, N and Y. The resistance of N is 2Ω and the reading on the voltmeter V is 14V . The reading on ammeter A_1 is 2A and the reading on ammeter A_2 is 1A . (The resistance of the ammeters and connecting wires may be ignored.)



- 9.1 State Ohm's law in words. (2)
- 9.2 How does the resistance of M compare to that of N, **GREATER THAN, LESS THAN OR EQUAL TO**? Explain your answer. (2)
- 9.3 If the emf of the battery is 17V , calculate the internal resistance of the battery. (3)
- 9.4 Calculate the potential difference across the resistor N. (3)
- 9.5 Calculate the resistance of Y. (4)

[14]

Question 10

Deaths associated with lightning in South Africa are about four times higher than the global average. A typical thundercloud may be at a potential of $1.2 \times 10^8\text{V}$ and the lightning strike may result in a charge transfer of 20C .

- 10.1 Define electric current. (2)
- 10.2 Calculate the current generated during the above mentioned thunder strike, if the charge transfer takes place in $1.1 \times 10^{-4}\text{s}$. (3)
- 10.3 Calculate the amount of energy transferred during the strike. (3)

Injuries caused by lightning can be reduced if the necessary precautions are taken. The following is an example of such a precaution:

IF YOU ARE FAR FROM A SHELTER DURING LIGHTNING, CROUCH WITH YOUR FEET TOGETHER

10.4 Give a reason why you must do the following:

10.4.1 Crouch (1)

10.4.2 Keep your feet together (1)

[10]

Question 11

Diagrams I and II each show two magnet poles and the end-view of a conducting coil situated between the poles. The diagrams illustrate the principle on which electric motors and generators work. The current in the coils is conventional current.



11.1 Use the appropriate rule to determine:

11.1.1 The direction of the force (**UP** or **DOWN**) on the conductor at A. (1)

11.1.2 The direction of the current (**IN** or **OUT**) at B if the applied force on the conductor is downwards (1)

11.2 State which of the two diagrams illustrate the basis for an AC generator. (1)

11.3 A certain generator operates at a maximum voltage of 22V. A 60W appliance is connected to the generator. Calculate the resistance of the appliance. (4)

[7]

Question 12 (change this question)

During an experiment to determine the work function of a certain metal, light of different frequencies was shone on the metal surface and the corresponding kinetic energies of the photoelectrons were recorded as shown in the table below.

METAL	WORK FUNCTION (W_0) IN J
Beryllium	8.0×10^{-19}
Copper	7.5×10^{-19}
Gold	4.85×10^{-19}

- 12.1 Define the term work function. (2)
- 12.2 Give a reason why different metals have different work functions (1)
- 12.3 Light of wavelength 1.72×10^{-9} m is shone onto a metal X. The average speed of the emitted electrons is $1,59 \times 10^7$ m·s⁻¹. Identify metal X by performing a relevant calculation. (6)
- 12.4 What conclusion about the nature of light is drawn from the photo-electric effect? (1)
- 12.5 A piece of gold is exposed to UV light. If one of the wavelengths of the light irradiated is 220nm. Calculate the kinetic energy of an electron emitted from the gold by a photon of this light. (4)

[14]

TOTAL 150

**DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)**

**GEGEWENS VIR FISIESTE WETENSAPPE GRAAD 12
VRAESTEL 1 (FISIKA)**

TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES

NAME/NAAM	SYMBOL/SIMBOOL	VALUE/WAARDE
Acceleration due to gravity <i>Swaartekragversnelling</i>	g	9,8 m·s ⁻²
Universal gravitational constant <i>Universele gravitasiekonstant</i>	G	6,67 x 10 ⁻¹¹ N·m ² ·kg ⁻²
Radius of the Earth <i>Radius van die Aarde</i>	R _E	6,38 x 10 ⁶ m
Mass of the Earth <i>Massa van die Aarde</i>	M _E	5,98 x 10 ²⁴ kg
Speed of light in a vacuum <i>Spoed van lig in 'n vakuum</i>	c	3,0 x 10 ⁸ m·s ⁻¹
Planck's constant <i>Planck se konstante</i>	h	6,63 x 10 ⁻³⁴ J·s
Coulomb's constant <i>Coulomb se konstante</i>	k	9,0 x 10 ⁹ N·m ² ·C ⁻²
Charge on electron <i>Lading op elektron</i>	e	-1,6 x 10 ⁻¹⁹ C
Electron mass <i>Elektronmassa</i>	m _e	9,11 x 10 ⁻³¹ kg

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

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

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 $E_k = \frac{1}{2} mv^2$	$W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$ $\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$
$W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{\text{ave}} = F v_{\text{ave}}$	

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 $E = h \frac{c}{\lambda}$
$E = W_0 + E_k$ where/waar $E = hf$ and/en $W_0 = hf_0$ and/en $E_k = \frac{1}{2} mv^2$	

ELECTROSTATICS/ELEKTROSTATIKA

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ 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)
$R_s = R_1 + R_2 + \dots$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$	$q = I \Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/WISSELSTROOM

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