higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

PHYSICAL SCIENCE

(First paper)

NQF LEVEL 3

(10021003)

16 November 2022 (X-paper)
09:00–12:00

Requirements: Graph paper must be supplied.

Nonprogrammable calculators may be used.

This question paper consists of 14 pages, 1 information sheet and 1 formula sheet.

399Q1N2216

Copyright reserved

TIME: 3 HOURS
MARKS: 150

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Start each section on a new page.
5. Show all calculations, formulae and substitutions.
6. Approximate all answers to TWO decimal places.
7. Write neatly and legibly.

Copyright reserved

SECTION A

QUESTION 1

Give ONE term for each of the following descriptions by writing it next to the question number (1.1–1.5) in the ANSWER BOOK.

1.1 Consider a bus carrying passengers moving at a speed of 60 km/h. The driver suddenly applies brakes and the passengers start moving forward. Which property of matter explains this phenomenon?

1.2 When blowing air into a bottle, it generates a standing wave, creating a note. Which wave property is responsible for this?

1.3 Region of space in which an electric charge experiences a force

1.4 Amount of charge stored per unit volt

1.5 Law that explains why potential difference is directly proportional to electric current at a constant temperature

(5 × 1) **[5]**

QUESTION 2

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) in the ANSWER BOOK.

COLUMN A		COLUMN B	
2.1	Equivalent SI unit for resistance	A	$A.V^{-1}$
2.2	Speed recorded on a speed trap when a driver passes it	B	average speed
2.3	Force acting between two objects being pulled by a rope	C	F = EQ
2.4	Coulomb's law	D	$V.A^{-1}$
2.5	Force inversely proportional to the square of the distance of two charges	E	$F = \frac{KQ_1Q_2}{r^2}$
		F	instantaneous speed
		G	electrostatic force
		H	tension force
		I	electric field at a point
		J	gravitational force

(5 × 1) **[5]**

Copyright reserved

QUESTION 3

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (3.1–3.5) in the ANSWER BOOK.

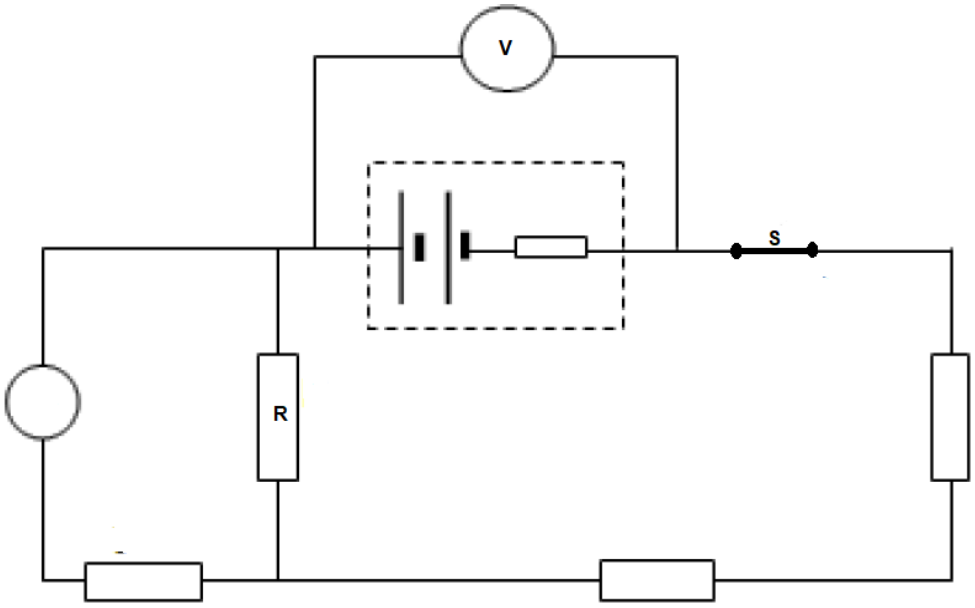
3.1 Accuracy refers to how close a measurement is to the correct value for that measurement.

3.2 The reason trucks struggle to accelerate uphill is because their mass is inversely proportional to their acceleration.

3.3 The shortest distance between a line of action of a force and the pivot is called the rotational distance.

3.4 A transformer steps up or down DC voltages.

3.5



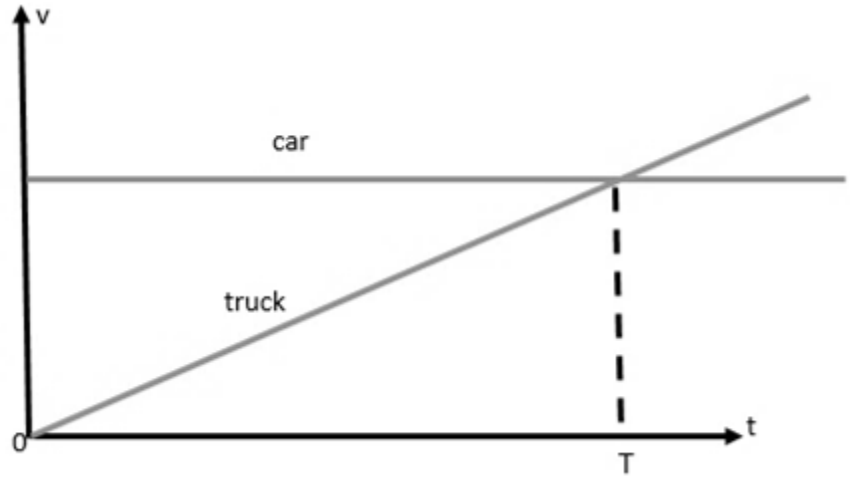
If resistor R is removed and replaced by a wire of negligible resistance, the total current in the circuit decreases.

(5 × 2) **[10]**

QUESTION 4

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (4.1–4.5) in the ANSWER BOOK.

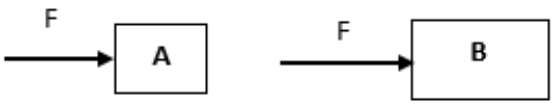
4.1 The motions of a car and a truck along a straight road are represented by the velocity-time graphs below.



Which vehicle has covered a larger distance at T?

A They will have travelled the same distance.
B The car will have travelled further than the truck.
C The truck will have travelled further than the car.
D The car will not have moved.

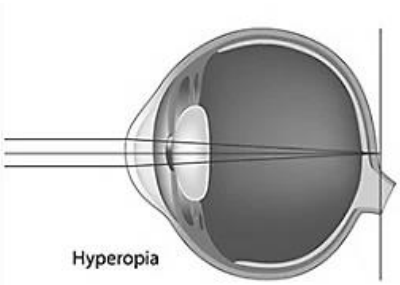
4.2 Equal forces act on each of two objects, A and B, as shown below. The mass of B is three times the mass of A. Ignore the effect of friction.



If the acceleration of object B is x, the acceleration of object A is …

A $\frac{x}{9}$
B $9x$
C $\frac{x}{3}$
D $3x$

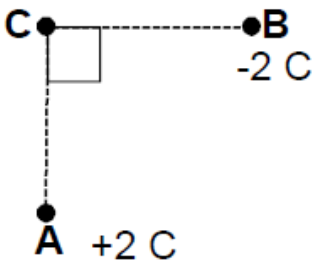
4.3 Far-sightedness is the result of an eyeball being too short, causing the light to project past the retina making near vision blurry as shown in the diagram below.



This problem could most easily be corrected by the use of a/an … lens.

A convex
B concave
C achromatic
D microscopic

4.4 Two charges, +2 C and -2 C, are placed in fixed positions A and B respectively. A positive test charge is placed at position C.



Which ONE of the following arrows indicates the direction of the net electric field at point C?

A 

B 

C 

D 

4.5 When the turns ratio of a transformer is 20 and the primary AC voltage is 12 V, the secondary voltage is …

A 12 V.
B 120 V.
C 240 V.
D 2 400 V.

(5 × 3) **[15]**

TOTAL SECTION A: 35

SECTION B

QUESTION 5: MEASURES

5.1 A car travelling at 100 km/h arrives at its destination after 30 minutes.

What distance did it cover in meters? (3)

5.2 Learners perform an experiment to determine how adding the number of cells in series in a circuit affects the brightness of two bulbs connected in series in that circuit.

From the experiment performed, identify the:

5.2.1 Independent variable

5.2.2 Dependent variable

(2 × 1) (2)
[5]

QUESTION 6: MECHANICS: LINEAR HORIZONTAL MOTION

Traffic officers on the side of a road records a speed of 180 km/h on a speed trap for a car passing by. One officer gets in a police car and chases the car with the siren on. The car driver sees the light of the traffic car behind him and applies the brakes immediately to stop after 25 s after passing the speed trap. The traffic officer accelerated at 2 $m.s^{-2}$ until he caught up with the car.

6.1 Is the 180 km/h recorded on the speedometer the average or the instantaneous velocity? (1)

6.2 Explain the phrase *the officer accelerated by 2 $m.s^{-2}$*. (2)

6.3 Calculate the distance that the car driver travelled before stopping. (4)

6.4 Draw, not according to scale, a graph to show the change in position versus time. Label only the axes and show the shape of the graph. (2)

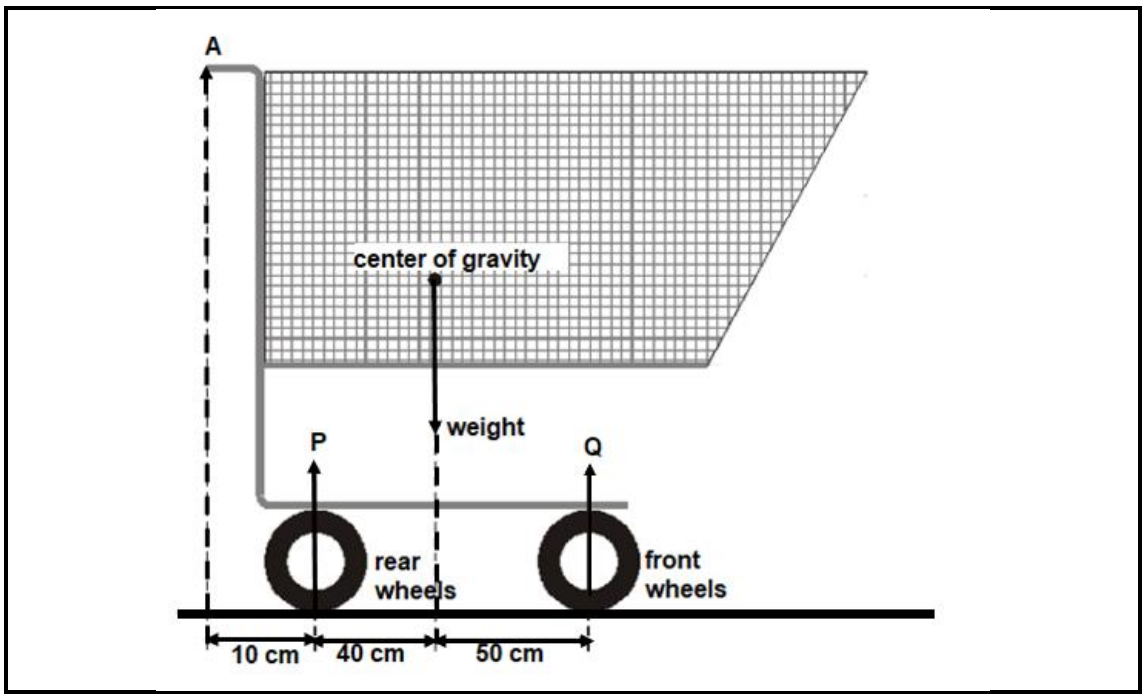
6.5 The average reaction time of humans to a visual stimulus is 0,25 seconds.

Had a cow attempted to cross the road 10 m away since passing the speed trap, would the car driver be able to avoid hitting it at the speed that he was travelling? Perform calculations to prove and explain the answer. (4)

[13]

QUESTION 7: MECHANICS: VECTORS AND PARALLEL FORCES

7.1 The figure below shows a supermarket trolley. The weight of the trolley and its contents is 160 N.



[Adapted from: *www.google.com*]

Explain the term *centre of gravity*. (2)

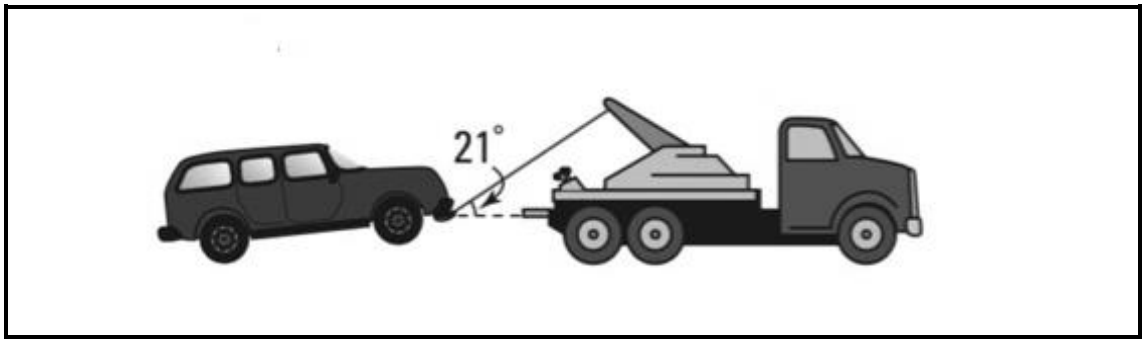
7.2 P and Q are the resultant forces that the ground exerts on the rear and front wheels respectively.

Calculate the magnitude of force:

7.2.1 P (4)

7.2.2 Q (2)

7.3 A tow truck pulls a car with a cable that makes an angle of 21° with the horizontal as shown in the diagram below. The force exerted by the cable is $6,5 \times 10^3$ N.



[Source: *www.google.com*]

7.3.1 Name the force exerted by the rope on the car. (1)

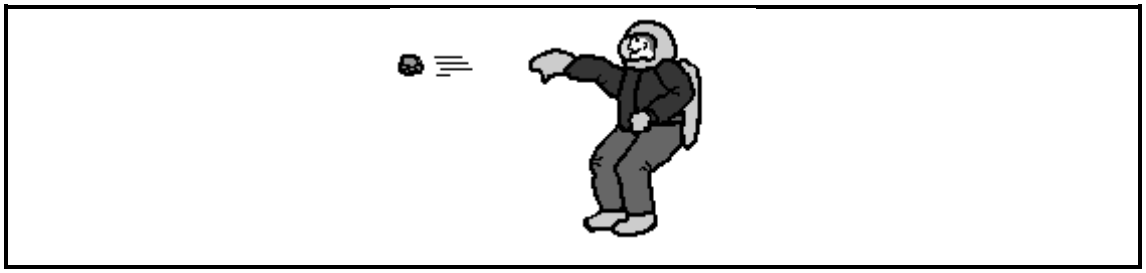
7.3.2 Draw a closed vector diagram labelling all forces acting on the car and the angle. (4)

7.3.3 Calculate the magnitude of the force causing the car to move horizontally. (4)

[17]

QUESTION 8: MECHANICS: NEWTON'S LAWS

8.1 Imagine a place in the cosmos far from all gravitational and frictional influences. Suppose that you visit that place and throw a rock as shown in the diagram below.

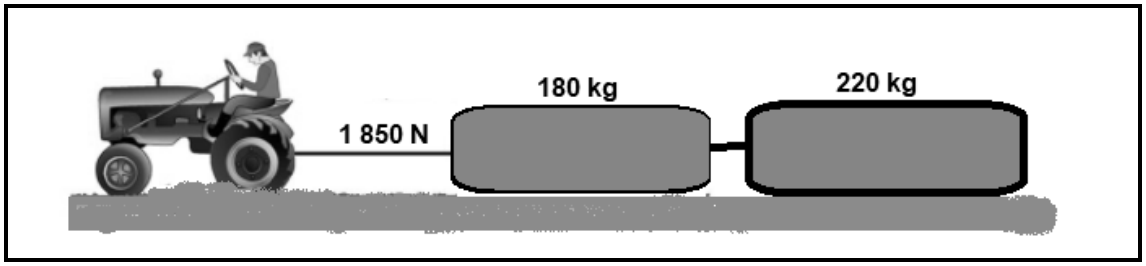


[Source: scienceclass.com]

8.1.1 Explain what will happen to the rock. (2)

8.1.2 Which law explains the observations in QUESTION 8.1.1? (1)

8.2 A tractor is being used to pull two large logs across a field. A chain connects the logs to each other. The front log is connected to the tractor by a separate chain. The mass of the front log is 180 kg. The mass of the back log is 220 kg. The coefficient of friction between the logs and the field is approximately 0,45. The tension in the chain connecting the tractor to the front log is 1 850 N.



[Adapted from: *www.google.com*]

8.2.1 State Newton's second law of motion in words. (2)

8.2.2 Draw free-body diagrams showing all forces acting on the 180 kg log and the 220 kg log in the direction of their respective motions. (3)

8.2.3 Calculate the acceleration of the logs. (7)

8.2.4 Calculate the tension in the chain that connects the logs. (3)

[18]

QUESTION 9: WAVES, SOUND AND LIGHT

9.1 High noise exposure is hazardous to hearing. The relevant physical quantity that explain this is sound intensity.

9.1.1 Which of the properties of light is intensity related to? (1)

9.1.2 Draw TWO separate graphs to show light of …

(a) less intensity

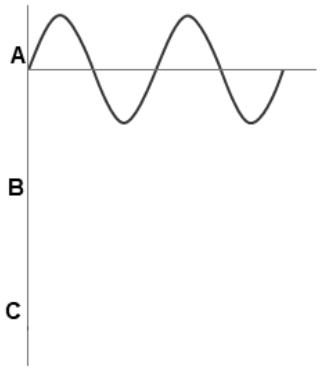
(b) more intensity

(2 × 2) (4)

9.2 People wear noise-cancelling headphones if they want to listen to something alone.

9.2.1 Which type of interference assists a listener to not hear other sounds? (1)

9.2.2 Assuming that the solid line A in the graph below represents incoming noise, redraw pattern A and complete the pattern in B and C to show how the noise gets completely blocked from the listener in C.



(3)

9.3 Thunder is heard three seconds after lightning is seen. The speed of sound is 345 m.s^{-1}.

How far away is the storm? (2)

9.4 Wind instruments like trumpets are generally open pipes. The wavelength of the resonant frequency will be decided by the length of the pipe.

If a sound with a frequency of 384 Hz is produced at the resonant point of $\frac{3}{4}\lambda$ when the length of the air column is 67,5 cm, calculate the speed of the sound produced.

HINT: $\text{Air column } (l) = \text{Resonant point } (\frac{3}{4}\lambda)$ (5)

9.5 After the age of 40 most people find it difficult to see nearby objects. To correct this, doctors recommend glasses with a lens that can allow them to see objects that are near.

9.5.1 Name TWO types of thin lenses. (2)

9.5.2 Name the eye condition when a person cannot see nearby objects. (1)

9.5.3 Which type of lens can be used to correct the condition named in QUESTION 9.5.2? (1)

9.5.4 Draw a ray diagram to show how an image forms from the lens in QUESTION 9.5.3 for an object placed between the optical centre of the lens and the focal point. (5)

[25]

QUESTION 10: ELECTRICITY AND MAGNETISM: ELECTROSTATICS AND ELECTROMAGNETIC INDUCTION

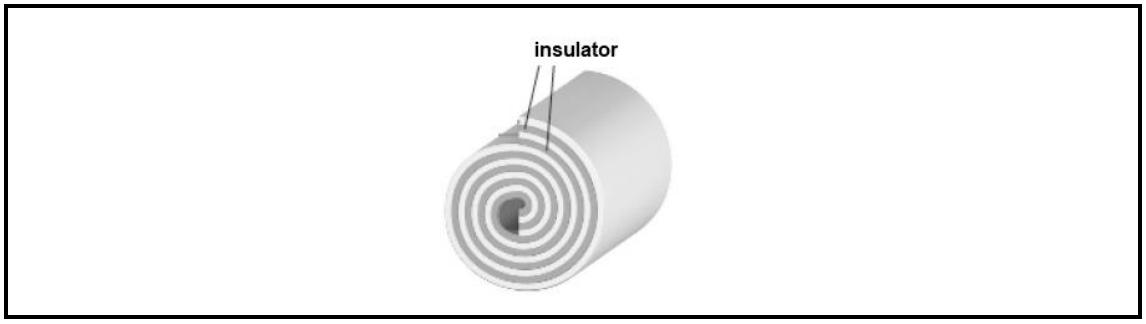
10.1 Electrostatic painting is an innovative method used for painting metals and certain types of plastics. Surface tension forms drops, which are then attracted by unlike charges to the surface to be painted. If the object is a conductor, the electric field is perpendicular to the surface.

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

10.1.2 Draw a diagram to show a pattern of the movement of charge from the paint to the surface. (3)

10.1.3 If dry air between the paint and the surface can support a maximum electric field strength of about $3,0 \times 10^6$ $V.m^{-1}$, calculate the voltage between the spray paint and the surface if the spray paint is 2,5 cm from the surface. (3)

10.2 A capacitor consists of a pair of parallel plates in area A separated by a small distance d. Often the two plates are rolled into the form of a cylinder with a paper or other insulating material as shown below.



10.2.1 Name the insulating material between the parallel plates of a capacitor. (1)

10.2.2 The plates of the parallel plate capacitor in QUESTION 10.2 are 20 cm × 3,0 cm and separated by a 1,00 mm air gap.

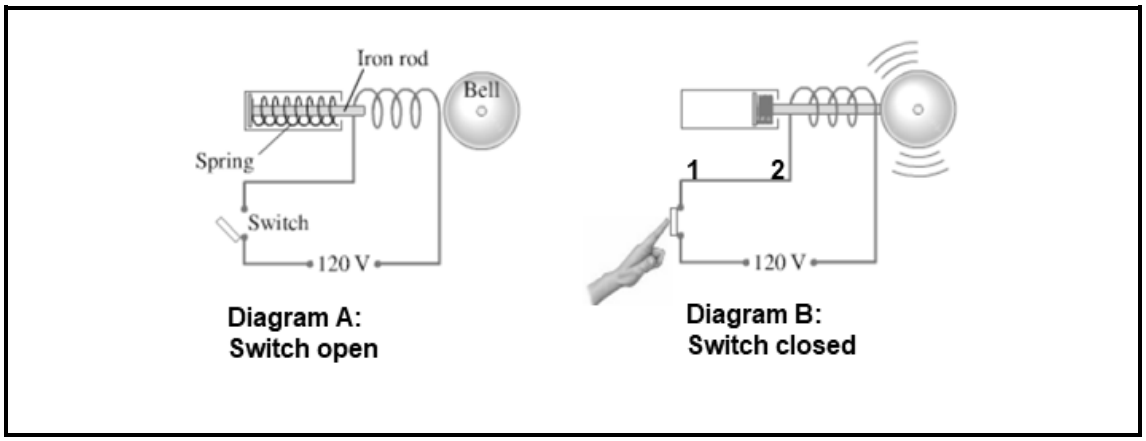
Calculate the charge on each plate.

HINT: The dielectric constant (K) of air is 1. (5)

10.2.3 If the charge in QUESTION 10.2.2 remains constant, draw a graph to show how this will affect the relationship between the potential difference across the plates of the capacitor and the capacitance. (2)

Copyright reserved

10.3 Modern circuit breakers that protect houses and buildings contain magnetic sensors that react quickly. Doorbell magnetic sensors consist of solenoids.



[Adapted from: www.google.com]

10.3.1 When the switch in diagram B is closed, will the direction of the electric current be from 1 to 2 or from 2 to 1? (1)

10.3.2 Name and state the law used to determine the direction of the current in the electric doorbell in QUESTION 10.3.1. (3)

[20]

QUESTION 11: ELECTRICITY AND MAGNETISM: ELECTRIC CIRCUITS

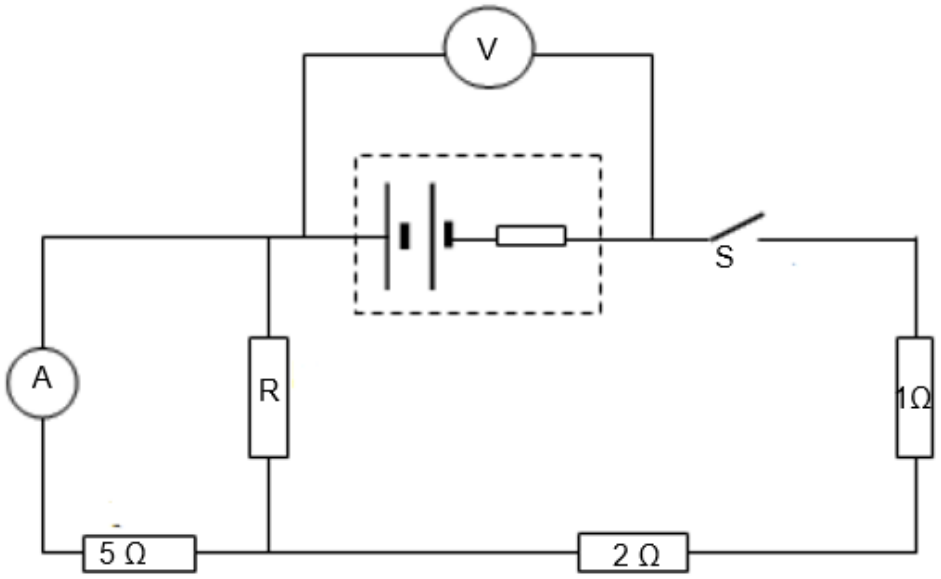
11.1 Electrical energy is very important to everyday living as it is converted to other forms of energy. When paying for an electric bill or buying prepaid electricity, we pay for electrical energy not power. South Africa operates on a 230 V supply voltage. In a particular household, the power for the following devices are:

Electric bulbs:	100 W
Electric radio:	350 W
Electric blow drier:	1 200 W
Electric heater:	1 800 W

11.1.1 Define the term *electric power*. (2)

11.1.2 Which device listed in QUESTION 11.1 uses the most electric current? Explain the answer using a mathematical relationship. (3)

11.2 A toy car has a resistance of 5 Ω and an internal resistance r. A learner uses the circuit below to obtain the potential difference required for the toy car to function. When switch S is closed, the reading on the voltmeter reading drops to 10,5 V and the toy car functions at its maximum power of 4 W.



11.2.1 With the switch open as shown in the diagram, the voltmeter reading is 12 V.

Which value is the 12 V reading on the voltmeter? (1)

11.2.2 Briefly explain why the reading on the voltmeter drops when switch S is closed. (2)

11.2.3 Calculate the internal resistance of the battery. (6)

11.2.4 Calculate the magnitude of the unknown resistor R. (3)

[17]

TOTAL SECTION B: 115
GRAND TOTAL: 150

Copyright reserved

INFORMATION SHEET

PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9{,}8\ m.s^{-2}$
Speed of light in a vacuum	c	$3{,}0 \times 10^{8}\ m.s^{-1}$
Planck's constant	h	$6{,}63 \times 10^{9}\ J.s$
Coulomb's constant	k	$9{,}0 \times 10^{9}\ N.m^{2}.C^{-2}$
Charge of an electron	e	$-1{,}6 \times 10^{-19}\ C$
Electron mass	m_e	$9 \times 10^{-31}\ kg$
Permittivity of free space	ε_0	$8{,}85 \times 10^{-12}\ F.m^{-1}$

Copyright reserved

FORMULA SHEET

MECHANICS

$v = u + at$	$F = \frac{Gm_1m_2}{r^2}$
$v^2 = u^2 + 2as$	$MA = \frac{load}{effort}$
$S = ut + \frac{1}{2}at^2$	$VR = \frac{S_E}{S_R}$
$F = ma$ $Fg = mg$ $W = mg$	$W = F \times s$
$\tau = \perp F.s$	$Efficiency = \frac{MA}{VR}$
$Ek = \frac{1}{2}mv^2$	$R^2 = X^2 + Y^2$
$Ep = mgh$	$Fx = Fcos\theta$
$v = \frac{s}{t}$	$Fy = Fsin\theta$

WAVES, SOUND AND LIGHT

$V = f\lambda$
$T = \frac{1}{f}$

MAGNETISM AND ELECTRICITY

$F = \frac{kQ_1Q_2}{r^2}$	$R_T = R_1 + R_2 + R_3 \ldots$
$E = \frac{kQ}{r^2}$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \ldots$
$C = \frac{\kappa\, \varepsilon o\, A}{d}$	$Q = It$
$C = \frac{Q}{V}$	$V = IR$
$E = \frac{V}{d}$	$V = \frac{W}{Q}$
$E = \frac{F}{q}$	$Emf = I(R + r)$ $Emf = IR + Ir$
$\Delta\Phi B = B \perp A = BAcos\,\theta$	$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_1}{I_2}$
$E = -N\frac{\Delta\Phi B}{\Delta t}$	

Copyright reserved