GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PREPARATORY EXAMINATION

2022

10841

PHYSICAL SCIENCES: PHYSICS

PAPER 1

TIME: 3 hours

MARKS: 150

17 pages + 3 data sheets and an answer sheet

PHYSICAL SCIENCES: Paper 1

10841E

X05

INSTRUCTIONS AND INFORMATION

1. This question paper consists of TEN questions. Answer ALL the questions in the ANSWER BOOK.

2. You may use a non-programmable calculator.

3. You may use appropriate mathematical instruments.

4. You are advised to use the attached DATA SHEETS.

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

6. Write neatly and legibly.

7. Start EACH question on a NEW page in the ANSWER BOOK.

8. Leave ONE line between two sub-questions, for example, between QUESTION 2.1 and QUESTION 2.2.

9. Show ALL formulae and substitutions in ALL calculations.

10. Round-off your FINAL numerical answers to a minimum of TWO decimal places, where needed.

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

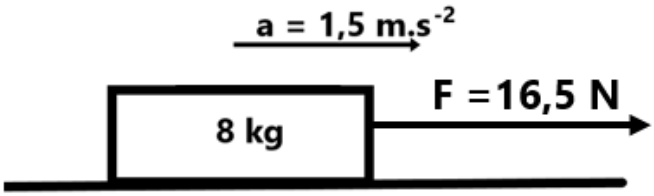
QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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 numbers (1.1 to 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 Which of the following best illustrates balanced forces?

A A person lifting a heavy object from the ground
B A big rock free-falling to the ground
C A light stationary object
D A force of a box on the earth and a force of the earth on the box (2)

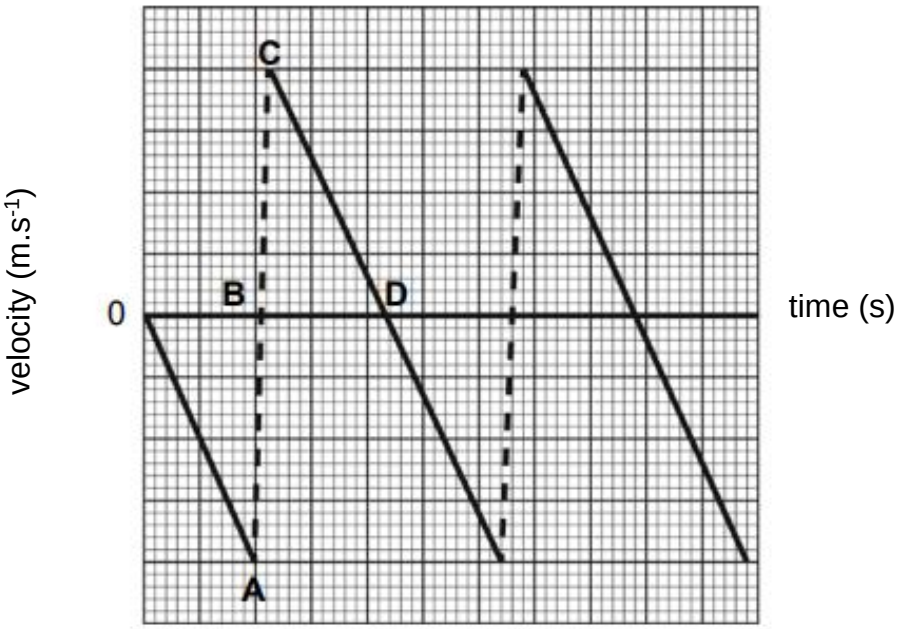
1.2 An 8 kg box is placed on a rough surface as shown below.



If a force of 16,5 N is applied to the box, it accelerates at 1,5 $m \cdot s^{-2}$ to the right. The frictional force between the 8 kg box and the surface is ...

A 0 N.
B 4,5 N.
C 10,3 N.
D 29,4 N. (2)

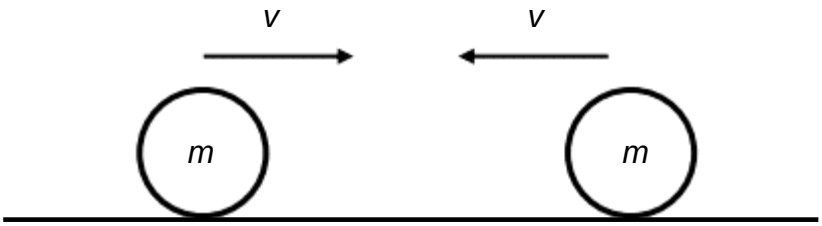
1.3 A ball is dropped from a certain height above the ground and bounces a few times as it hits the ground. The velocity-time graph below describes the motion of the ball from the time it is dropped. Ignore all the effects of air friction.



In relation to the velocity-time graph for the bouncing ball shown above, which statement below is correct?

A Down is taken as the positive direction and the ball is at the highest position of its bounce at point C.
B Down is taken as the positive direction and the ball is at the highest position of its bounce at point D.
C Down is taken as the negative direction and the ball is at the highest position of its bounce at C.
D Down is taken as the negative direction and the ball is at the highest position of its bounce at D. (2)

1.4 Two identical solid spheres, each with a mass ***m*** and travelling at a speed ***v***, move towards each other in an isolated system. The spheres have a head-on **elastic collision**.



Which statement is correct for the collision as described above?

A The spheres stick together on impact.
B The total kinetic energy after impact is mv^2.
C The total kinetic energy before impact is zero.
D The total momentum before impact is 2mv. (2)

1.5 The mechanical energy of a moving object will remain constant if …

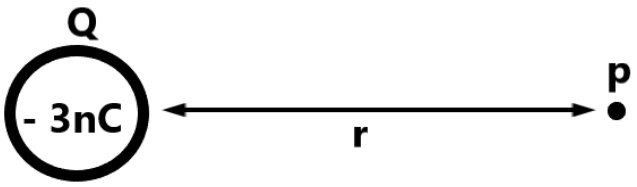
A there are frictional forces present.
B there is only gravitational force acting on it.
C only the kinetic energy remains constant.
D only the gravitational potential energy remains constant. (2)

1.6 A train is moving at a constant velocity of 10 $m \cdot s^{-1}$ while sounding its whistle which has a frequency of 500 Hz.

Take the speed of sound in air as 340 $m \cdot s^{-1}$. What frequency will be heard by a man sitting in the train?

A 500 Hz
B More than 500 Hz
C Less than 500 Hz
D No sound will be heard. (2)

1.7 The diagram below shows a point ***p*** at a distance ***r*** from a charged sphere ***Q***.



The electric field strength at point ***p*** is …

A directly proportional to ***r*** and to the right.
B directly proportional to the square of ***r*** and to the left.
C inversely proportional to the square of ***r*** and to the right.
D inversely proportional to the square of ***r*** and to the left. (2)

1.8 Which of the following statements about an AC generator is TRUE?

A The minimum potential difference produced is not zero volts.
B The emf produced decreases as the number of windings in the armature increases.
C The maximum value of the AC can be increased by increasing the period of rotation.
D The maximum value of the AC produced can be increased by increasing the speed of rotation of the coil. (2)

1.9 A battery with internal resistance is connected to a fixed resistor **R**.
A voltmeter is connected across the battery as in diagram **A**. The battery is replaced by one with the same emf but with a larger internal resistance **(r),** as shown in diagram **B.**

In diagram **B**: How would the voltmeter reading and the current through the fixed resistor change, compared to diagram **A,** when switch **S** is closed?

Diagram A

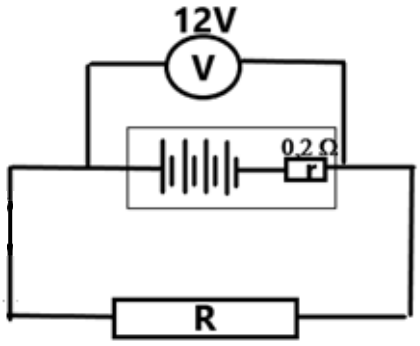
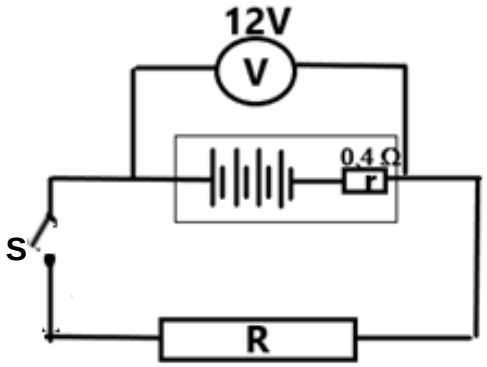


Diagram B

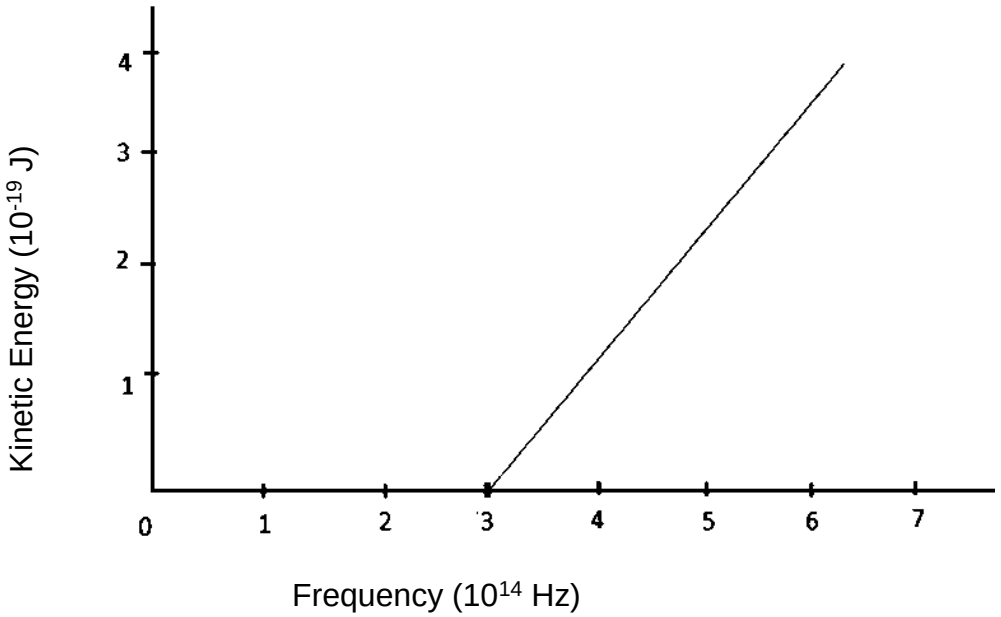


	Voltmeter reading	**Current through resistor**
A	Decreases	Decreases
B	Decreases	Stays the same
C	Stays the same	Decreases
D	Stays the same	Stays the same

(2)

1.10 The graph below shows the kinetic energy versus frequency for a photocell that has a sodium metal cathode.

The work function of sodium is 4,41 x 10^{-19} J.



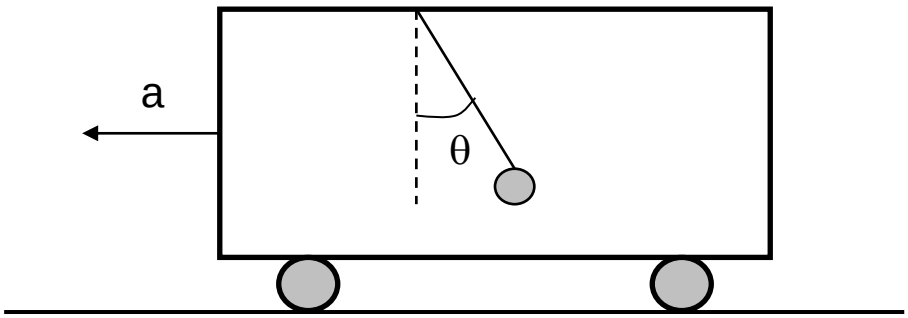
The threshold frequency of sodium is ...

A 4,41 x 10^{14} Hz.
B 3 x 10^{14} Hz.
C 3 x 10^{14} J.
D 4,41 x 10^{-19} J. (2)

[20]

QUESTION 2 (Start on a new page.)

A group of learners design a device that consists of a light ball on a string hanging from the roof of a cargo truck. This device is used to determine the acceleration of the truck. When the truck is stationary or moving at a constant speed, the ball will hang straight down, but when it is undergoing a constant acceleration, the ball hangs down at an angle θ, as shown in the diagram below.



2.1 Draw a free body diagram of all the forces acting on the ball. (2)

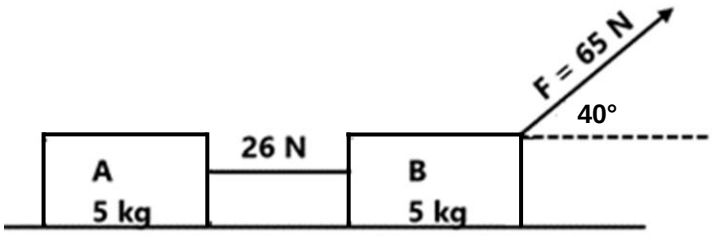
2.2 In this case the mass of the ball is 50 g and the angle θ is 18°.

Calculate the:

2.2.1 Horizontal force on the ball (4)

2.2.2 Magnitude of the acceleration of the truck (3)

2.3 **A** and **B** below are two identical blocks, each with a mass of 5 kg, joined together by a light inextensible string. The blocks are being pulled with a force of 65 N at an angle of 40° to the horizontal. The two blocks accelerate to the right at an acceleration of 2,17 $m \cdot s^{-2}$ and the tension in the rope is 26 N.



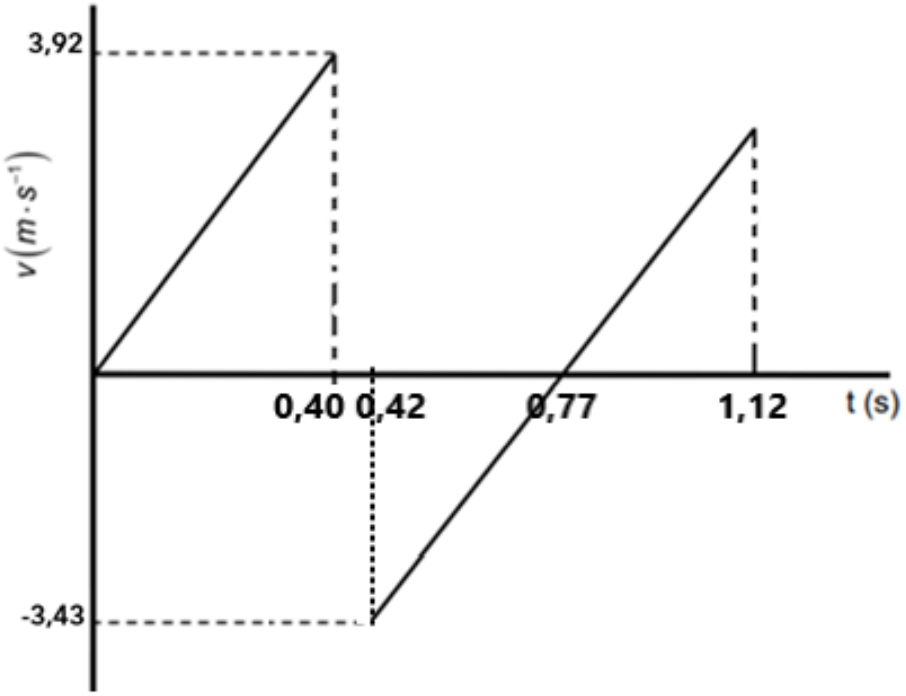
2.3.1 Calculate the friction on each block. (5)

2.3.2 Explain why the frictional forces on the two blocks differ. (3)

[17]

QUESTION 3 (Start on a new page.)

A 50 g ball is dropped from a certain height. The velocity-time graph below represents the motion of the ball as it bounces vertically on a concrete floor. The time of contact during the bounce is 0,02 s. Ignore all effects of air friction.



3.1 Define a *projectile*. (2)

3.2 Write down the magnitude of the velocity with which the ball leaves the ground after bouncing. (1)

3.3 Draw a labelled free-body diagram showing all the forces acting on the ball at 0,77 s. (2)

3.4 Use the information given on the graph and calculate the:

3.4.1 Acceleration of the ball (3)

3.4.2 Height from which the ball was dropped (4)

3.5 On a set of axes, draw a position-time graph for the motion of the ball from 0 s to 1,12 s. Use the ground as zero reference. Indicate the height from which the ball was dropped and all the relevant times on the t-axis on your graph. (4)

3.6 Give ONE term for the rate of change of momentum. (2)

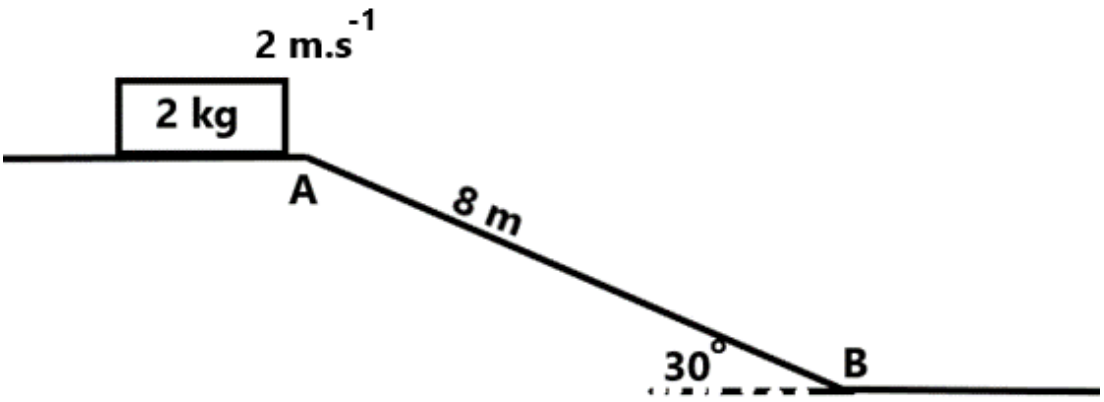
3.7 Calculate the magnitude of the force exerted by the floor on the ball for the time of contact. (3)

3.8 If a softer ball is used and the time of contact with the floor is increased while the change in momentum remains constant, how will it influence the force on the ball? Write only INCREASES, DECREASES or REMAINS THE SAME.

Explain the answer. (3)
[24]

QUESTION 4 (Start on a new page.)

A wooden box slides down a rough 8 m long inclined plane **AB**. The initial velocity of the box at **A** is 2 m·s^{-1} as shown in the diagram below.



4.1 Define a *conservative force*. (2)

4.2 Name the conservative force in the diagram above. (1)

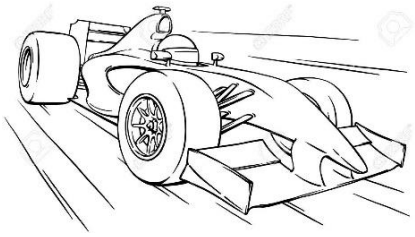
4.3 State the work-energy theorem in words. (2)

4.4 The velocity of the block at point **B** is 6,92 m·s^{-1}. Use ENERGY PRINCIPLES ONLY to calculate the frictional force that the block experiences as it moves from point **A** to point **B**. (4)

4.5 The coefficient of friction for the last horizontal stretch after point **B** is 0,35. Calculate the distance the block will travel before coming to a complete stop without using equations of motion. (4)
[13]

QUESTION 5 (Start on a new page.)

Grade 12 learners conduct an investigation to verify the speed of a race car using the Doppler effect. A race car driving around a racecourse at constant speed emits a single frequency of 200 Hz. A learner standing on the final straight records the sound using a cell phone, as the car approaches him and after passing him.



5.1 For this investigation, write down the following:

5.1.1 A dependent variable (2)

5.1.2 One controlled variable (2)

5.1.3 A suitable investigative question for this experiment (2)

5.2 When playing back the sound recorded on the cell phone in the presence of an oscilloscope, a difference in frequency of 67,15 Hz was registered. Use the information above to calculate the speed of the race car. Take the speed of sound in air as 340 $m \cdot s^{-1}$. (5)

5.3 The spectrum of light from most stars contains lines corresponding to helium gas.

Diagram **A** shows the helium spectrum as observed in a laboratory.

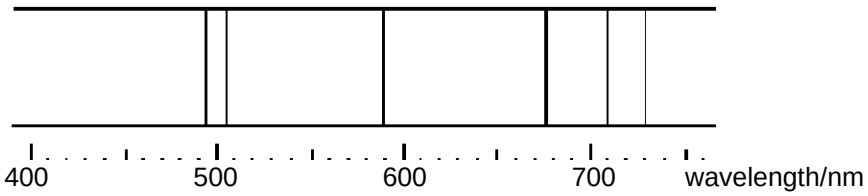
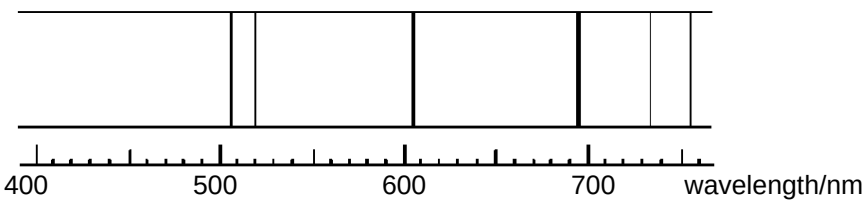


Diagram **B** shows the helium spectrum of light from a distant star.

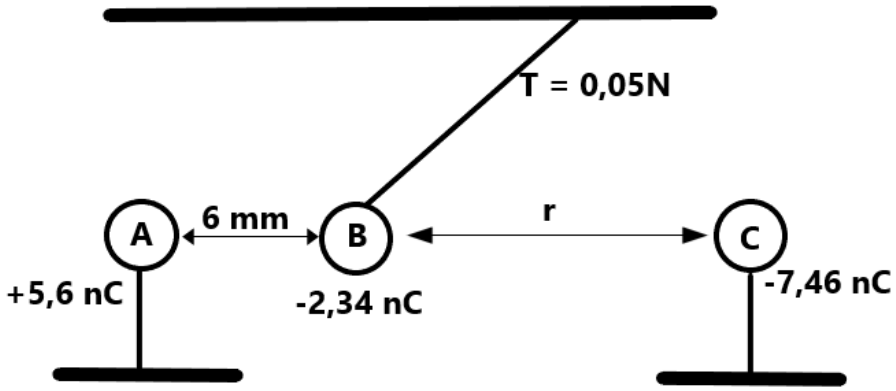


5.3.1 Is the distant star moving AWAY FROM or TOWARDS the earth? Explain the answer. (3)

[14]

QUESTION 6 (Start on a new page.)

A small polystyrene sphere, **B**, hangs from the ceiling and is attached by a string of negligible mass. Two other spheres, **A** and **C** are suspended on insulated stands. The charges on each sphere are **A** = +5,6 nC, **B** = - 2,34 nC and **C** = -7,46 nC. The mass of sphere **B** is 5,085 x 10^{-3} kg. Assume that the surfaces of all the three spheres are conducting.



6.1 Define *electrical field strength at a point*. (2)

6.2 Sketch the electric field pattern around spheres **B** and **C** if **A** was removed. (3)

6.3 Charge **B** experiences a net force of 0,004078 N due to charges **A** and **C**. Find the distance, **r**, between charges **B** and **C**. (5)

6.4 Charges **A** and **B** are allowed to touch and then moved back to the original distance between them.

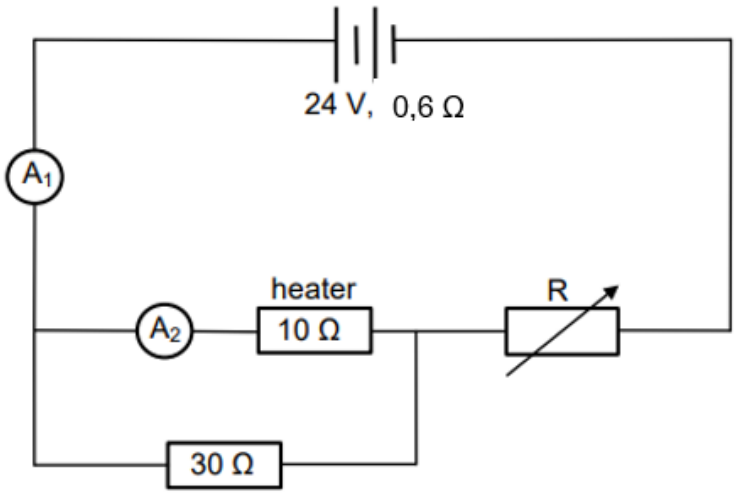
6.4.1 Calculate the new charge on each sphere. (2)

6.4.2 Explain the change, if any, to the field pattern between **B** and **C**. (3)

[15]

QUESTION 7 (Start on a new page.)

In the circuit below, the battery has an emf of 24 V and an internal resistance of 0,6 Ω. The heater has a resistance of 10 Ω and the fixed resistor has a resistance of 30 Ω. The variable resistor, **R**, can change between 0 Ω and 15 Ω.



7.1 The variable resistor, **R**, is set at a resistance of 3,5 Ω.

Calculate:

7.1.1 The total resistance of the circuit (including the battery) (5)

7.1.2 The current measured by ammeter A_2 (3)

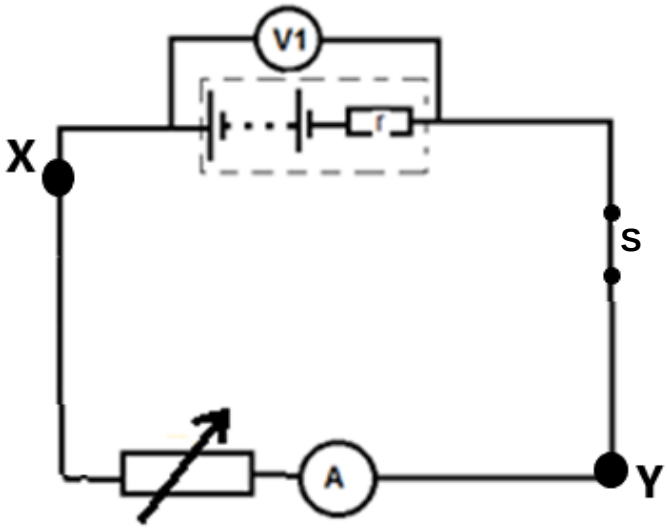
7.2 The variable resistor is now adjusted to have an even higher resistance value.

How will this affect the power dissipated by the heater? Write only INCREASES, DECREASES or REMAINS THE SAME. Explain the answer by making use of a suitable equation. (3)

[11]

QUESTION 8 (Start on a new page.)

Learners perform an experiment to determine the internal resistance, **r**, of a battery. They use a variable resistor as the external resistance as shown in the diagram below.



Switch **S** is closed. Readings from the voltmeter and ammeter are recorded after each change of the resistor.

Experiment no.	Current (mA)	Potential difference (V)
1	0,00	1,5
2	131	1,30
3	229	1,15
4	327	1,00
5	652	0,50

8.1 Use the information in the table above to plot a graph of potential difference versus current. Use the graph paper supplied at the end of the question paper. (4)

8.2 Use the graph to determine the following:

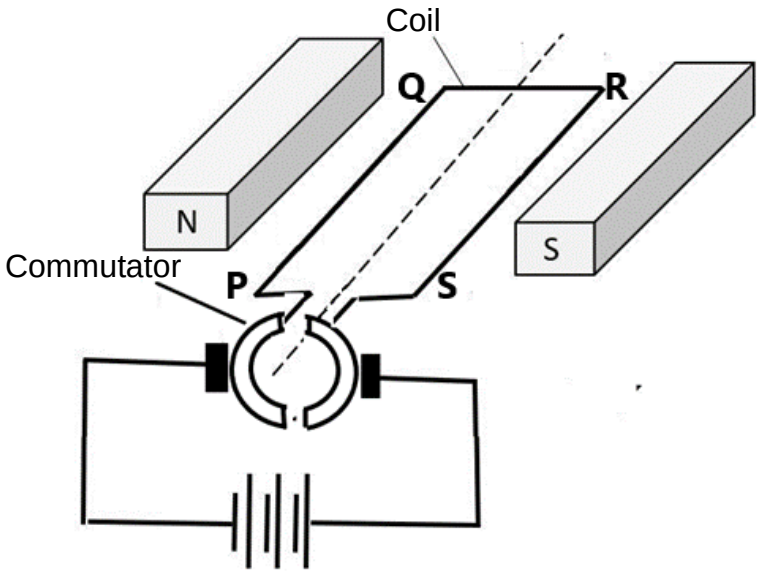
8.2.1 The emf of the battery (1)

8.2.2 The internal resistance of the battery
Use an equation to justify the method used. (3)

8.3 A conducting wire of negligible resistance is connected between the points **X** and **Y**. How does this affect the temperature of the battery? Write down only INCREASES, DECREASES or REMAINS THE SAME.
Explain the answer. (3)
[11]

QUESTION 9 (Start on a new page.)

The diagram below shows a simple model of a DC motor.



9.1 Describe the energy change that occurs in a DC motor. (2)

9.2 Explain the term *DC*. (2)

9.3 In which direction will the conventional current in the coil flow?
Write only FROM **P to Q** or FROM **Q to P**. (1)

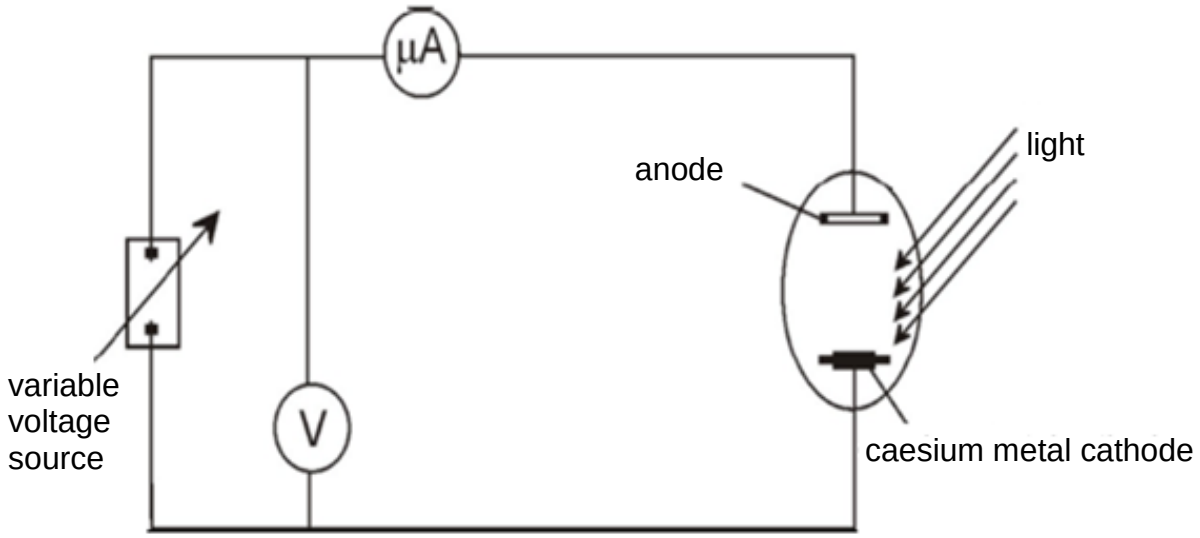
9.4 Explain the change that needs to be made for this motor to be an AC motor. (2)

9.5 A heater labelled 2 000 W, 220 V and 50 Hz is connected to an AC circuit.
Calculate the maximum current that flows through the heater. (5)
[12]

QUESTION 10 (Start on a new page.)

A photoelectric cell is connected in a circuit. The lowest frequency of light that will emit electrons from its caesium surface is $5{,}1 \times 10^{14}$ Hz.

Violet light of wavelength 400 nm is incident on the caesium surface.



10.1 Define *threshold frequency*. (2)

10.2 Calculate:

10.2.1 The work function of caesium (3)

10.2.2 The amount of energy carried by the incident photons of violet light (3)

10.2.3 The maximum kinetic energy of the photoelectrons emitted from the caesium surface when violet light shines on it (4)

10.3 Give ONE application, other than a photovoltaic cell, which makes use of the particle nature of light. (1)

[13]

TOTAL: 150

END

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 *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasiekonstant*	G	$6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$
Radius of the Earth *Radius van die Aarde*	R_E	$6,38 \times 10^6\ m$
Mass of the Earth *Massa van die Aarde*	M_E	$5,98 \times 10^{24}\ kg$
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	$9,11 \times 10^{-31}\ kg$

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*

$F_{net} = ma$	$p = mv$
$f_s^{max} = \mu_s N$	$f_k = \mu_k N$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = G\frac{m_1 m_2}{d^2}$ or/*of* $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or/*of* $g = G\frac{M}{r^2}$

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

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* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$	

ELECTROSTATICS/*ELEKTROSTATIKA*

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

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

ANSWER SHEET

QUESTION 8.1

NAME OF LEARNER: _____