GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION

PREPARATORY EXAMINATION

2016

10841

PHYSICAL SCIENCES: PHYSICS

FIRST PAPER

TIME: 3 hours

MARKS: 150

16 pages and 3 data sheets

P.T.O.

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(First Paper)

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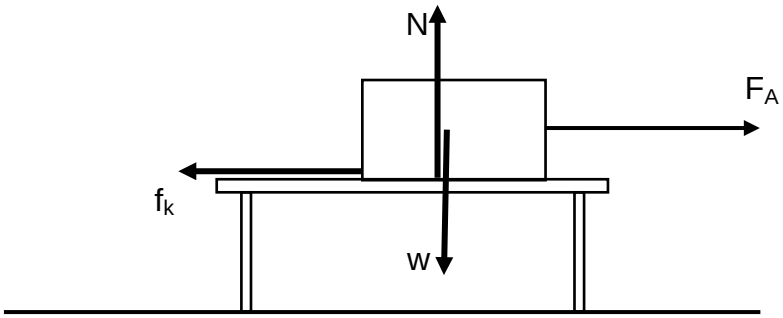
INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of 10 questions. Answer ALL the questions in the ANSWER BOOK.
3. Start the answer to each question on a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line open between sub-questions, for example between Question 2.1 and Question 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached DATA SHEETS.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Give brief discussions, et cetera where required.
12. Write neatly and legibly.

QUESTION 1

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.10) in the ANSWER BOOK, for example 1.11 C.

1.1 The diagram below shows a box being pulled by force $\mathbf{F_A}$ along a horizontal surface. The box slides towards the right at constant velocity.



Which ONE of the following statements about the forces acting on the box is correct?

A N is greater than w.
B w is greater than N.
C F_A is greater than f_k.
D F_A is equal to f_k. (2)

1.2 The magnitude of the impulse on a ball bouncing off a wall is equal to the ...

A net force of the ball on the wall.
B product of the net force on the ball and the time it acts.
C change in velocity of the ball.
D product of the mass and the acceleration of the ball. (2)

1.3 When a bus suddenly accelerates from rest, standing passengers tend to fall backwards. This observation is best explained using ...

A Newton's first law of motion.
B Newton's second law of motion.
C Newton's third law of motion.
D Newton's law of universal gravitation. (2)

1.4 Which ONE of the following will NOT increase the output current of a generator?

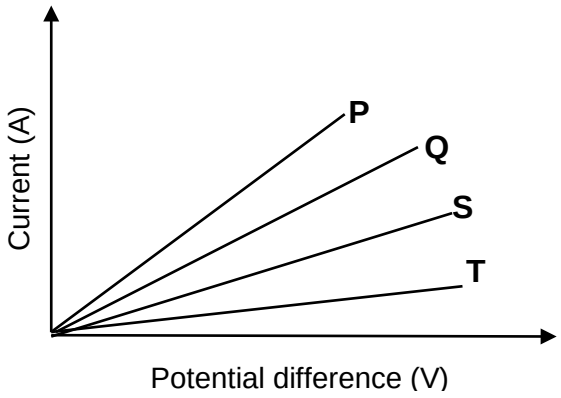
A Increase the number of turns in the coil.

B Wind the armature coil around an aluminium core.

C Increase the speed of rotation of the armature coil.

D Increase the strength of the magnet. (2)

1.5 The current versus potential difference graphs below were obtained for four resistors **P, Q, S** and **T**.



The resistor with the second largest resistance is:

A **P**

B **Q**

C **S**

D **T** (2)

1.6 A metallic surface emits photoelectrons when irradiated with green light.

When the green light is replaced by ultraviolet light, the kinetic energy (E_k) of the emitted photoelectrons will …

A increase.

B decrease.

C drop to zero.

D remain the same. (2)

1.7 Two objects attract each other with a force of magnitude **F** when they are a distance **r** apart.

If each mass is TRIPLED (3 times larger), the new gravitational force that the one object exerts on the other will be:

A 9**F**

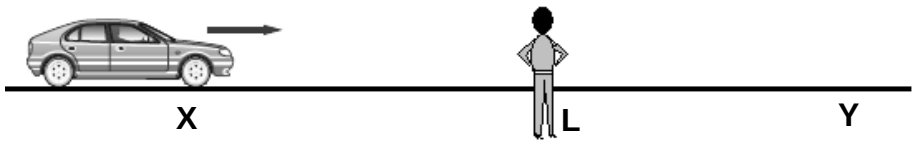
B 18**F**

C 24**F**

D 36**F**

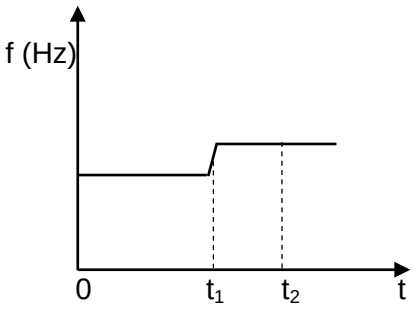
(2)

1.8 A car sounds its horn whilst travelling at constant velocity along a straight road. At time t = 0 the car is at position **X** as shown below. At time t = t_1 the car moves past a stationary listener **L**. At time t = t_2 the car is at position **Y**.

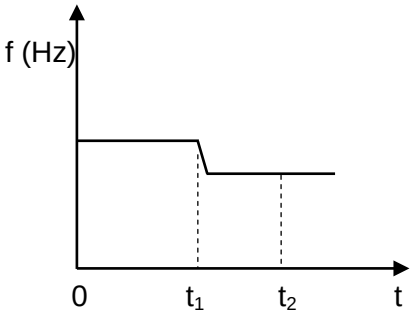


Which ONE of the following graphs best represents the variation of the frequency (pitch) of the horn with time as heard by the listener?

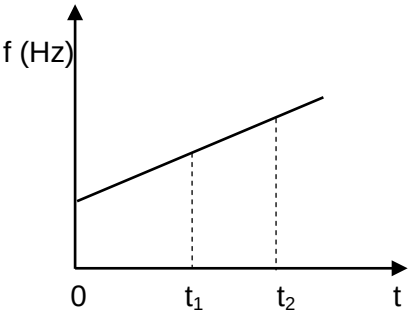
A



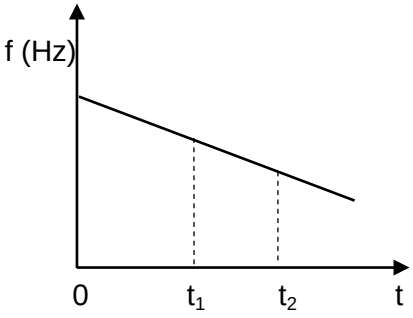
B



C

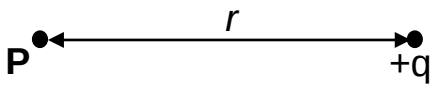


D



(2)

1.9 Point **P** is situated a distance *r* from point charge q as shown below. The electric field at point **P** due to point charge *q* is found to be *E*.



The electric field at point **Q** which is on a distance $\frac{1}{3}r$ from point charge *q* will be:

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

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

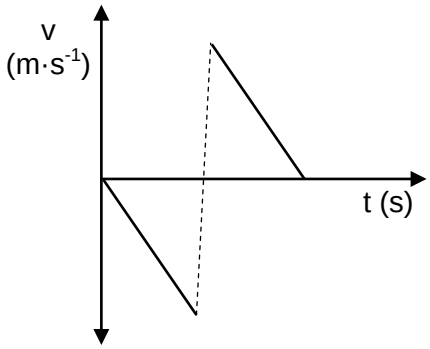
C $3E$

D $9E$

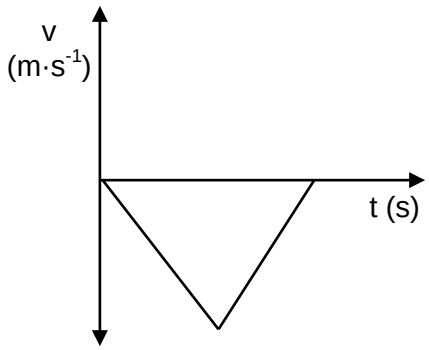
(2)

1.10 A ball is dropped to the ground from a certain height and bounces back to the same height. Which ONE of the following velocity versus time graphs represents the motion of the ball if downwards is taken as positive.

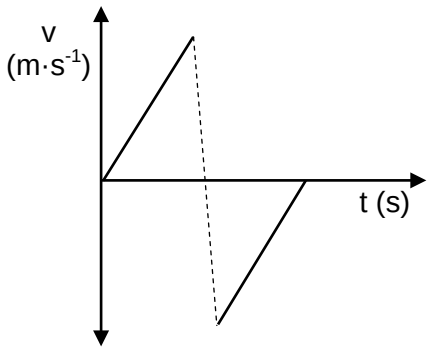
A



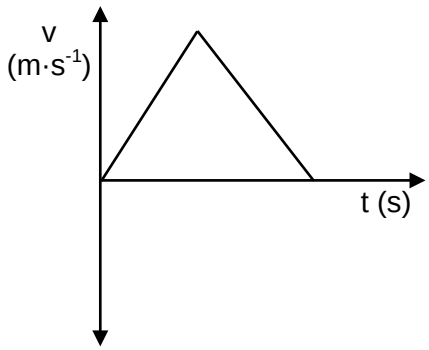
B



C



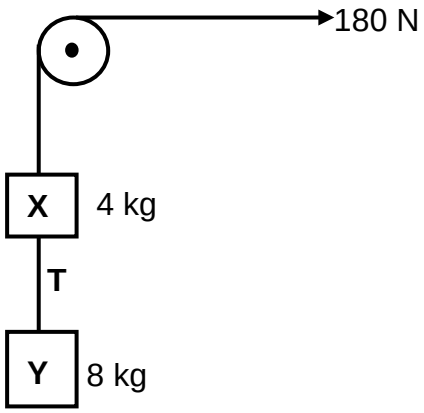
D



(2)
[20]

QUESTION 2 (Start on a new page.)

Block **X** of mass 4 kg is connected to block **Y** of mass 8 kg by a light, inextensible string. Another light, inextensible string attached to block **X** runs over a frictionless pulley. The system is pulled by means of a constant force of 180 N as shown in the diagram below. Ignore the effects of air resistance.



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

2.2 Draw a labelled free body diagram showing ALL the forces acting on object **X.** (3)

2.3 Calculate the:

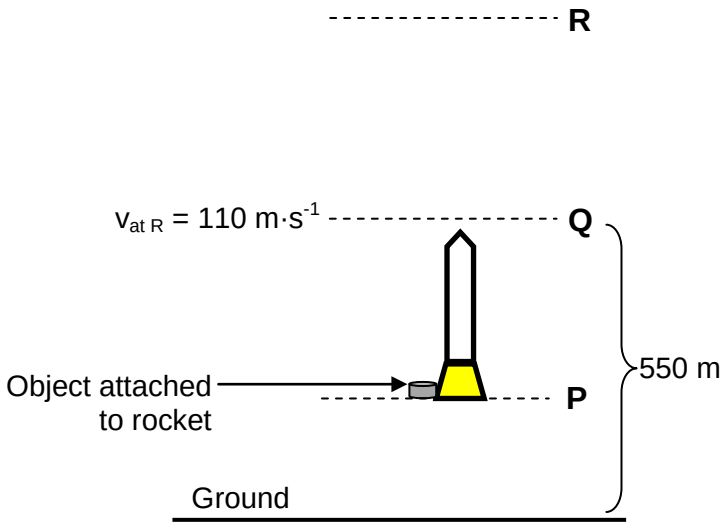
2.3.1 tension **T** in the string connecting the two blocks. (4)

2.3.2 magnitude of the acceleration of block **X**. (2)

[11]

QUESTION 3 (Start on a new page.)

A stationary rocket on the ground is launched vertically upwards. When it is 550 m above the ground (point **Q**), an object is released from the rocket. At this instant the velocity of the rocket is 110 $m \cdot s^{-1}$. The object reaches its MAXIMUM height ABOVE ground at point **R**. Ignore the effects of air friction.



3.1 Give a reason why the object keeps moving upwards after it is released from the rocket. (1)

3.2 What is the direction of the acceleration of the object at:

3.2.1 point **P?** (1)

3.2.2 point **R?** (1)

3.3 **ONLY** use EQUATIONS OF MOTION to calculate the time taken by the OBJECT to:

3.3.1 reach its maximum height after being released from the rocket at point **Q**. (3)

3.3.2 reach the ground after being released from the rocket at point **Q**. (4)

3.4 Sketch the velocity versus time graph for the complete motion of the object.
On the graph indicate the following:

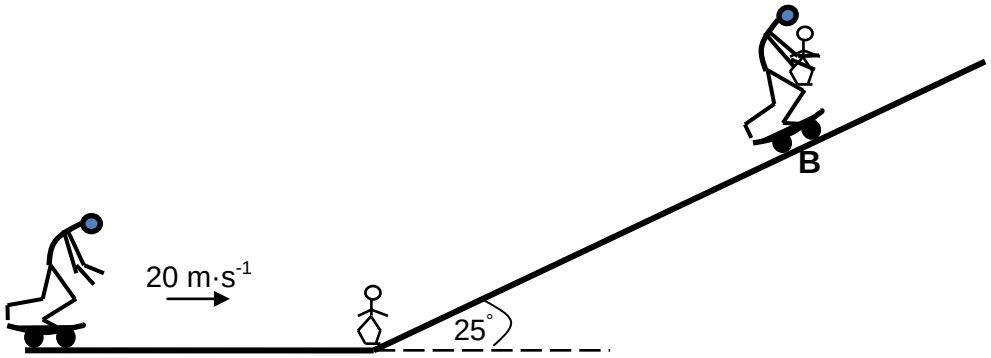
- Initial velocity.
- Time to reach its maximum height.
- Time when it reaches the ground. (4)

[14]

QUESTION 4 (Start on a new page.)

A roller-skater approaches an inclined plane at a constant velocity of 20 $m \cdot s^{-1}$ as shown below. Just before reaching the incline, he picks up a boy standing in his way and then continues up the incline and reaches point **B**.

The total mass of the roller skater is 68 kg and that of the boy is 12 kg.



4.1 State the principle of conservation of linear momentum. (2)

4.2 Calculate the magnitude of the combined velocity of the roller-skater and the boy just after the boy is picked up. (4)

4.3 Use energy principles to calculate the distance that they will move up the incline before coming to a stop at point **B**. Ignore the effects of friction. (5)

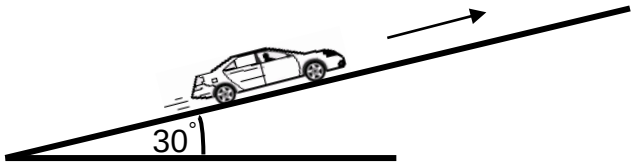
4.4 How will the answer to QUESTION 4.3 be affected if friction between the wheels of the roller-skate and the surface is NOT ignored?

Choose from INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

[13]

QUESTION 5 (Start on a new page.)

A car of mass 700 kg moves up a rough inclined plane as shown in the diagram below.



5.1 What is the net work done on the car if the car moves up the inclined plane at CONSTANT velocity? (1)

5.2 Draw a labelled free body diagram showing all the forces acting on the car as it moves up the inclined plane. (4)

5.3 The car now starts from rest at the base of the slope and accelerates up the inclined plane. The car's engine exerts a force of 6 000 N and the coefficient of kinetic friction between the wheels of the car and surface is 0,32.

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

5.3.2 Use energy principles to calculate the magnitude of the velocity of the car after moving a distance of 70 m up the incline. (8)

[15]

QUESTION 6 (Start on a new page.)

6.1 A flying bat emits sound waves at a frequency of 75 Hz. A stationary observer detects the frequency of the sound waves emitted as 73 Hz. The speed of sound in air is 340 $m \cdot s^{-1}$.

6.1.1 State the Doppler Effect in words. (2)

6.1.2 Is the bat flying TOWARDS or AWAY from the observer? (1)

6.1.3 Calculate the speed at which the bat is flying. (4)

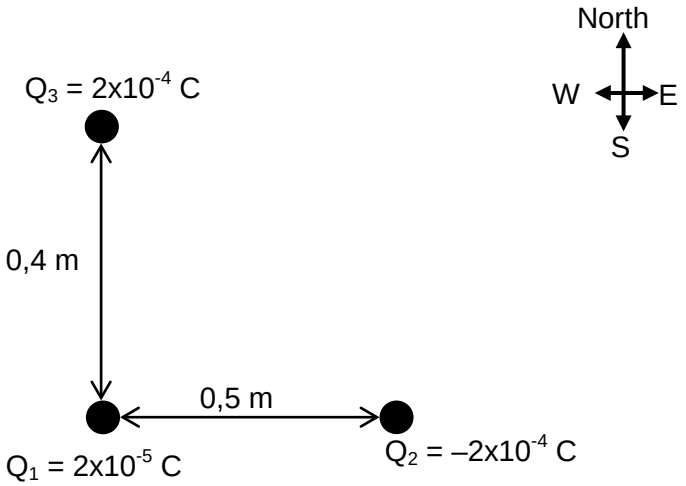
6.2 Briefly explain the observations that enable scientists to tell that the universe is expanding. (4)

6.3 State TWO applications of the Doppler Effect in medicine. (2)

[13]

QUESTION 7 (Start on a new page.)

Three charges Q_1, Q_2 and Q_3 carrying charges of +2 x 10^{-5} C, -2 x 10^{-4} C and +2 x 10^{-4} C respectively are positioned as shown in the diagram below.



7.1 State Coulomb's Law in words. (2)

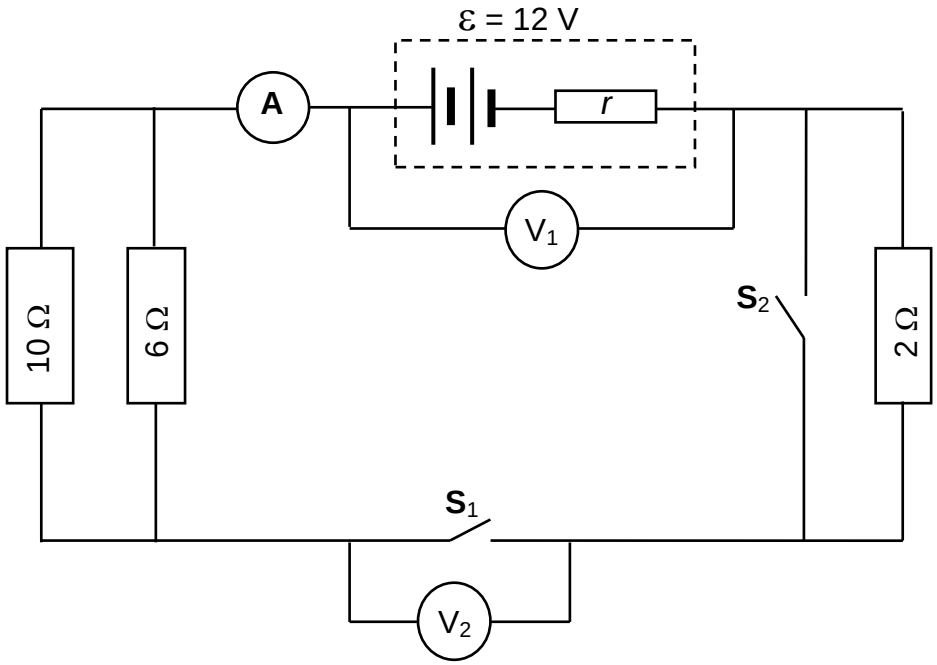
7.2 Draw a diagram that shows the electrostatic forces exerted on $\mathbf{Q_1}$ by $\mathbf{Q_2}$ and $\mathbf{Q_3}$. (2)

7.3 Calculate the net electrostatic force exerted on $\mathbf{Q_1}$ by $\mathbf{Q_2}$ and $\mathbf{Q_3}$. (7)

[11]

QUESTION 8 (Start on a new page.)

The battery in the circuit represented below has an emf of 12 V and an internal resistance *r*. Voltmeter V_1 is connected across the battery. The resistance of the connecting wires is negligible.



Switches **S_1** and **S_2** are both open.

8.1 Write down the reading on voltmeter V_2. (1)

8.2 Switch **S_1** is now closed. Switch **S_2** remains open. The reading on V_1 is now 10 V.

Calculate the:

8.2.1 total external resistance of the circuit. (4)

8.2.2 internal resistance of the battery. (5)

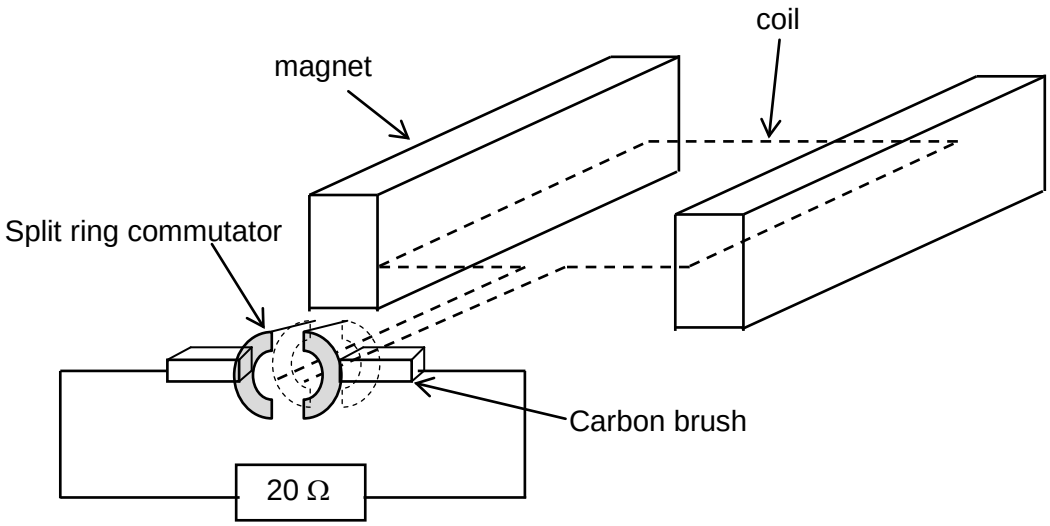
8.3 Both switches **S_1** and **S_2** are now closed.

How will the reading on the ammeter be affected? CHOOSE from INCREASES, DECREASES or REMAINS THE SAME. Explain the answer. (3)

[13]

QUESTION 9 (Start on a new page.)

The diagram below shows the essential parts of a generator.



9.1 The coil rotates within the magnetic field.

Write down the type of current (**AC** or **DC**):

9.1.1 Induced in the coil. (1)

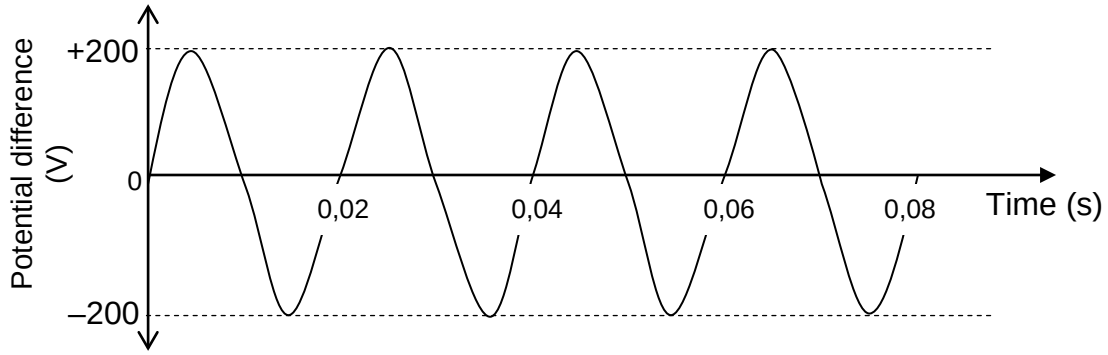
9.1.2 Passing through the 20 Ω resistor.
Give a reason for the answer. (2)

9.2 An AC generator is used in the commercial production of electricity.

9.2.1 State ONE fundamental difference in construction between an AC generator and a DC generator. (2)

9.2.2 Fully explain why AC is preferred to DC for transmission of electricity over long distances. (3)

9.3 The diagram below shows the output of an AC generator. A 20 Ω resistor is connected in the circuit.



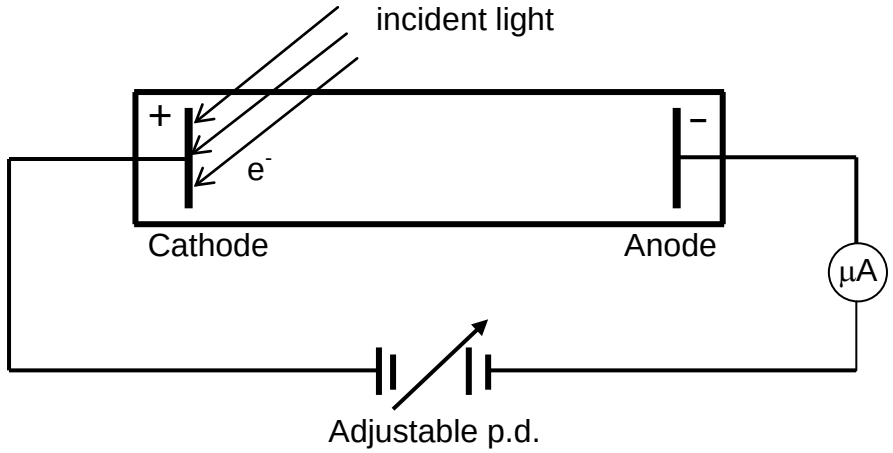
Calculate the:

9.3.1 frequency of the power source. (2)

9.3.2 average power dissipated in the resistor. (5)
[15]

QUESTION 10

Incident light of different wavelengths was shown on a metal cathode in an evacuated tube as shown in the diagram below.



It was found that light of 500 nm releases electrons with zero kinetic energy. The micro-ammeter gives a zero reading.

10.1 Define the term *work functio*n. (2)

10.2 Calculate the work function of the metal used as cathode. (5)

10.3 How will each of the following affect the reading on the micro-ammeter?

Choose from INCREASES, DECREASES or REMAINS THE SAME.

10.3.1 The intensity of the light is increased. (1)

10.3.2 Light of a wavelength 550 nm is used. (1)

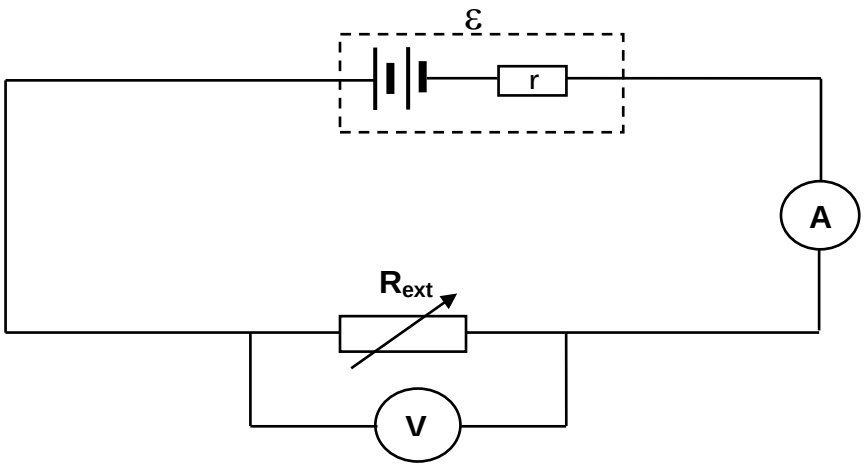
The metal cathode is now irradiated with light of wavelength 400 nm.

10.4 Calculate the maximum kinetic energy of an emitted photo-electron. (5)

[14]

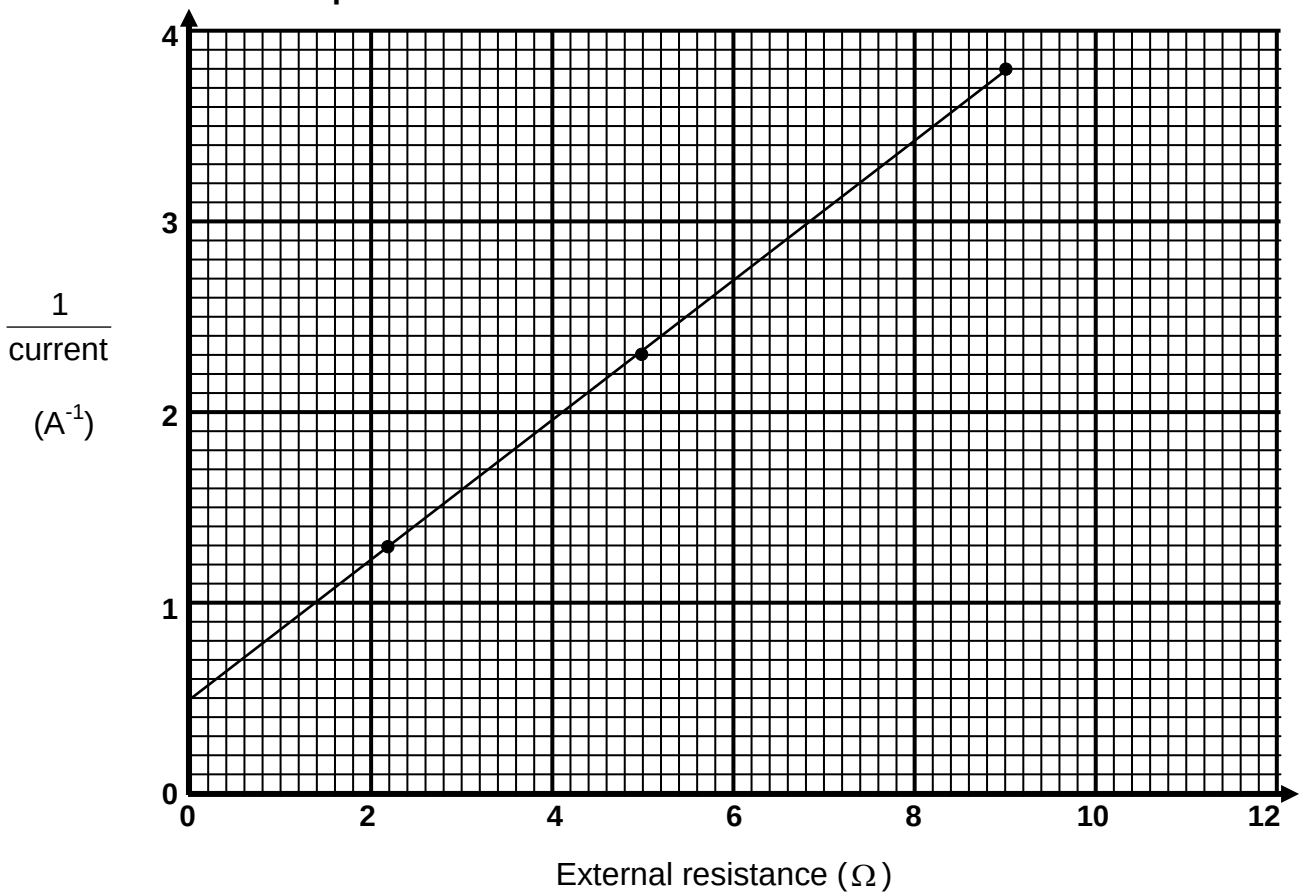
QUESTION 11 (Start on a new page.)

A learner set up the circuit shown below to measure the internal resistance of a battery.



She records the readings on the voltmeter and ammeter for different resistances of the rheostat. The graph below was obtained from the results.

Graph of inverse of current versus external resistance



11.1 Define the term *emf*. (2)

11.2 Calculate the gradient of the above graph. (3)

11.3 What is represented by the gradient in QUESTION 11.2? (1)

11.4 Use the information on the graph to calculate the:

11.4.1 emf of the battery. (2)

11.4.2 internal resistance of the battery. (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 *Swaartekragversnelling*	g	$9,8\ m{\cdot}s^{-2}$
Universal gravitational constant *Universele gravitasiekonstante*	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·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

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

$W = F\Delta x\cos\theta$	$U = mgh$ 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* $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gemid} = Fv_{gemid}$	

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* $E = \frac{hc}{\lambda}$
$E = W_o + E_{k(max)}$ 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)
$R_s = R_1 + R_2 + ...$ $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$	$q = I\Delta t$
$W = Vq$ $W = VI\Delta t$ $W = I^2R\Delta t$ $W = \frac{V^2\Delta t}{R}$	$P = \frac{W}{\Delta t}$ $P = VI$ $P = I^2R$ $P = \frac{V^2}{R}$

ALTERNATING CURRENT/*WISSELSTROOM*

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

END