education

Department:
Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHSC.1

PHYSICAL SCIENCES: PHYSICS (P1)

FEBRUARY/MARCH 2010

MARKS: 150

TIME: 3 hours

This question paper consists of 13 pages, 3 data sheets and 1 page of graph paper.

MORNING SESSION

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the appropriate spaces on the ANSWER BOOK and attached GRAPH PAPER.

2. Answer ALL the questions in the ANSWER BOOK except QUESTION 14.2.

3. Answer QUESTION 14.2 on the attached GRAPH PAPER. Place the GRAPH PAPER inside the front cover of the ANSWER BOOK and hand it in with the ANSWER BOOK.

4. This paper consists of TWO sections:

   SECTION A (25)
   SECTION B (125)

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

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) in the ANSWER BOOK.

1.1 The rate at which energy is transferred (1)

1.2 The term used to describe light of a single frequency (1)

1.3 The work done per unit charge moved between two points in an electric field (1)

1.4 The fundamental principle on which electric generators operate (1)

1.5 The excited state in a laser medium where electrons remain for a longer period of time than normal (1)
[5]

QUESTION 2: FALSE ITEMS

Each of the five statements below is FALSE. Write down the correct statement next to the question number (2.1 – 2.5) in the ANSWER BOOK.

NOTE: Correction by using the negative of the statement, for example "… IS NOT …", will not be accepted.

2.1 The rate of change of momentum is equal to the impulse. (2)

2.2 If the net work done on a moving object is zero, the velocity of the object decreases. (2)

2.3 The nodal lines in the interference pattern of blue light are the result of constructive interference. (2)

2.4 Radio waves are sound waves that can travel through a vacuum. (2)

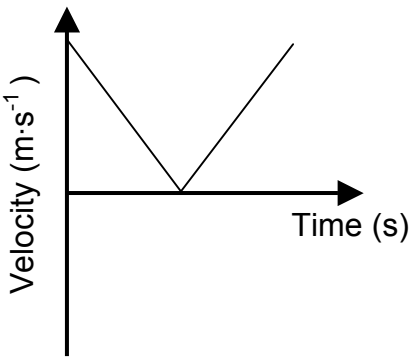
2.5 When a spectrum consists of discrete lines, it is a continuous spectrum. (2)
[10]

QUESTION 3: MULTIPLE-CHOICE QUESTIONS

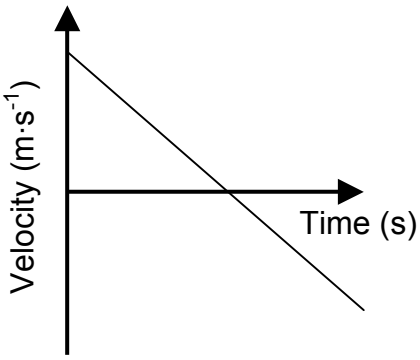
Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A – D) next to the question number (3.1 – 3.5) in the ANSWER BOOK.

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

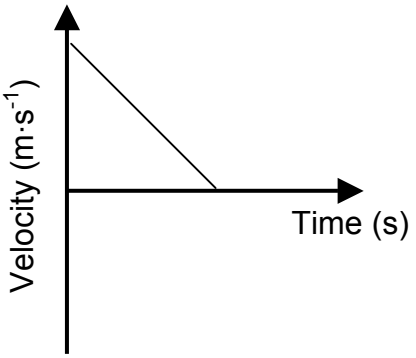
A



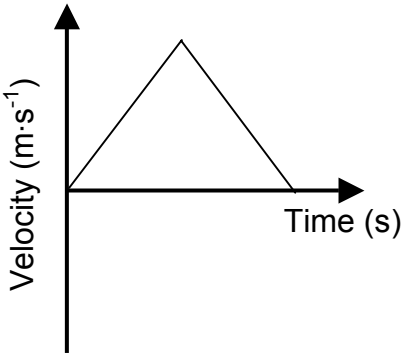
B



C



D



(2)

3.2 A net force *F* acts on each of two isolated objects, P and Q, as shown below. The mass of Q is three times that of P. (Ignore the effects of friction.)

If the rate of change of momentum of object Q is *x*, then the rate of change of momentum of object P is as follows:

A $\frac{1}{9}x$

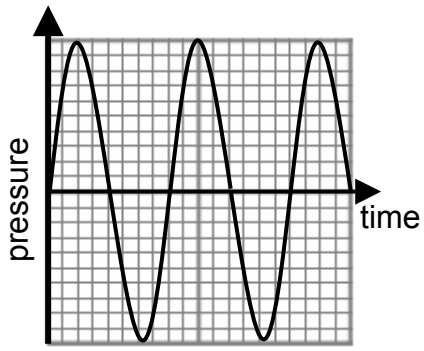
B $\frac{1}{3}x$

C x

D $3x$

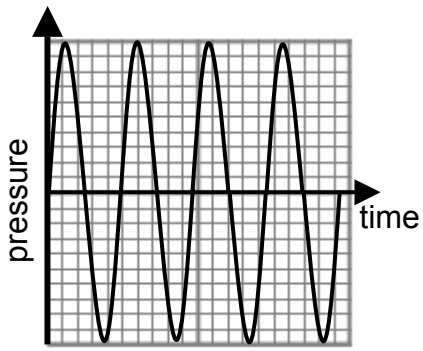
(2)

3.3 The pressure versus time graph below represents a sound wave in air emitted by a stationary source.

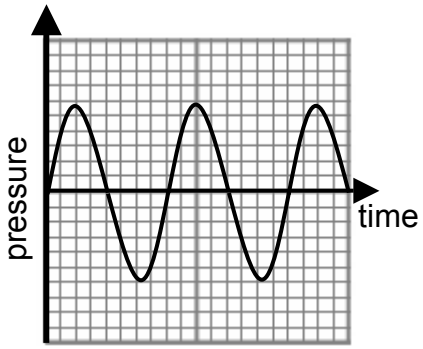


Which ONE of the following graphs best represents the sound wave, as observed by a stationary observer, if the source is moving towards the observer?

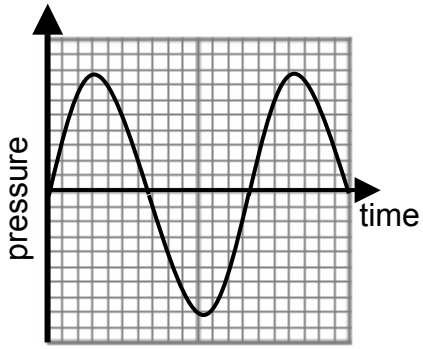
A



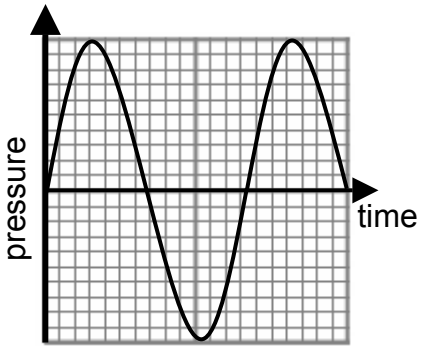
B



C

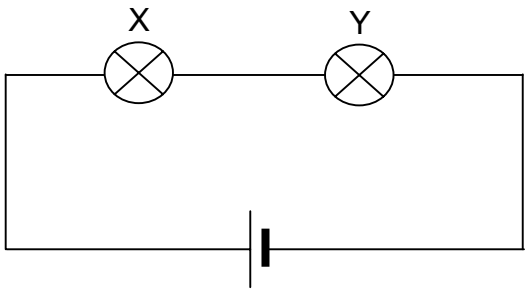


D



(2)

3.4 The diagram below shows two light bulbs, X and Y, connected in series to a battery with negligible internal resistance.



If bulb X glows brighter than bulb Y, then the …

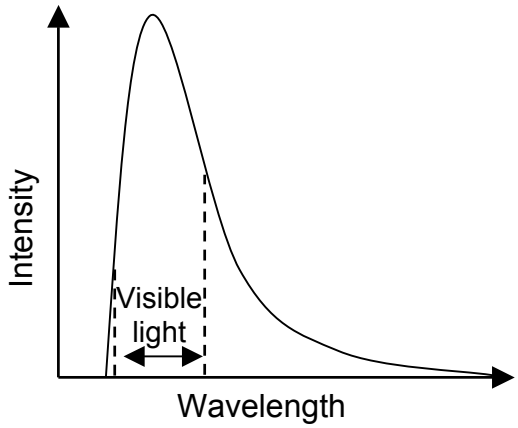
A current through bulb X is smaller than that through bulb Y.

B resistance of bulb X is smaller than that of bulb Y.

C resistance of bulb X is greater than that of bulb Y.

D current through bulb X is greater than that through bulb Y. (2)

3.5 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 (2)

[10]

TOTAL SECTION A: 25

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start each question on a NEW page.

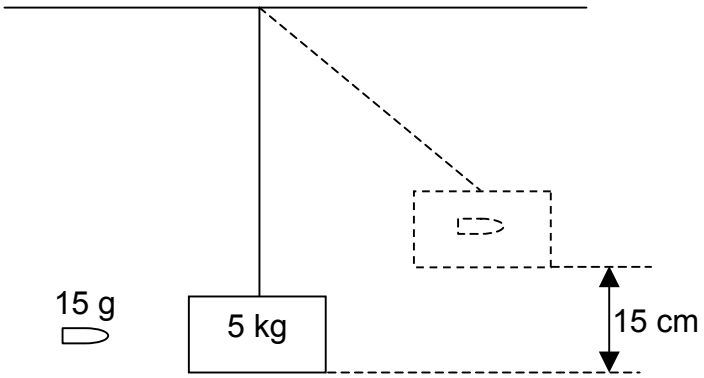
2. Leave a line between two subquestions, for example between QUESTION 4.1 and QUESTION 4.2.

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

4. Round off your answers to TWO decimal places where applicable.

QUESTION 4 (Start on a new page.)

During an investigation a police officer fires a bullet of mass 15 g into a stationary wooden block, of mass 5 kg, suspended from a long, strong cord. The bullet remains stuck in the block and the block-bullet system swings to a height of 15 cm above the equilibrium position, as shown below. (Effects of friction and the mass of the cord may be ignored.)



4.1 State the law of conservation of momentum in words. (2)

4.2 Use energy principles to show that the magnitude of the velocity of the block-bullet system is 1,71 $m \cdot s^{-1}$ immediately after the bullet struck the block. (3)

4.3 Calculate the magnitude of the velocity of the bullet just before it strikes the block. (4)

4.4 The police officer is pushed slightly backwards by the butt of the rifle, which he is holding against his shoulder, whilst firing the rifle. Use the relevant law of motion to explain why this happens. (3)

[12]

QUESTION 5 (Start on a new page.)

A supervisor, 1,8 m tall, visits a construction site. A brick resting at the edge of a roof 50 m above the ground suddenly falls. At the instant when the brick has fallen 30 m the supervisor sees the brick coming down directly towards him from above.

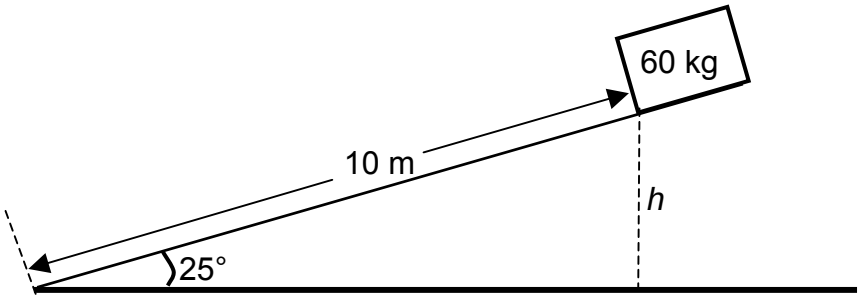
Ignore the effects of friction and take the downwards motion as positive.

5.1 Calculate the speed of the brick after it has fallen 30 m. (3)

5.2 The average reaction time of a human being is 0,4 s. With the aid of a suitable calculation, determine whether the supervisor will be able to avoid being hit by the brick. (6)
[9]

QUESTION 6 (Start on a new page.)

A box of mass 60 kg starts from rest at height *h* and slides down a rough slope of length 10 m, which makes an angle of 25° with the horizontal. It undergoes a constant acceleration of magnitude 2 $m \cdot s^{-2}$ while sliding down the slope.



6.1 State the work-energy theorem in words. (2)

6.2 Draw a free-body diagram to show ALL the forces acting on the cardboard box **while it slides down the slope.** (3)

6.3 **The box reaches the bottom of the slope.**

Calculate the following:

6.3.1 The kinetic energy of the box, using the equations of motion (5)

6.3.2 The work done on the box by the gravitational force (4)

6.3.3 The work done on the box by the frictional force, using the work-energy theorem (4)

6.3.4 The magnitude of the frictional force acting on the box (3)
[21]

QUESTION 7 (Start on a new page.)

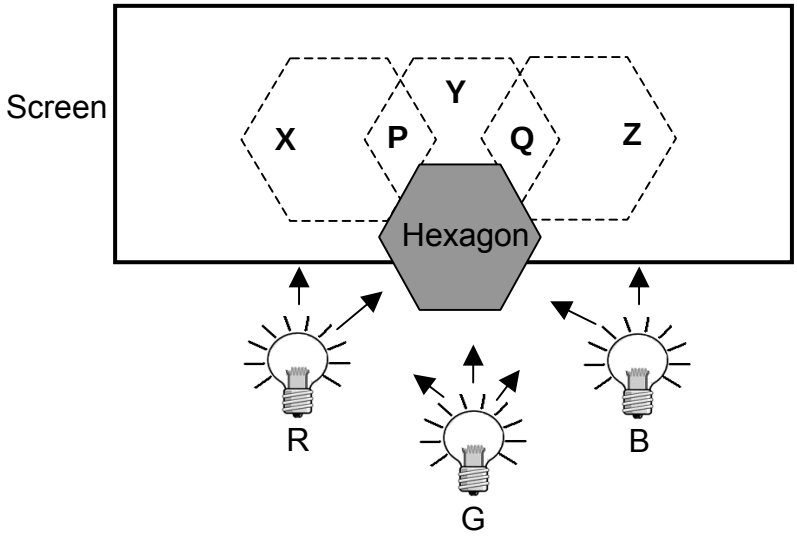
An ambulance with its siren on, moves **away** at constant velocity from a person standing next to the road. The person measures a frequency which is 90% of the frequency of the sound emitted by the siren of the ambulance.

7.1 Name the phenomenon observed. (1)

7.2 If the speed of sound in air is 340 $m \cdot s^{-1}$, calculate the speed of the ambulance. (5)
[6]

QUESTION 8 (Start on a new page.)

8.1 A technician shines light from a red (R), a green (G) and a blue (B) lamp onto a hexagon cut from cardboard. Coloured shadows X, Y and Z, of the hexagon, appear on a white screen behind the hexagon, as shown below. The coloured shadows overlap in regions P and Q.



8.1.1 Which colour model is used to explain colour mixing of light? (1)

8.1.2 Write down the letters X, Y and Z in your ANSWER BOOK and next to each the colour of the shadow observed on the screen.

(HINT: No red light reaches shadow Z, no green light reaches shadow Y and no blue light reaches shadow X.) (3)

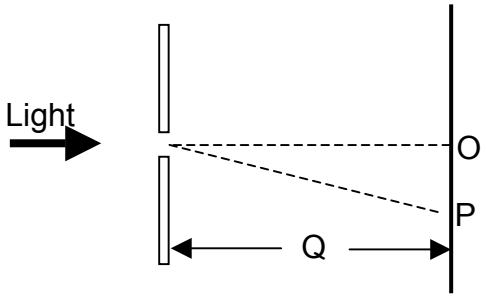
8.1.3 Write down the letters P and Q in your ANSWER BOOK and next to each the colour observed on the screen for each region. (2)

8.2 Your school uses a green light to illuminate an indoor garden in the office block. The gardener finds that, despite correct watering and fertilising, the plants are in a poor state. He blames the light for the problem.

Briefly explain why the green light might be the problem. (2)
[8]

QUESTION 9 (Start on a new page.)

Light of a single frequency pass through a single slit. The first minimum is observed at point P on a screen, as shown in the diagram below. Point O is the midpoint of the central bright band. The distance OP is 2,5 cm and the slit width is 3,2 x 10^{-5} m.



9.1 What can be deduced about the nature of light from this observation? (1)

9.2 Explain how the minimum is formed at point P. (2)

9.3 If the wavelength of the incident light is 600 nm, calculate the distance Q between the screen and the slit. (5)

9.4 The original slit is now replaced by a second slit of different width, while the distance Q and the wavelength of the incident light remain the same. Distance OP changes to 4 cm.

9.4.1 How does the slit width of the second slit compare to that of the first slit? Only write down GREATER THAN, SMALLER THAN or EQUAL TO. (1)

9.4.2 Explain your answer to QUESTION 9.4.1 without performing a calculation. (2)

[11]

QUESTION 10 (Start on a new page.)

Capacitors are circuit devices used to store electrical energy. The capacitance of capacitors depends, amongst other factors, on the plate area. The larger the plate area, the more the energy that can be stored.

10.1 Apart from plate area, state TWO other factors that can influence the capacitance of a capacitor. (2)

10.2 A certain parallel plate capacitor consists of two plates, each having dimensions of 2 cm by 10 cm. The plates are 0,2 mm apart and are held at a potential difference of 20 V. The space between the plates is filled with air.

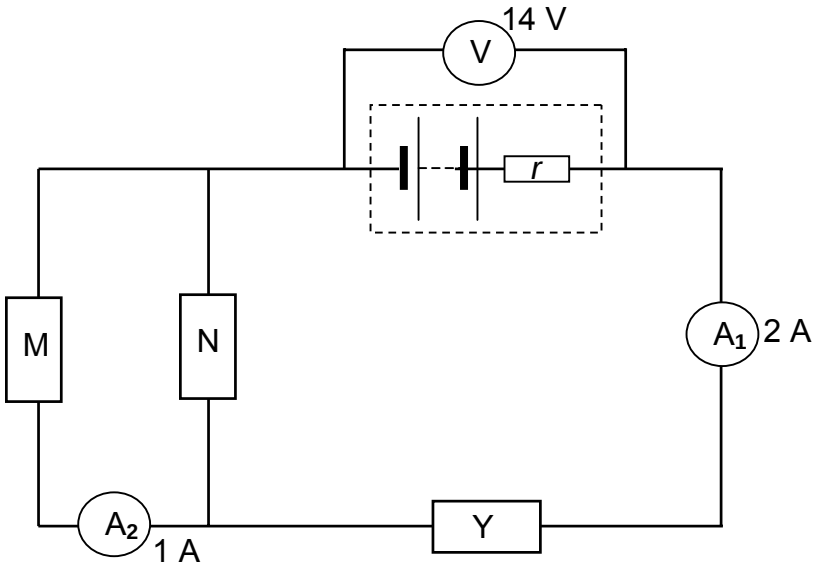
10.2.1 Sketch the electric field pattern between the two oppositely charged parallel plates of the capacitor. (3)

10.2.2 Calculate the capacitance of this capacitor. (5)

[10]

QUESTION 11 (Start on a new page.)

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 2 Ω and the reading on voltmeter V is 14 V. The reading on ammeter A_1 is 2 A and the reading on ammeter A_2 is 1 A. (The resistance of the ammeters and the connecting wires may be ignored.)



11.1 State Ohm's law in words. (2)

11.2 How does the resistance of M compare with that of N? Explain how you arrived at the answer. (2)

11.3 If the emf of the battery is 17 V, calculate the internal resistance of the battery. (5)

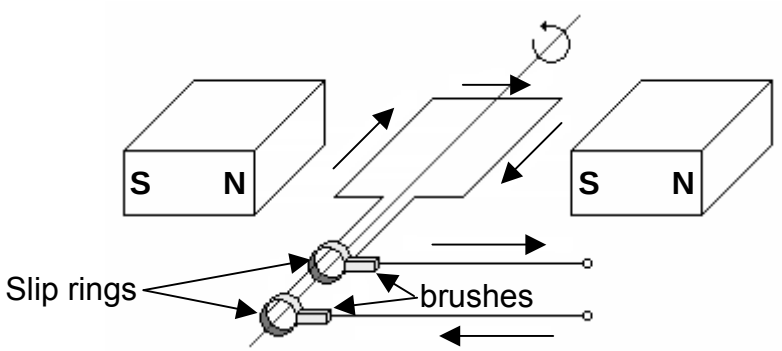
11.4 Calculate the potential difference across resistor N. (3)

11.5 Calculate the resistance of Y. (4)

[16]

QUESTION 12 (Start on a new page.)

12.1 A simplified sketch of a generator is shown below.



12.1.1 Is the output voltage AC or DC? Give a reason for your answer. (2)

12.1.2 State TWO effects on the output voltage if the coil is made to turn faster. (2)

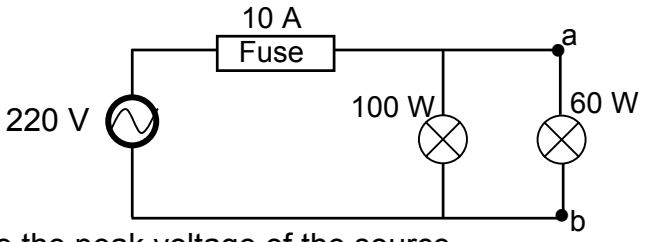
12.1.3 What is the position of the coil relative to the magnetic field when the output voltage is a maximum? (1)

12.2 In South Africa, the major source of electricity is coal-driven generators. Recently society has become concerned about fossil fuels (like coal) as the primary source of electrical energy. Some business people have proposed that government should invest in windmills as an alternative source of energy.

State ONE advantage and ONE disadvantage of using windmills over coal-driven generators in supplying energy. (2)
[7]

QUESTION 13 (Start on a new page.)

Lights in most households are connected in parallel, as shown in the simplified circuit below. Two light bulbs rated at 100 W; 220 V and 60 W; 220 V respectively are connected to an AC source of rms value 220 V. The fuse in the circuit can allow a maximum current of 10 A.



13.1 Calculate the peak voltage of the source. (3)

13.2 Calculate the resistance of the 100 W light bulb, when operating at optimal conditions. (3)

13.3 An electric iron, with a power rating of 2 200 W, is now connected across points a and b. Explain, with the aid of a calculation, why this is not advisable. (5)

[11]

QUESTION 14 (Start on a new page.)

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.

Frequency of incident light (x 10^{14} Hz)	Kinetic energy of photoelectrons (x 10^{-19} J)
6,6	0,7
8,2	1,6
9,2	2,2
10,6	3,0
12,0	3,8

14.1 Define the term *work function*. (2)

14.2 Use the data in the table above to draw a graph of kinetic energy versus frequency on the graph paper provided. (6)

14.3 Extrapolate your graph to cut the X-axis.

14.3.1 What is the frequency at the point of intercept? (2)

14.3.2 What term is used to describe this frequency? (1)

14.4 Use your graph to determine the work function of the metal. (3)

[14]

TOTAL SECTION B: 125

GRAND TOTAL: 150

DATA FOR PHYSICAL SCIENCES
PAPER 1 (PHYSICS)

GEGEWENS VIR FISIESE WETENSKAPPE
VRAESTEL 1 (FISIKA)

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

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Acceleration due to gravity *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
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	$6,63 \times 10^{-34}\ J{\cdot}s$
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	$8,85 \times 10^{-12}\ F{\cdot}m^{-1}$

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*

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

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

$v = f\lambda$ 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* $E = h\frac{c}{\lambda}$
$\sin\theta = \frac{m\lambda}{a}$	$hf = W_0 + \frac{1}{2}mv^2 = hf_0 + \frac{1}{2}mv^2$

ELECTROSTATICS/*ELEKTROSTATIKA*

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

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)
$q = I\,\Delta t$	$W = Vq = VI\,\Delta t = I^2R\,\Delta t = \frac{V^2\Delta t}{R}$
$P = \frac{W}{\Delta t} = VI = I^2R = \frac{V^2}{R}$	

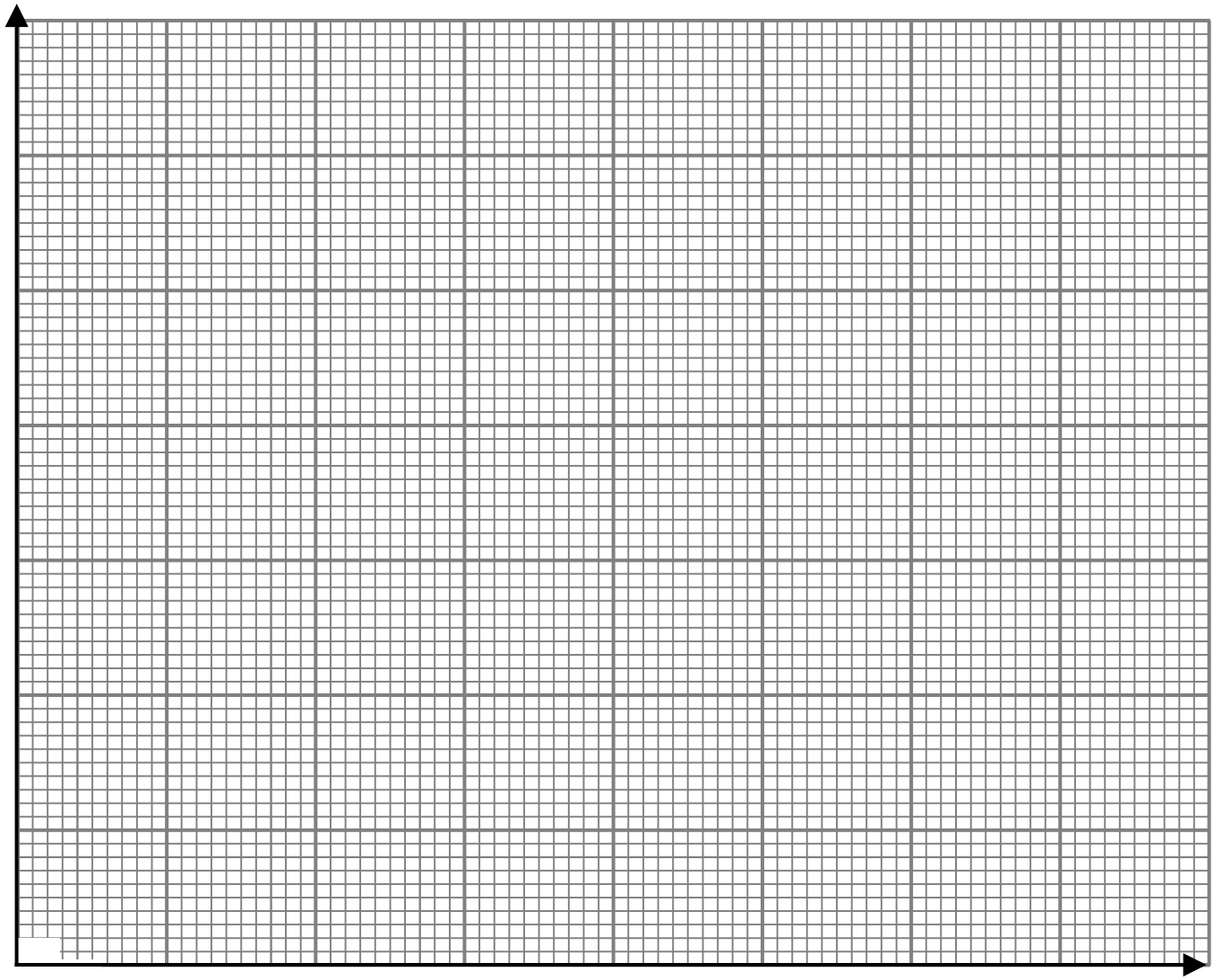
ALTERNATING CURRENT/*WISSELSTROOM*

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

CENTRE NUMBER:

EXAMINATION NUMBER:

QUESTION 14.2



(6)

NB.: PLEASE HAND IN TOGETHER WITH YOUR ANSWER BOOK.