education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS P1

PREPARATORY EXAMINATION 2008

MARKS: 150

TIME: 3 hours

This question paper consists of 15 pages, a 3-page data sheet and 1 answer sheet.

INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate spaces on the ANSWER SHEET and ANSWER BOOK.

2. Answer ALL the questions.

3. Answer SECTION A on the attached ANSWER SHEET.

4. Answer SECTION B in the ANSWER BOOK.

5. Non-programmable calculators may be used.

6. Appropriate mathematical instruments may be used.

7. Number the answers correctly according to the numbering system used in this question paper.

8. Data sheets are attached for your use.

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

SECTION A

Answer this section on the attached ANSWER SHEET.

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.5) on the attached ANSWER SHEET.

1.1 The force that acts on a body in free fall (1)

1.2 The physical quantity that is equivalent to the change in the momentum of a body (1)

1.3 A change in the observed pitch of a sound produced by a moving object (1)

1.4 A current that changes direction every half cycle (1)

1.5 A device that produces monochromatic, coherent and collimated light (1)
[5]

QUESTION 2: MATCHING ITEMS

Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A – J) next to the question number (2.1 – 2.5) on the attached ANSWER SHEET.

COLUMN A		COLUMN B	
2.1	The net (resultant) force is equal to the rate of change in momentum	A	red
2.2	Visible light with the highest frequency	B	DC motor
2.3	A motor that makes use of a split-ring commutator	C	cyan, magenta and yellow
2.4	An electronic circuit component that can store electric charge	D	Newton's Second Law
2.5	Three primary colours of paint	E	conservation of momentum
		F	blue, green and red
		G	violet
		H	capacitor
		I	AC motor
		J	diode

[5]

QUESTION 3: TRUE/FALSE ITEMS

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write 'true' or 'false' next to the question number (3.1 – 3.5) on the attached ANSWER SHEET. Correct the statement if it is FALSE.

3.1 If an object has momentum it must have kinetic energy. (2)

3.2 A passenger, walking at 1 $m \cdot s^{-1}$ west in a train that is travelling at 2 $m \cdot s^{-1}$ west, has a velocity of 3 $m \cdot s^{-1}$ west relative to the train. (2)

3.3 A yellow filter will transmit green and blue light and absorb red light. (2)

3.4 2 A rms alternating current is equivalent to 2 A direct current. (2)

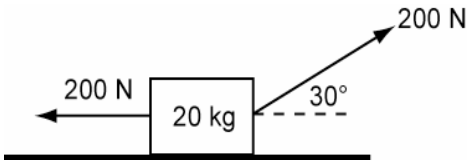
3.5 Scattering is when light is re-emitted in all directions by an object with the same frequency at which it was absorbed. (2)

[10]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and make a cross (X) in the block (A – D) next to the question number (4.1 – 4.5) on the attached ANSWER SHEET.

4.1 Two forces, each of magnitude 200 N, are simultaneously applied to a crate at rest on a horizontal surface as shown in the diagram below. Ignore the effects of friction.



Work will be done by the net force on the crate because the crate will …

A be lifted off the surface.

B accelerate to the left.

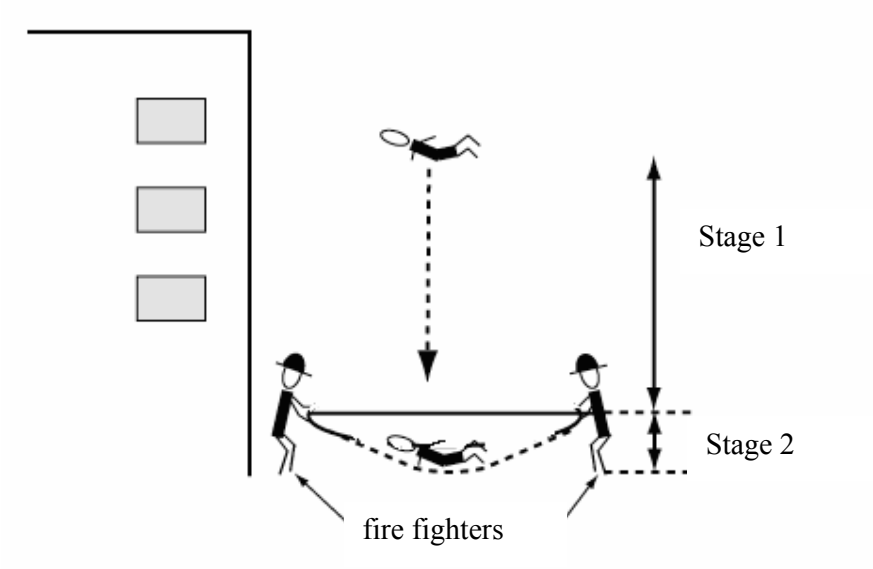
C accelerate to the right.

D remain at rest. (3)

4.2 A man jumps from a window of a multiple-storey building at a certain height above a fire fighters' safety net.

- **Stage 1:** It takes 0,3 seconds to reach the net.
- **Stage 2:** The net stretches by 1 m on impact before the man comes to rest after 0,2 seconds.

Air resistance can be ignored.



Which ONE of the following statements regarding the mechanical energy and momentum of the man is TRUE?

	STAGE 1	STAGE 2
A	Mechanical energy and momentum remain constant.	Mechanical energy and momentum remain constant.
B	Mechanical energy and momentum remain constant.	Mechanical energy and momentum change.
C	Mechanical energy remains constant and momentum changes.	Mechanical energy remains constant and momentum changes.
D	Mechanical energy remains constant and momentum changes.	Mechanical energy and momentum change.

(3)

4.3 Which ONE of the following statements describing the condition for single-slit diffraction is CORRECT?

A The slit width is equal to the wavelength of the waves.

B The slit width is greater than the wavelength of the waves.

C The slit width is less than the wavelength of the waves.

D The wavelength of the waves is less than the distance to the screen. (3)

4.4 Which ONE of the statements below best explains the term *population inversion* in LASERS?

A Photons are emitted spontaneously in a random direction.

B Photons induce or stimulate electrons to change energy levels.

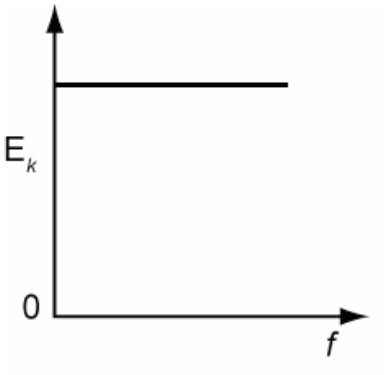
C High-energy electrons pass through a narrow slit.

D More electrons are excited than what will remain in the ground state. (3)

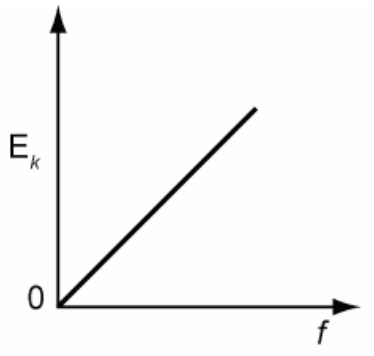
4.5 A metal is illuminated with light of frequency *f* and the electrons emitted have a maximum kinetic energy of E_k.

Which ONE of the following graphs best illustrates the relationship between kinetic energy (E_k) of the emitted electrons and frequency (*f*) of the incident light?

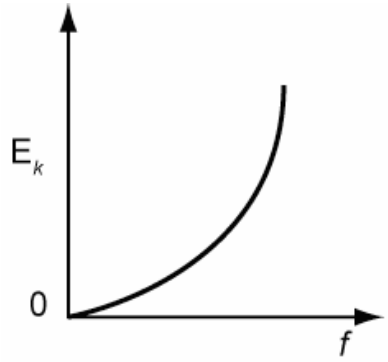
A



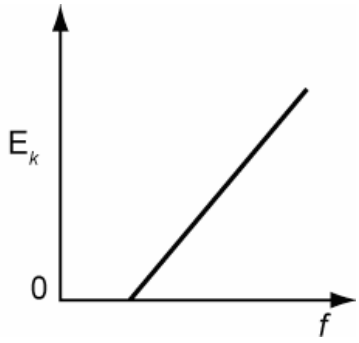
B



C



D



(3)
[15]

TOTAL SECTION A: 35

SECTION B

INSTRUCTIONS AND INFORMATION

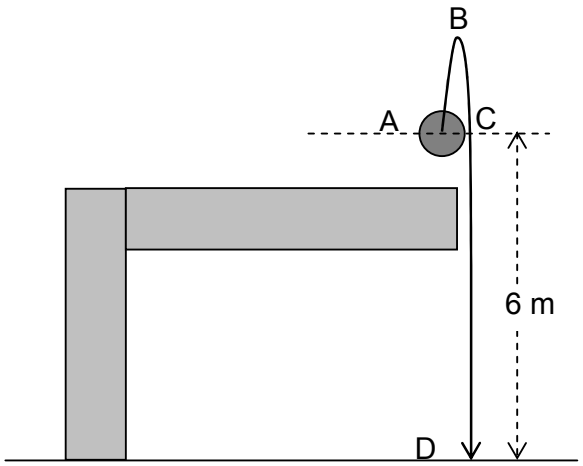
1. Answer this section in the ANSWER BOOK.

2. The formulae and substitutions must be shown in ALL calculations.

3. Round off your answers to TWO decimal places.

QUESTION 5

5.1 Marshall stands on a platform and kicks a soccer ball from 6 m above the ground (position A) vertically upwards into the air with an initial velocity of 4 $m \cdot s^{-1}$. The ball hits the ground (position D) after 1,6 seconds. The motion of the ball is represented in the diagram below. Ignore the effects of air resistance.



5.1 Calculate the maximum height (position B) the ball reaches above the ground. (5)

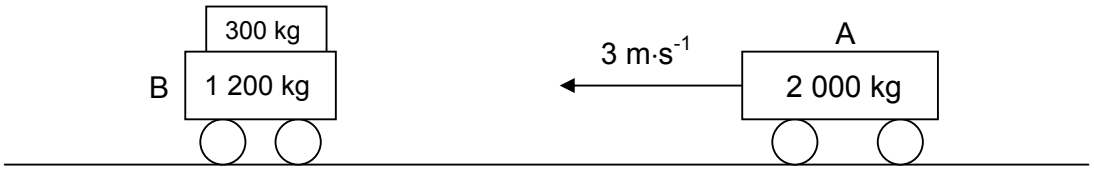
5.2 Calculate the time taken for the ball to reach maximum height (position B). (3)

5.3 Draw a sketch graph of position versus time for the motion of the ball from the moment it was kicked until it hits the ground. Use point A as the reference point (zero-position). Indicate ALL relevant position and time values at positions A, B, C and D. (5)

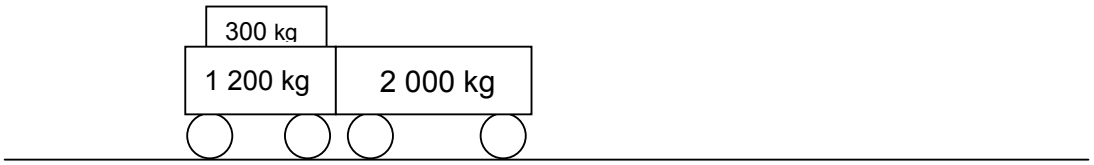
[13]

QUESTION 6

A railway truck A of mass 2 000 kg moves westwards with a velocity of 3 $m \cdot s^{-1}$. It collides with a stationary truck B of mass 1 200 kg, loaded with electronic equipment of mass 300 kg. The two trucks combined after the collision. Ignore the effects of friction.



BEFORE COLLISION



AFTER COLLISION

6.1 Write down magnitude and direction of the 'reaction force' to the weight of truck A. (2)

6.2 Calculate the velocity of truck B after the collision. (5)

6.3 Calculate the magnitude of the force that truck A exerts on truck B if the collision lasts for 0,5 s. (4)

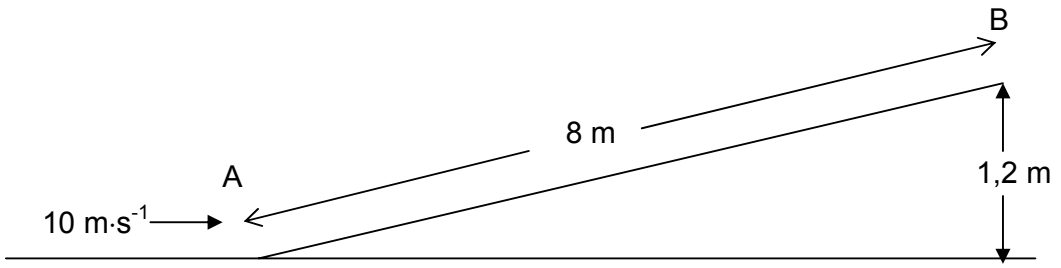
6.4 The electronic equipment on the stationary truck is wrapped in bubble plastic (plastic filled with air bubbles).

Use physics principles to explain why bubble plastic is preferred to ordinary plastic. (3)

[14]

QUESTION 7

Nthabiseng, a cyclist, is free-wheeling (moving without peddling) along a horizontal surface at a constant speed of 10 $m \cdot s^{-1}$. She reaches the bottom of a ramp (position A) that has a height of 1,2 m and a length of 8 m. While free-wheeling up the ramp, she experiences a frictional force of 18 N. The total mass of the cyclist and cycle is 55 kg.



7.1 Explain whether her mechanical energy is conserved or not as Nthabiseng moves from position A to position B. (2)

7.2 Calculate the kinetic energy of the cyclist at position A. (3)

7.3 Calculate the kinetic energy at the top of the ramp (position B). (8)
[13]

QUESTION 8

An ambulance moving at 40 $m \cdot s^{-1}$ approaches a traffic light where a blind man and his dog wait to cross the road. The siren of the ambulance emits sound waves at a frequency of 350 Hz. The pitch of the sound that the man hears gets higher as the ambulance moves towards him and decreases as the ambulance passes him and moves away.

8.1 Use a sketch of wave fronts to show why the pitch of the sound that the blind man hears is:

8.1.1 Higher as the ambulance approaches him (2)

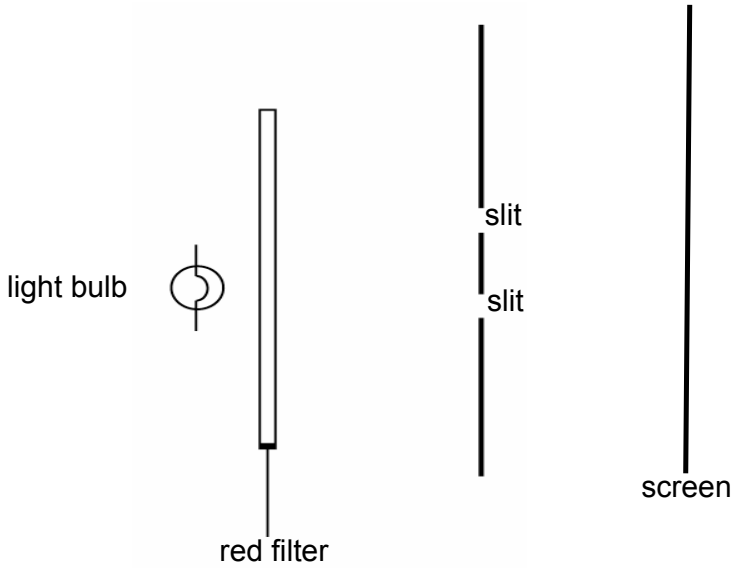
8.1.2 Lower as the ambulance moves away from him (2)

8.2 If the speed of sound in air is accepted as 340 $m \cdot s^{-1}$, determine the apparent frequency of the sound waves that the man hears while the ambulance approaches him. (5)

8.3 Explain how this effect can benefit a blind person. (2)
[11]

QUESTION 9

In a set-up to illustrate Young's double slit experiment, Renzo placed a red filter that allows only monochromatic red light to reach the slits between a light bulb and a double slit.



9.1 Define the term *monochromatic*. (2)

9.2 Describe the pattern that is observed on the screen with the naked eye once the red light has passed through the double slits. (2)

9.3 Explain the observation made in QUESTION 9.2. (2)

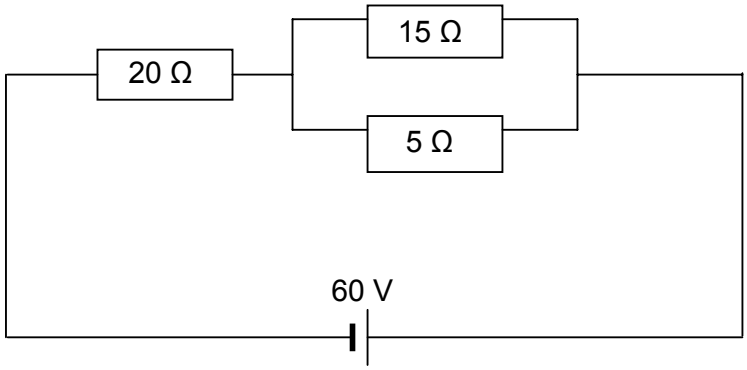
9.4 Describe and explain how the observed pattern will differ if the red filter is replaced by a blue one. (4)

9.5 How will the pattern observed be affected if the distance between the two slits is increased? (2)

[12]

QUESTION 10

Consider the electric circuit below and answer the questions that follow.



10.1 Calculate the magnitude of the current. (6)

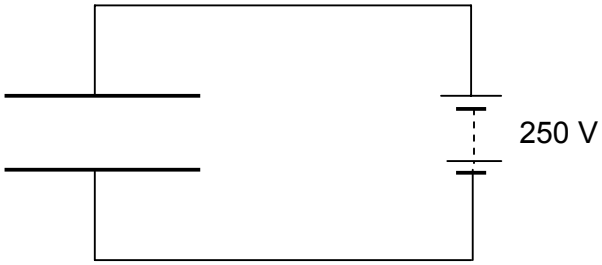
10.2 Calculate the potential difference across the 15 Ω resistor. (3)
[9]

QUESTION 11

Two parallel plates are arranged to form a capacitor. The area of each plate is 0,04 m^2. The plates are separated by a 0,002 m air gap.

11.1 Calculate the capacitance of the capacitor. (4)

This capacitor is connected across a 250 V source as shown below.



11.2 Calculate the charge that accumulates on each plate. (3)

11.3 State how the amount of the charge stored on each plate can be increased without altering the design of the capacitor. (2)

11.4 Write down the general name for the insulating material that is used to fill the space between the plates of a capacitor. (1)

11.5 Use your knowledge of capacitors to explain why it is dangerous to open an amplifier while it is in operation. (2)
[12]

QUESTION 12

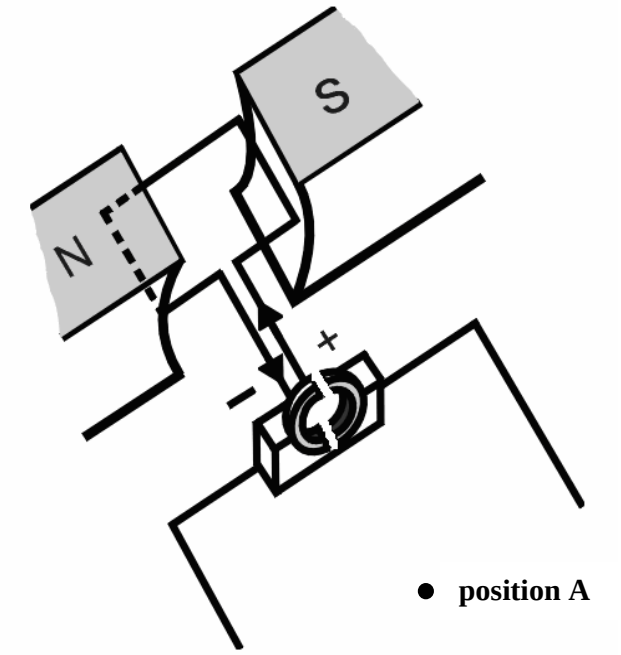
Electric motors are important components of many modern electrical appliances. AC motors are used in washing machines and vacuum cleaners, and DC motors are used in toys and tools.

12.1 What energy conversion takes place in electric motors? (2)

12.2 What is the essential difference in the design between DC motors and AC motors? (2)

12.3 List THREE ways in which the efficiency of the motor can be improved. (3)

12.4 Consider the diagram below. The conventional current flows in the direction indicated by the arrows.



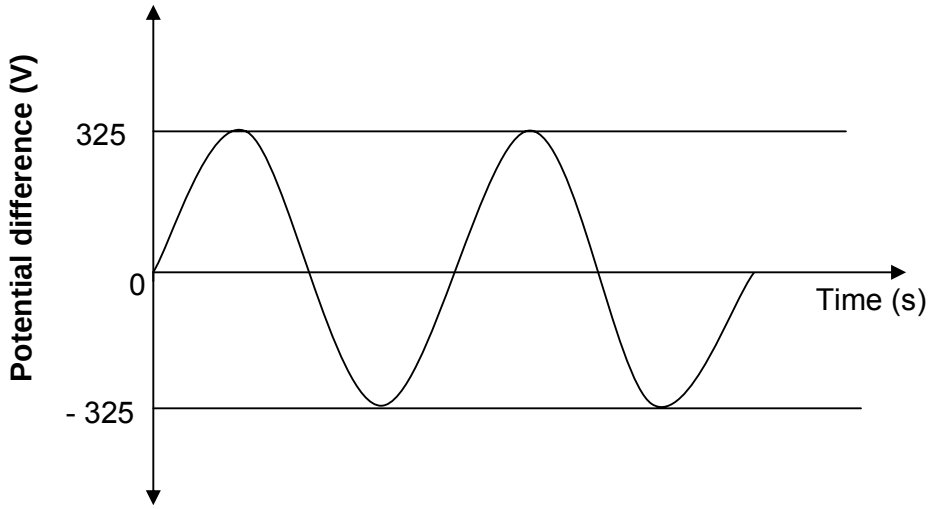
12.4.1 In which direction (clockwise or anti-clockwise), as seen from position A, will the coiled armature rotate if the switch is closed? (1)

12.4.2 Why does the armature continue moving in the same direction once it has reached the vertical position? (2)

[10]

QUESTION 13

The waveform below is a graphical representation of the variation of voltage (V) versus time (t) for an alternating current generator.

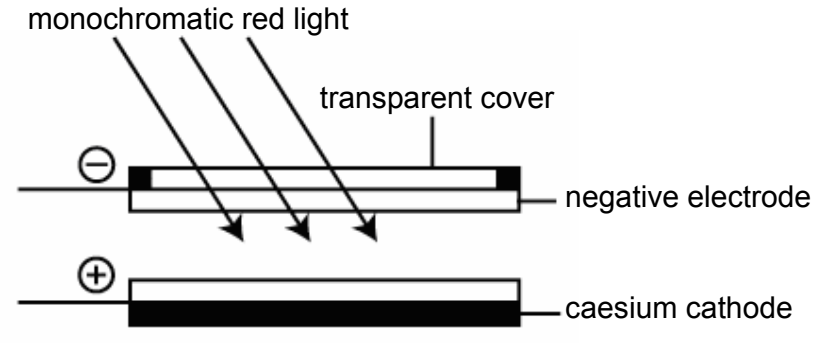


13.1 Explain the advantage of using alternating current at power stations. (2)

13.2 Calculate the average power dissipated by this generator if the rms current produced is 13 A. (5)
[7]

QUESTION 14

14.1 The sketch below shows the components of a photocell used in a camera light meter.



The photocell consists of a caesium cathode with a small work function. When monochromatic red light from a 50 W light bulb strikes the cathode in the photocell, the light meter registers a small current.

14.1.1 What name is given to the effect described above? (1)

14.1.2 What will the effect on the current be when the 50 W bulb is replaced by a 100 W bulb? Give a reason for your answer. (2)

14.1.3 What will be the effect on the kinetic energy of the emitted photo electrons when the 50 W red light is replaced with a 50 W blue light bulb. Give a reason for your answer. (3)

14.2 Ultraviolet lamps are often used in butcheries, even though they are potentially harmful.

14.2.1 Which property of UV light makes it harmful? (1)

14.2.2 Explain why UV light is used in butcheries. (1)

14.2.3 A photon of ultraviolet light carrying $2{,}95 \times 10^{-20}$ J of energy is shone onto a metal with a work function of 1×10^{-20} J. Calculate the speed of the ejected photo electron. (5)

[13]

TOTAL SECTION B: 115

GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES P1 (PHYSICS) GRADE 12

GEGEWENS VIR FISIESE WETENSKAPPE V1 (FISIKA) GRAAD 12

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	9,8 $m \cdot s^{-2}$
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	$3,0 \times 10^{8}$ $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	$6,63 \times 10^{-34}$ $J \cdot s$
Gravitational constant *Swaartekragkonstante*	G	$6,67 \times 10^{-11}$ $N \cdot m^2 \cdot kg^{-2}$
Coulomb's constant *Coulomb se konstante*	k	$9,0 \times 10^{9}$ $N \cdot m^{2} \cdot C^{-2}$
Charge on electron *Lading op elektron*	e	$-1,6 \times 10^{-19}$ C
Electron mass *Elektronmassa*	m_e	$9,11 \times 10^{-31}$ kg
Permittivity of free space *Permittiwiteit van vry ruimte*	ε_0	$8,85 \times 10^{-12}$ $F \cdot m^{-1}$
Permeability of free space *Permeabiliteit van vry ruimte*	μ_0	$4\pi \times 10^{-7}$ $T \cdot m \cdot A^{-1}$

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* $v_f^{\ 2} = v_i^{\ 2} + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ or/*of* $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE/*KRAG*

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p = mv_f - mv_i$	$F_g = mg$

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

$W = F\Delta x\cos\theta$	$U = E_P = mgh$
$K = E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K = \Delta E_k = E_{kf} - E_{ki}$
$P = \frac{W}{\Delta t}$	$P = Fv$

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

$v = f\lambda$ or/*of* $v = \nu\lambda$	$T = \frac{1}{f}$ or/*of* $T = \frac{1}{\nu}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ or/*of* $E = h\nu$ or/*of* $E = h\frac{c}{\lambda}$
$\lambda = \frac{h}{mv}$	$\sin\theta = \frac{m\lambda}{a}$
$hf = W_0 + \frac{1}{2}mv^2$	

MATTER AND MATERIALS/*MATERIE EN MATERIALE*

$F = k\Delta x$	Stress/*Spanning* $= \frac{F}{A}$
Strain/*Vervorming* $= \frac{\Delta x}{\ell}$	

ELECTRICITY AND MAGNETISM/*ELEKTRISITEIT EN MAGNETISME*

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ / $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$ / $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$
$\Phi = BA$	$P_{average} = V_{rms}I_{rms}$ / $P_{gemiddeld} = V_{wgk}I_{wgk}$ $P_{average} = \frac{V_{rms}^2}{R}$ / $P_{gemiddeld} = \frac{V_{wgk}^2}{R}$ $P_{average} = I^2_{rms}R$ / $P_{gemiddeld} = I^2_{wgk}R$

ELECTROSTATICS/*ELEKTROSTATIKA*

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{V}{d}$	$U = \frac{kQ_1Q_2}{r}$
$E = \frac{F}{q}$	$Q = It$
$C = \frac{Q}{V}$	$C = \frac{\varepsilon_0 A}{d}$

ELECTRIC CIRCUITS/*ELEKTRIESE STROOMBANE*

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$
$R_s = R_1 + R_2 + ...$	emf/*emk* (ε) = $I(R + r)$

NAME/*NAAM*:

ANSWER SHEET/*ANTWOORDBLAD*

QUESTION 1/*VRAAG 1*

1.1 _____ (1)
1.2 _____ (1)
1.3 _____ (1)
1.4 _____ (1)
1.5 _____ (1)
[5]

QUESTION 2/*VRAAG 2*

2.1 _____ (1)
2.2 _____ (1)
2.3 _____ (1)
2.4 _____ (1)
2.5 _____ (1)
[5]

QUESTION 3/*VRAAG 3*

3.1 _____
_____ (2)
3.2 _____
_____ (2)
3.3 _____
_____ (2)
3.4 _____
_____ (2)
3.5 _____
_____ (2)
[10]

QUESTION 4/*VRAAG 4*

4.1	A	B	C	D
4.2	A	B	C	D
4.3	A	B	C	D
4.4	A	B	C	D
4.5	A	B	C	D

(5 x 3) [15]

TOTAL SECTION A/*TOTAAL AFDELING A*: 35