

EXAMINATION	NATIONAL SENIOR CERTIFICATE
GRADE	12
DATE	NOVEMBER 2024
SUBJECT	PHYSICAL SCIENCES
PAPER	1
MARK TOTAL	150
DURATION (HOURS)	3
NUMBER OF PAGES	20



SOUTH AFRICAN COMPREHENSIVE ASSESSMENT INSTITUTE
SUID-AFRIKAANSE KOMPREENSIEWE ASSESSERINGSINSTITUUT



INSTRUCTIONS AND INFORMATION

1. Answer all questions in the **ANSWER BOOK**.
2. You may use a non-programmable calculator.
3. You may use appropriate mathematical instruments.
4. Number the answers correctly according to the numbering system used in this question paper.
5. **YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.**
6. Give brief motivations, discussions, et cetera, where required.
7. Start **EVERY** question on a **NEW** page in the **ANSWER BOOK**.
8. Leave **ONE** line open between sub questions, e.g. between **QUESTION 2.1** and **QUESTION 2.2**.
9. Show **ALL** the formulae and substitutions in **ALL** calculations.
10. Round the **FINAL** value of the numerical answers off to **TWO** decimal places.
11. Only write in **BLUE** pen.

QUESTION 1

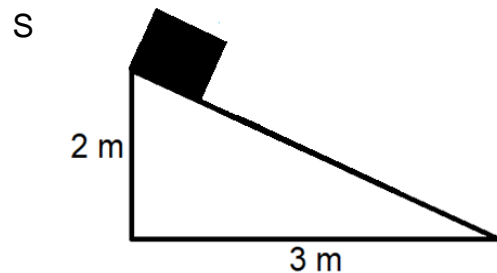
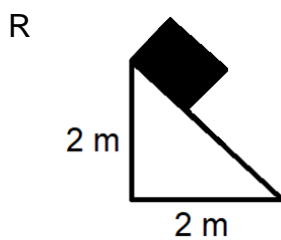
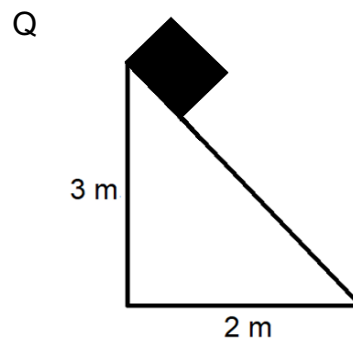
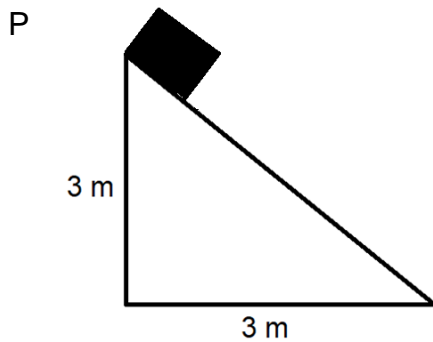
Various options are provided as possible answers to the following questions. Each question has only ONE correct answer. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 Which one of the following forces always acts perpendicular to the surface on which an object is placed?

- A Frictional force
- B Gravitational force
- C Tension force
- D Normal force

(2)

1.2 A block with mass m , sliding down a slope, experiences friction. In which of the following slopes (P to S) will the block experience the same magnitude of friction? (Assume that the coefficient of kinetic friction is the same on all the slopes.)



- A Q and S
- B P and R
- C P and Q
- D R and S

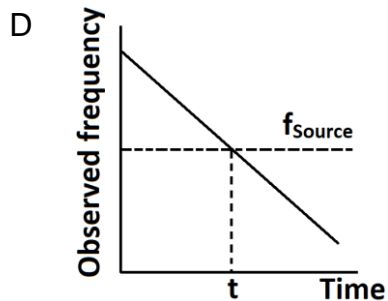
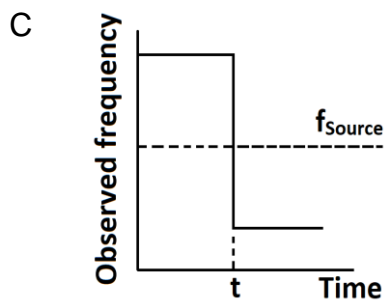
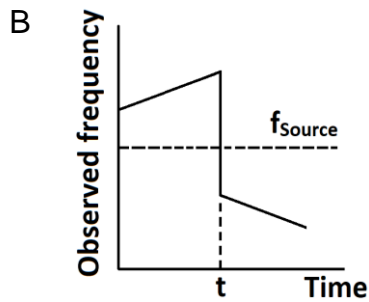
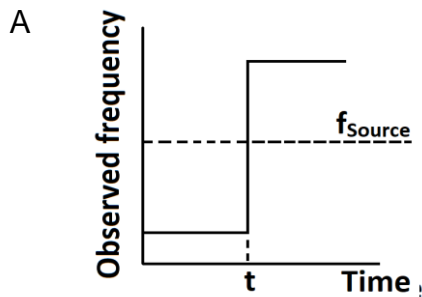
(2)

1.3 An ambulance approaches a stationary listener in a straight line with a constant velocity. The siren of the ambulance emits soundwaves with a frequency of f . What will the effect on the observed frequency be if the frequency of the sound emitted by the siren is changed from f to $2f$ while the ambulance is maintaining a constant velocity?

- A f
- B $2f$
- C $\frac{1}{2}f$
- D f^2

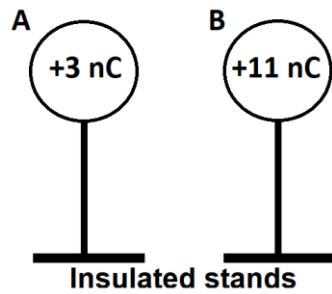
(2)

1.4 A taxi approaches a stationary observer with a constant velocity and hoots. At time t the taxi passes the observer with a constant velocity. Which option below best represents the observed frequency over time?



(2)

- 1.5 Two identical spheres, **A** and **B**, on insulated stands, carry charges of +3 nC and +11 nC respectively. The spheres are brought into contact and then separated.

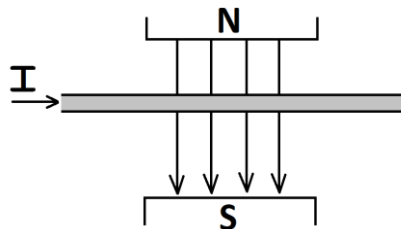


Which one of the following statements is true about sphere **A** and sphere **B** after they made contact and was separated again?

	Sphere A	Sphere B	Direction of electron transfer
A	become more positive	become more negative	A to B
B	become more negative	become more positive	A to B
C	become more negative	become more positive	B to A
D	become more positive	become more negative	B to A

(2)

- 1.6 A current carrying conductor is placed between two magnets, as shown in the diagram below.

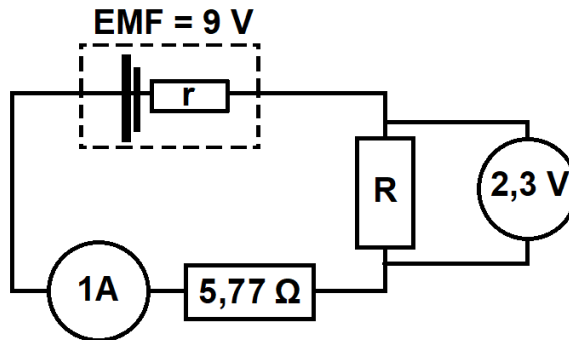


Which one of the following best describes the direction of the force experienced by the conductor?

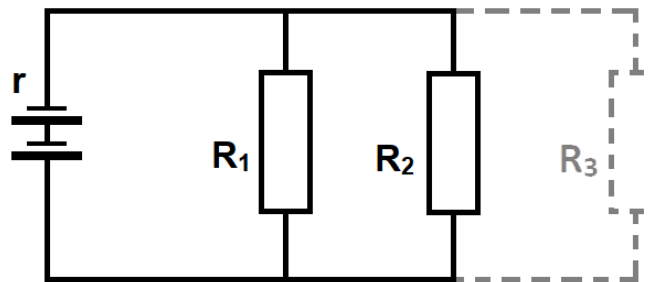
- A to the right
- B to the left
- C into the page
- D out of the page

(2)

- 1.7 Two resistors are connected in series as indicated in the circuit diagram below. Determine the internal resistance of a battery if the battery has an EMF of 9 V.



- A 0,34 Ω
 B 0,93 Ω
 C 1,3 Ω
 D 2 Ω
- (2)
- 1.8 The circuit diagram below shows two resistors (R_1 and R_2) connected to a battery with an internal resistance r .



If a third resistor (as indicated by the dotted line) is added to the parallel connection, how will the total resistance, current and internal resistance of the circuit change?

	Total resistance	Current	Internal resistance
A	Increase	Decrease	Increase
B	Decrease	Increase	Decrease
C	Increase	Decrease	Remains the same
D	Decrease	Increase	Remains the same

(2)

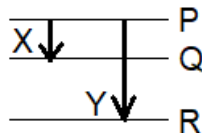


1.9 Learners investigate the effect of intensity of a light source on the average speed of emitted electrons and the current produced by the emitted electrons. They decide to increase the intensity of the light source. Which of the options below best describe the average speed of the emitted electrons and the current produced by a higher intensity light?

	Average speed of emitted electrons	Current produced
A	Increase	Remains constant
B	Increase	Decrease
C	Remains constant	Increase
D	Remains constant	Remains constant

(2)

1.10 The diagram below shows the electron transitions X and Y between different energy levels in an atom.



The wavelength of a photon emitted during transition **X**, from level **P** to **Q**, is λ , and the wavelength of the photon emitted during transition **Y**, from level **P** to **R** is $\frac{1}{3}\lambda$. If the energy difference between levels **P** and **Q** is **E**, then what is the energy difference between **P** and **R**?

- A 2E
- B 3E
- C $\frac{1}{2}E$
- D $\frac{1}{3}E$

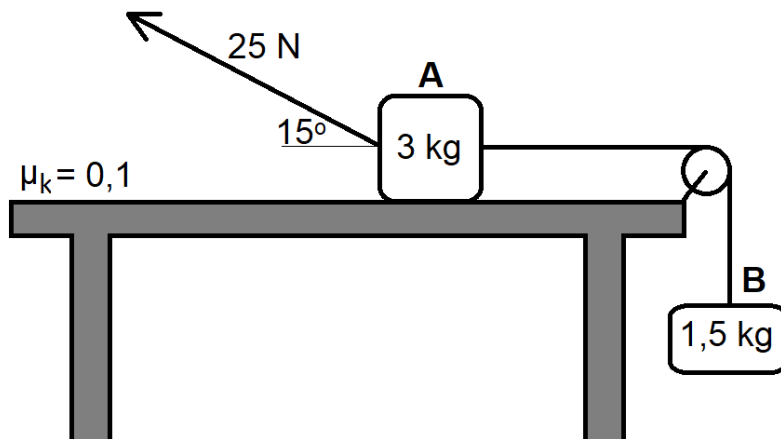
(2)

[20]



QUESTION 2 [Start on a new page]

A 3 kg block rests on a rough horizontal table and is connected to a 1,5 kg block by a light inextensible string, passing over a frictionless pulley. The 1,5 kg block hangs vertically as shown in the diagram below.



A force of 25 N is applied to the 3 kg block at an angle of 15° to the horizontal, causing the block to accelerate to the left. The coefficient of kinetic friction between the 3 kg block and the surface of the table is 0,1. Ignore the effects of air resistance.

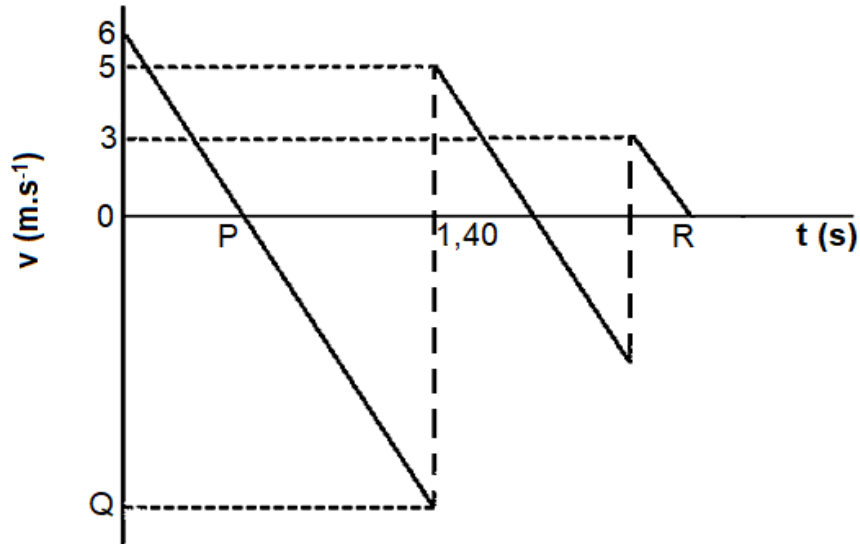
- 2.1 State *Newton's second law* in words. (2)
- 2.2 Calculate the magnitude of the kinetic frictional force acting on **block A**. (4)
- 2.3 Apply Newton's Second Law to **each** block and calculate the magnitude of the acceleration of **block B**. (6)
- 2.4 The applied force is **removed**. How will each of the following be affected? Choose from INCREASES, DECREASES or REMAINS THE SAME.
 - 2.4.1 normal force (1)
 - 2.4.2 coefficient of kinetic friction (1)

[14]

QUESTION 3 [Start on a new page]

A learner throws a ball **vertically upwards** but fails to catch the ball on its way downwards. The ball falls to the ground and bounces a few times as it hits the ground. The velocity-time graph below describes the motion of the ball from the time it is thrown, up to an unknown time **R**. The graph is not draw to scale. Ignore the effects of air resistance.

Take downwards as the negative direction.



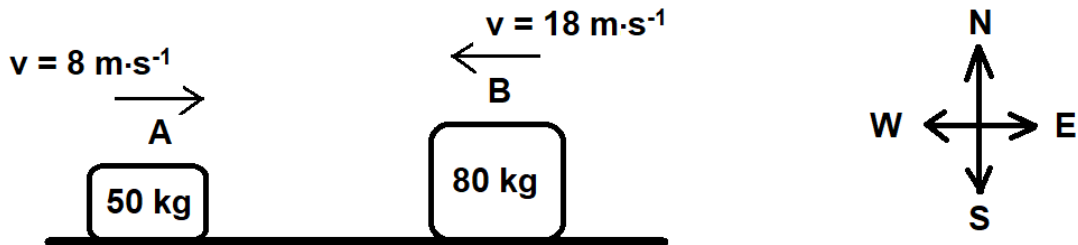
- 3.1 With what velocity was the ball thrown upwards? (1)
- 3.2 Calculate the time indicated by point **P** on the graph. (3)
- 3.3 Calculate the magnitude of the velocity indicated by point **Q** on the graph. (3)
- 3.4 **Without using equations of motion**, calculate the height from which the ball is thrown. (4)
- 3.5 Calculate the time (**R**) shown on the graph. (4)

[15]

QUESTION 4 [Start on a new page]

Two blocks slide on a frictionless surface towards one another. Block **A** of mass 50 kg travels east at a velocity of $8 \text{ m}\cdot\text{s}^{-1}$. Block **B** of mass 80 kg travels west at a velocity of $18 \text{ m}\cdot\text{s}^{-1}$. The two blocks collide head on with each other.

BEFORE



Immediately after the collision, block **A** moves west at $5 \text{ m}\cdot\text{s}^{-1}$.

AFTER

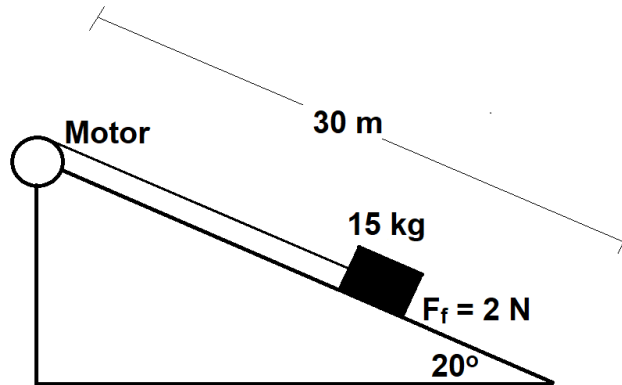


- 4.1 State the *Principle of conservation of linear momentum* in words. (2)
- 4.2 Calculate the velocity of block **B** immediately after the collision. (5)
- 4.3 Explain in words what is meant by an *elastic collision*. (2)
- 4.4 Use a calculation to determine if the collision was elastic or inelastic. (5)

[14]

QUESTION 5 [Start on a new page]

A block with a mass of 15 kg, that is attached to a motor, is being pulled upwards over a 30 m long slope with a **constant velocity**. The slope is inclined at 20° to the horizontal.



The frictional force experienced between the object and the slope is 2 N.

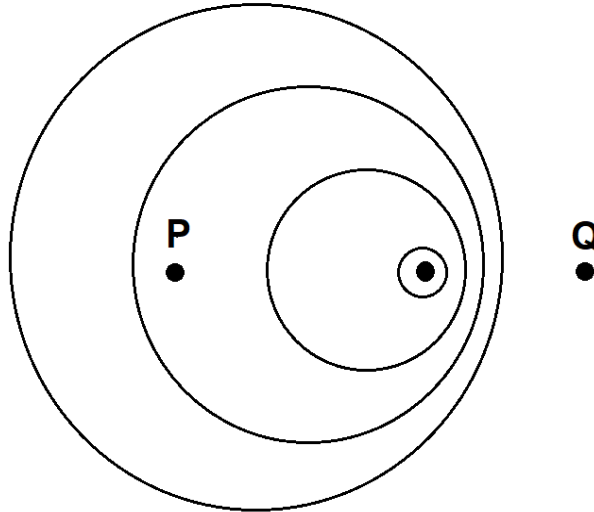
- 5.1 Define *work done on a block by a constant force* in words. (2)
- 5.2 Draw a free-body diagram of all the forces acting on the block. (4)
- 5.3 Calculate the work done **by the motor** to pull the block 30 m up the slope. (5)
- 5.4 Make use of **energy principles** to calculate the increase in potential energy as the block is pulled to the top of the slope. (3)

[14]

QUESTION 6 [Start on a new page]

A train is travelling **towards** a station at a constant velocity of $30 \text{ m}\cdot\text{s}^{-1}$ while sounding its horn. The horn of the train produces sound of frequency 375 Hz . Take the speed of sound in air as $340 \text{ m}\cdot\text{s}^{-1}$.

The diagram below shows the wave fronts of the sound produced from the horn as a result of this motion.



- 6.1 State the *Doppler effect* in words. (2)
- 6.2 At which side of the diagram, **P** or **Q**, is the station situated? Give a reason for the answer. (2)
- 6.3 Calculate the frequency of the sound of the horn heard by a person standing on the platform at the train station. (4)
- 6.4 An engineer is sitting next to the train driver as the train approaches the station. Calculate the wavelength of the sound heard by the engineer. (3)

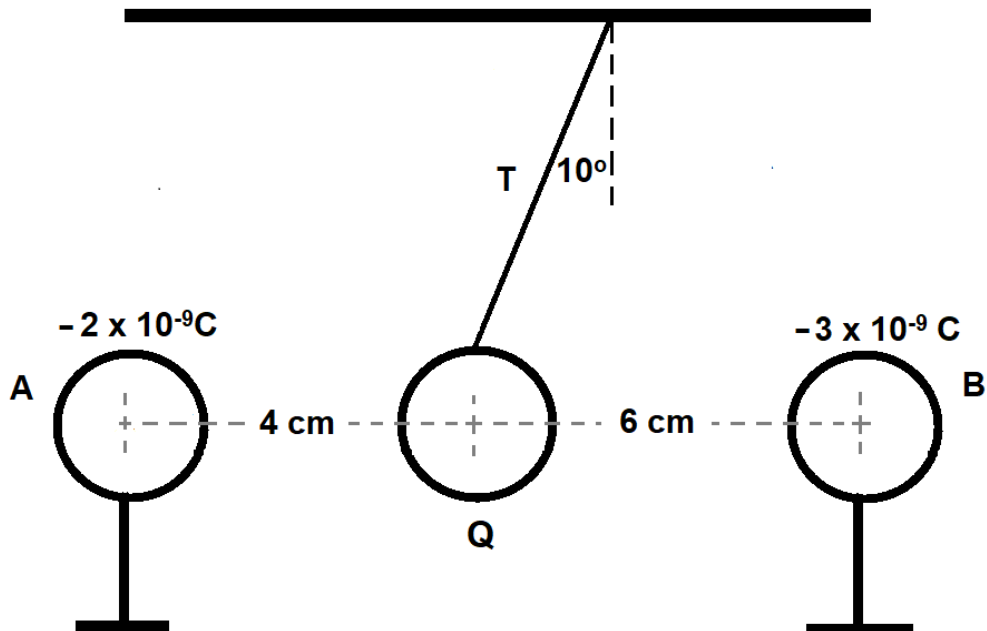
[11]



QUESTION 7 [Start on a new page]

7.1 Spheres **A** and **B**, with a charge of $-2 \times 10^{-9} \text{ C}$ and $-3 \times 10^{-9} \text{ C}$ respectively, are placed on insulated stands.

Negative sphere **Q** hangs in **equilibrium** from the roof (at an angle of 10° to the vertical) by an inextensible, insulated string.



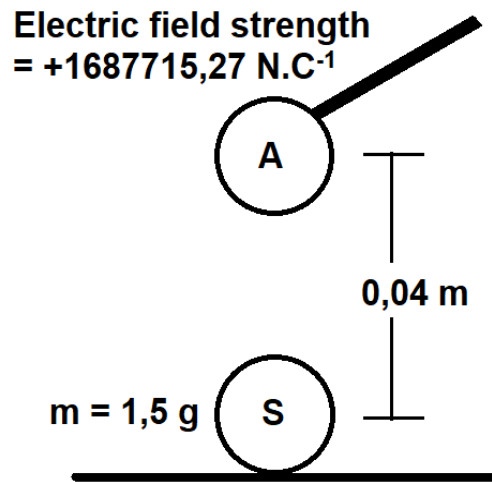
Spheres **A**, **Q** and **B**, lie on the same horizontal line as indicated by the diagram above. Sphere **Q** has a mass of $1,953 \times 10^{-5} \text{ g}$. The diagram is not drawn to scale.

7.1.1 State *Coulomb's law* in words. (2)

7.1.2 Draw a free body diagram of all the forces acting on sphere **Q**. (4)

7.1.3 Calculate the charge on sphere **Q**. (7)

- 7.2 The diagram below indicates a small, charged metal ball (**A**) with an electric field strength of $1687715,27 \text{ N.C}^{-1}$, attached to an insulated rod. The small metal ball (**A**) is held $0,04 \text{ m}$ directly above a similar $1,5 \text{ g}$ ball with an unknown charge, which lies stationary on an insulated table.

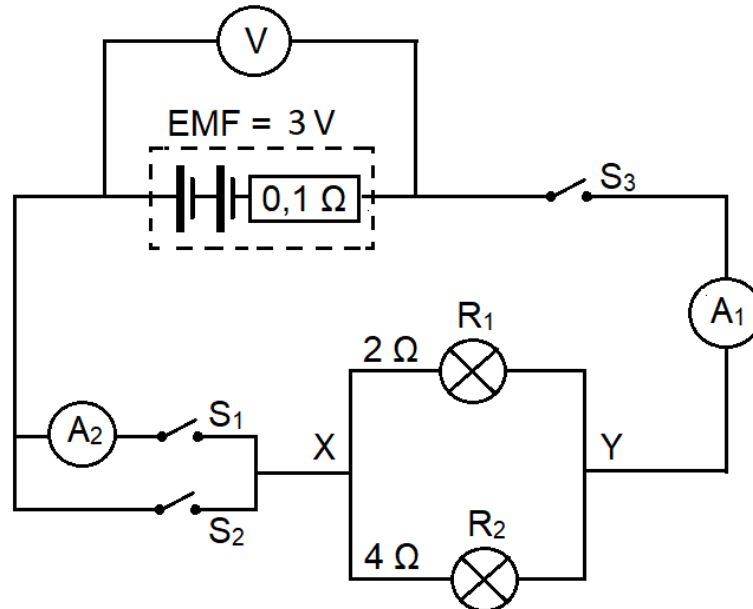


- 7.2.1 Draw a diagram showing the electric field pattern around the small metal ball (**A**). Treat this charge as an isolated charge. (2)
- 7.2.2 Calculate the magnitude of charge **S**, of the $1,5 \text{ g}$ ball, just before it is picked up by the electrostatic force. (6)

[21]

QUESTION 8 [Start on a new page]

The circuit diagram below shows two light bulbs connected in parallel to a battery with an EMF of 3 V and an internal resistance of $0,1 \Omega$. The battery is connected to two switches (S_1 and S_2) in parallel as well as to two bulbs (R_1 and R_2) in parallel. A third switch (S_3) is connected in series with the battery. Ammeters A_1 and A_2 measure the current at their respective positions while voltmeter V reads the potential difference across the battery.



8.1 State *Ohm's Law* in words. (2)

WITH SWITCH S_1 AND S_3 CLOSED

8.2 Calculate the total external resistance of the circuit. (3)

8.3 Calculate the current that passes through ammeter A_1 . (3)

8.4 Calculate the reading on voltmeter V . (3)

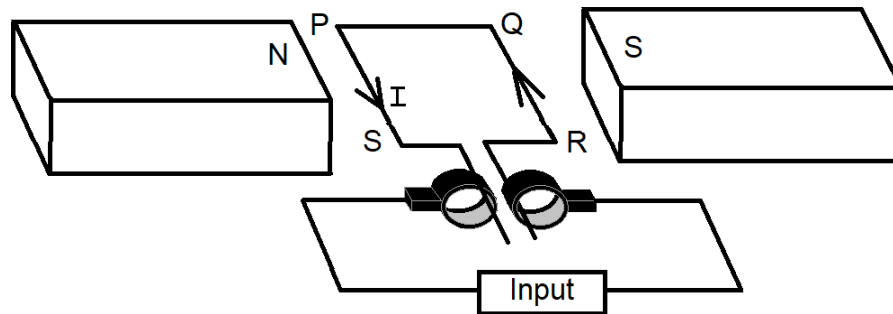
8.5 Explain what happens to the reading on A_2 if switch S_2 is ALSO closed? (2)

8.6 Calculate the power dissipated in resistor R_2 . (3)

[16]

QUESTION 9 [Start on a new page]

9.1 The diagram below is a simplified representation of a motor. When the coil is in the position indicated below current flows from R to Q.

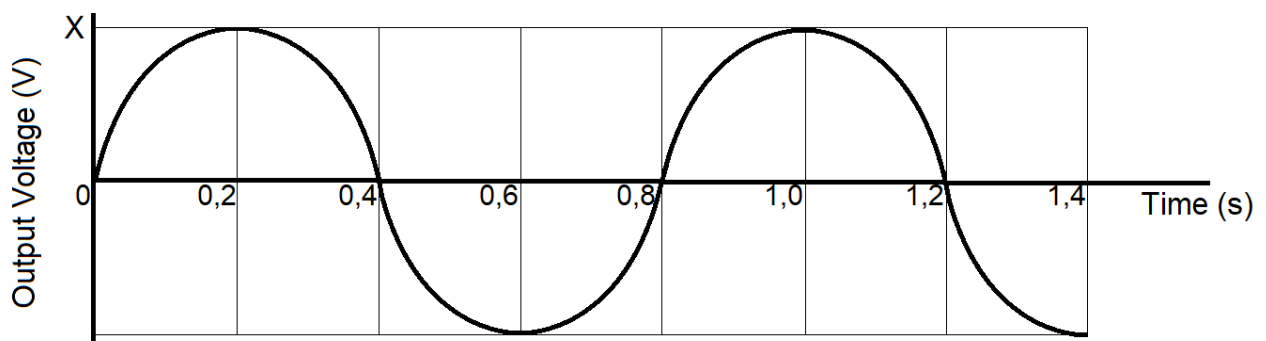


9.1.1 Is this a DC motor or an AC motor? Give a reason for the answer. (2)

9.1.2 What energy conversion takes place in the motor above? (1)

9.1.3 Besides using stronger magnets or an adjusted input source, state TWO ways in which the voltage of the motor can be increased. (2)

9.2 The graph below shows the output voltage produced from an AC generator. Point X represents the maximum voltage produced by the AC generator.



9.2.1 How many rotations are made by the coil? (1)

9.2.2 Determine the frequency of the alternating current depicted in the graph above. (2)

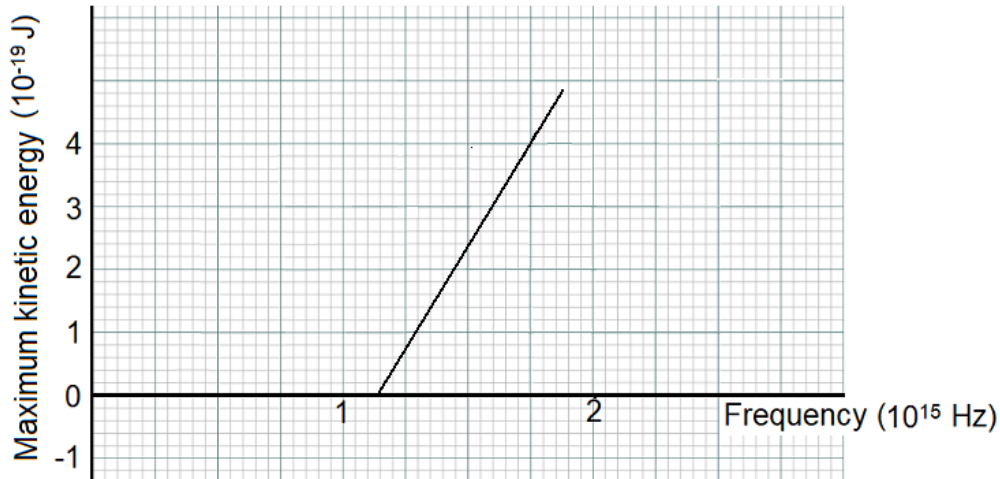
9.2.3 Calculate the maximum voltage (X) produced by the generator if the generator has an output of 2 160,35 W and produces a maximum current of 18 A. (4)

9.2.4 Copy the set of axes above in your ANSWER BOOK and sketch the graph of output voltage versus time for 1,4 s if a DC source is used instead of the AC source. (2)

[14]

QUESTION 10 [Start on a new page]

10.1 The graph below represents data for an investigation regarding the maximum kinetic energy of the emitted photoelectrons and the frequency of emitted light when photons are radiated on a metal surface.



10.1.1 Define the term *work function* in words. (2)

10.1.2 Calculate the work function of the metal. (3)

10.2 A source of bright red light and a source of faint blue light are shone in turn on to the metal surface for the same length of time. In both cases, electrons are ejected from the metal surface.

10.2.1 The wavelength of blue light is 440 nm. Calculate the energy of a photon from this source. (3)

10.2.2 Why is the maximum kinetic energy of the electrons ejected by **faint blue light** greater than the maximum kinetic energy of the electrons ejected by **bright red light**? (3)

[11]

GRAND 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 <i>Swaartekragversnelling</i>	g	9,8 m·s ⁻²
Universal gravitational constant <i>Universele gravitasiekonstante</i>	G	6,67 x 10 ⁻¹¹ N·m ² ·kg ⁻²
Radius of the Earth <i>Radius van die Aarde</i>	R _E	6,35 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 or q _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

$v_f = v_i + a\Delta t$ or/of $v_f = v_i + g\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$ or/of $\Delta y = v_i\Delta t + \frac{1}{2} g\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ or/of $v_f^2 = v_i^2 + 2g\Delta y$	$\Delta x = \left(\frac{v_f - v_i}{2}\right)\Delta t$ or/of $\Delta y = \left(\frac{v_f - v_i}{2}\right)\Delta t$

FORCE/KRAG

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$ or/of $F_g = mg$
$F = \frac{GmM}{r^2}$ or/of $g = \frac{GM}{r^2}$	$F_s^{max} = \mu_s N$ $f_k = \mu_k N$

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

WAVES, SOUND AND LIGHT / GOLWE, KLANK EN LIG

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \left(\frac{v \pm v_L}{v \pm v_s}\right) f_s$	$E = hf$ or/of $E = \frac{hc}{\lambda}$
$E = W_o + K_{max}$ or/of $E = W_o + E_{k(max)}$	
$E = hf$ and/en $W_o = hf_o$ and/en $K_{max} = \frac{1}{2}mv_{max}^2$ or/of $E_{k(max)} = \frac{1}{2}mv_{max}^2$	

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 $n = \frac{Q}{q_e}$	$V = \frac{W}{q}$

ELECTRIC CIRCUITS / ELEKTRIESE STROOMBANE

$R = \frac{V}{I}$	$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
$R_s = R_1 + R_2 + \dots$	emf = I(R + r) or/of emk = I(R + r)
$q = I\Delta t$	
$P = \frac{W}{\Delta t}$	$W = Vq$
$P = VI$	$W = VI\Delta t$
$P = I^2R$	$W = I^2R\Delta t$
$P = \frac{V^2}{R}$	$W = \frac{V^2\Delta t}{R}$

ALTERNATING CURRENT / WISSELSTROOM

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ or/of $I_{wgk} = \frac{I_{maks}}{\sqrt{2}}$	$P_{ave} = V_{rms} I_{rms}$ or/of $P_{gem} = V_{wgk} I_{wgk}$
$V_{rms} = \frac{V_{max.}}{\sqrt{2}}$ or/of $V_{wgk} = \frac{V_{maks}}{\sqrt{2}}$	$P_{ave} = I_{rms}^2 R$ or/of $P_{gem} = I_{wgk}^2 R$
	$P_{ave} = \frac{V_{rms}^2}{R}$ or/of $P_{gem} = \frac{V_{wgk}^2}{R}$