LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

PHYSICAL SCIENCES: PHYSICS (P1)

SEPTEMBER 2019

EPHSCP1

MARKS: 150

TIME: 3 hours

This question paper consists of 18 pages and 3-paged data sheets.

INSTRUCTIONS AND INFORMATION

1. Write your NAME in the appropriate space on the ANSWER BOOK.

2. This question paper consists of 10 questions.

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

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

5. Leave ONE line between two subquestions, 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 motivations, discussions, et cetera where required.

12. Write neatly and legibly.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

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 number (1.1 – 1.10) in the ANSWER BOOK, for example
1.11 E

1.1 The force that opposes the motion of a moving object relative to a surface is called…

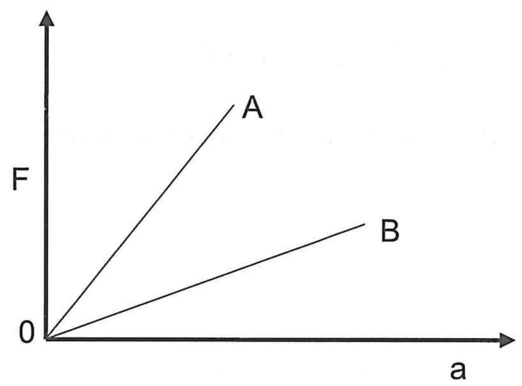
A applied force.

B kinetic friction.

C normal force.

D static friction. (2)

1.2 In an investigation of Newton's Second Law of motion; graphs of acceleration (**a**) versus force (**F**) for two objects, **A** and **B**, are obtained; as shown in the diagram below.



Which ONE of the following statements is True?

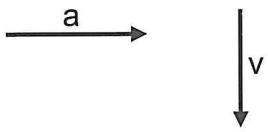
A The objects have equal masses

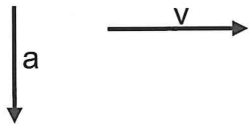
B Object A has the smaller mass

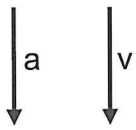
C Object B has the smaller mass

D Gradient of the graph is independent of mass (2)

1.3 Which ONE of the diagrams BEST represents the <u>acceleration</u> (**a**), and <u>velocity</u> (**v**) for an object moving **upwards** in the absence of air resistance?

A


B


C


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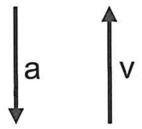


(2)

1.4 Which ONE of the following combinations of base units represents the "*rate of change of momentum*" of an object?

A $kg{\cdot}m{\cdot}s^{-1}$

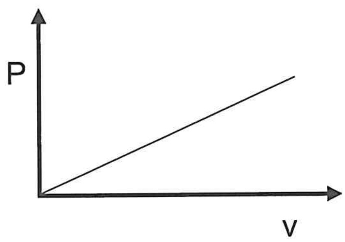
B $kg{\cdot}m{\cdot}s^{-2}$

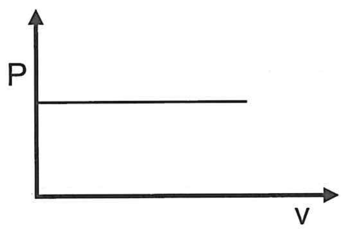
C $kg{\cdot}m^{2}{\cdot}s^{-2}$

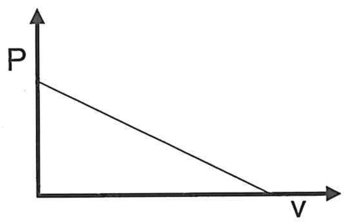
D $kg{\cdot}m^{2}{\cdot}s^{-3}$ (2)

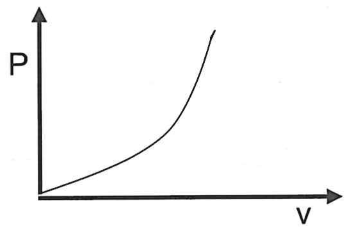
1.5 A car moves along a level road with CONSTANT ACCELERATION.

Which ONE of the following graphs shows the relationship between power (**P**) and velocity (**v**) for the car?

A


B


C


D


(2)

1.6 When light wave from a distant star is analysed, it is found that the wave is *red-shifted.*

This confirms that the wave experienced a/an …

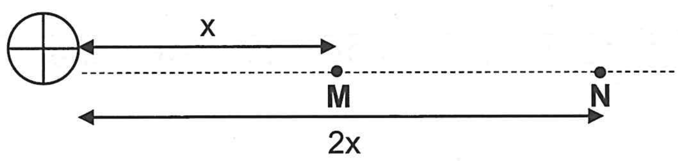
A decrease in wavelength and increase in frequency.

B decrease in wavelength and decrease in frequency.

C increase in wavelength and decrease in frequency.

D increase in wavelength and increase in frequency. (2)

1.7 The magnitude of the electric field is **E** at point **M** close to the charged sphere.



Which ONE of the following is the CORRECT magnitude of the electric field at point **N**, which is **twice** as far from the sphere as point **M** (as shown in the diagram above)?

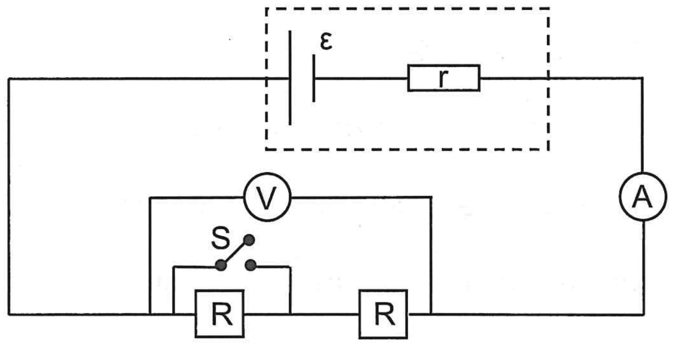
A $\frac{1}{2}$E

B 2 E

C $\frac{1}{4}$E

D 4 E (2)

1.8 Consider the circuit diagram below.

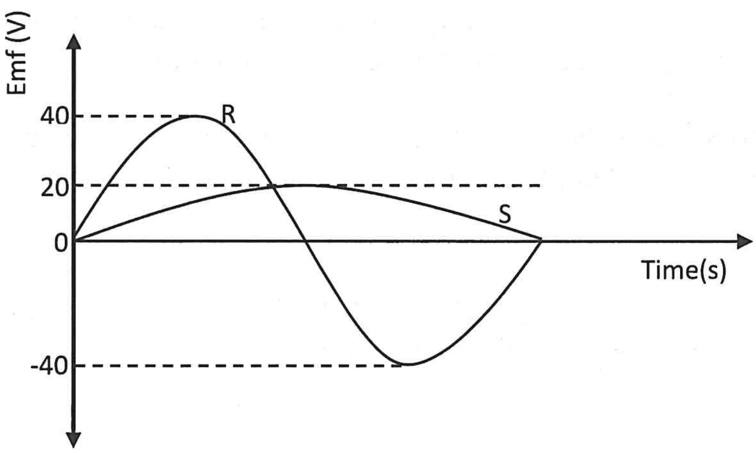


Which ONE of the following combinations CORRECTLY represents the change in the readings on the **ammeter** and the **voltmeter** when switch **S** is closed?

	AMMETER READING	VOLTMETER READING
A	Decreases	Decreases
B	Decreases	Increases
C	Increases	Deceases
D	Increases	Increases

(2)

1.9 Graph **R** in the diagram below represents the output emf of an AC generator.



Which ONE of the following changes has been made to the generator to produce graph **S**?

A The strength of the magnetic field has been halved

B The surface area of the coil has been halved

C The number of turns of the coil has been halved

D The speed of rotation of the coil has been halved (2)

1.10 A material with a photoelectric work function of $W_0 = hf_0$ is illuminated with light of frequency $f = 3f_0$

The **maximum kinetic energy** of the photoelectrons will be …

A $2hf_0$.

B $3hf_0$.

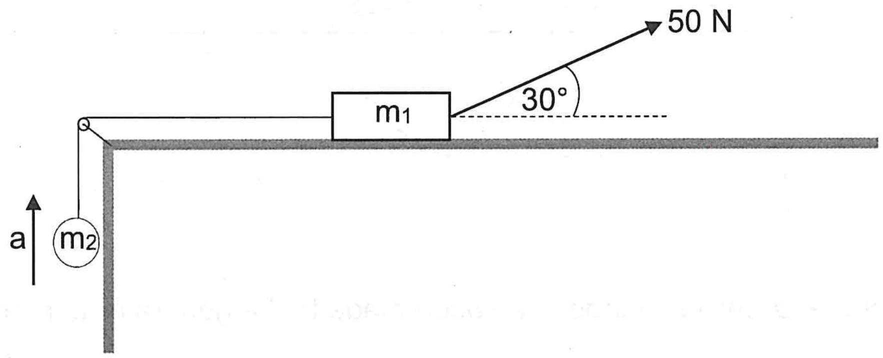
C $4hf_0$.

D $6hf_0$. (2)
[20]

QUESTION 2 (Start on a new page)

2.1 A block of mass m_1 = 5 kg, on a *rough*, horizontal surface is connected to a ball of mass m_2 = 200 g by a string over a frictionless pulley.

A force of magnitude 50 N at an angle of 30° with the horizontal is applied to the block, as shown in the diagram below.



The coefficient of kinetic friction between the block and the surface is 0,21. Ignore the effects of air resistance and the masses of the string and pulley.

2.1.1 State, in words, *Newton's Second Law of Motion* in terms of acceleration. (2)

2.1.2 Draw a labelled free-body diagram for the block. (5)

2.1.3 Applying Newton's Second Law, calculate the tension in the string connecting the block to the ball. (6)

2.2 A body of mass m kg is at a distance of 500 km above the surface of the Earth.

Calculate the *percentage* by which the *weight* of the body is reduced at this altitude. (4)
[17]

QUESTION 3 (Start on a new page)

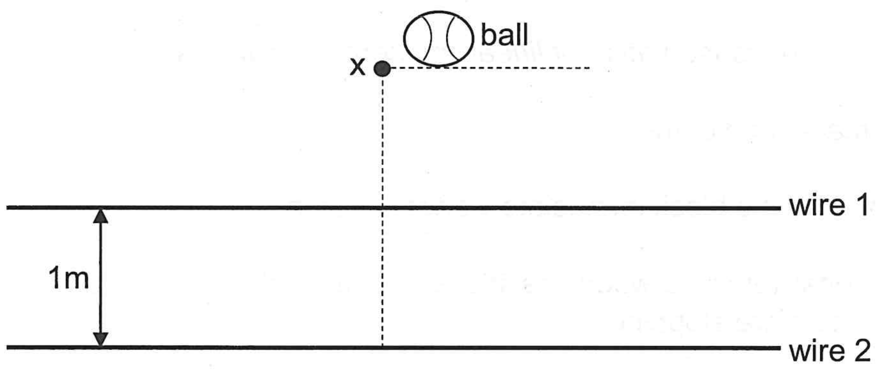
3.1 A person **on Earth** throws a rubber ball upwards at a speed of 20 $m \cdot s^{-1}$. The only force that acts on the ball whilst it is in motion is the gravitational force.

3.1.1 Write down the type of motion that the ball undergoes. (1)

3.1.2 Explain, with reference to **weight** and **mass** of an object, why a heavy object does not accelerate more than a lighter one when BOTH are falling in the absence of air resistance. (1)

3.1.3 Taking the gravitational acceleration on Jupiter to be 22,5 $m \cdot s^{-2}$, determine the speed with which he/she would have to throw the same ball so that it would rise to the **same height** on Jupiter. (5)

3.2 Two horizontal wires are placed parallel to each other, 1 m apart and one directly above the other. A ball is dropped from some point **X** above the two wires, as shown in the diagram below. Neglect the effect of air resistance.



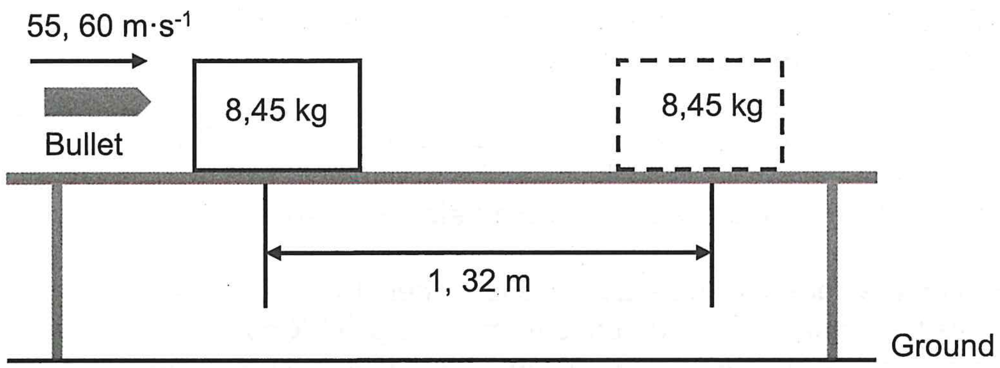
3.2.1 Write down the acceleration of the ball at point **X.** (1)

The ball takes 0,2 s to pass between the two wires.

3.2.2 Calculate the speeds (v_1 and v_2) of the ball as it passes the wires, **1** and **2**, respectively. (6)
[14]

QUESTION 4 (Start on a new page)

The 17,5 g bullet in the diagram below moves with speed of 55,60 m·s^{-1}, strikes a 8,45 kg block **resting** on the table; and bounces straight back with a speed of 12, 60 m·s^{-1}.



4.1 State the *Principle of conservation of linear momentum* in words. (2)

4.2 Calculate the magnitude of the:

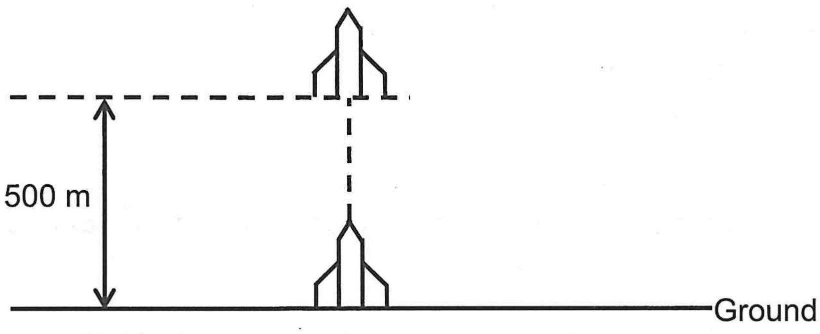
4.2.1 Velocity of the block immediately after collision (3)

4.2.2 Frictional force between the block and the table if the block moves 1,32 m before stopping. (5)

4.3 Draw vector diagrams (not to scale) to illustrate the relationship among the initial momentum (p_i), the final momentum (p_f), and the change in momentum (Δp) for the bullet. (3)
[13]

QUESTION 5 (Start on a new page)

A 150 000 kg rocket is launched **from rest** straight up into the air. The rocket motor generates a thrust of 4,0 x 10^6 N.



Ignore the effects of air resistance and any mass loss.

5.1 Define the term *conservative force*. (2)

5.2 Classify air resistance as a CONSERVATIVE FORCE or a NON-CONSERVATIVE FORCE. (1)

5.3 Draw a labelled free-body diagram for the rocket whilst in motion. (2)

5.4 State, in words, the *work(kinetic) energy theorem*. (2)

5.5 Use the theorem in **QUESTION 5.4** above to calculate the speed of a rocket at a height of 500 m. (4)

[11]

QUESTION 6 (Start on a new page)

A person riding a bike at 15 $m \cdot s^{-1}$ passes a stationary car of which the alarm is blaring. The frequency of the alarm is 18 kHz and the speed of sound in air is 340 $m \cdot s^{-1}$at that moment.

6.1 State the *Doppler Effect* in words. (2)

6.2 Calculate the:

6.2.1 Frequency of the alarm that the person hears while riding **towards** the car (4)

6.2.2 Frequency of the alarm that the person hears while riding **away from** the car (3)

6.3 Write down the frequency (in Hz) of the alarm that the person hears at the instant he/she is exactly next to the car. (1)

6.4 Draw a sketch graph of frequency versus time showing the apparent frequency of the person.

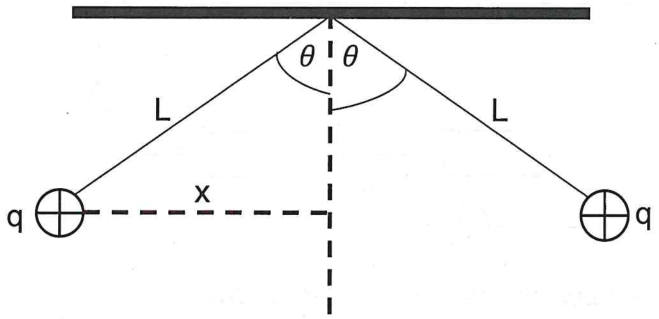
Clearly show the values of the following on the graph:

- Frequency of the alarm when the person approaches the car
- Frequency of the alarm when the person recedes (moves away) from the car (2)

[12]

QUESTION 7 (Start on a new page)

7.1 Two identical small charged spheres, EACH having a mass of 3,00 x 10^{-2} kg and carrying the same charge q, hang in equilibrium, as shown in the diagram below. The length L of each string is 150 mm, and the angle θ is $5{,}00^{0}$.

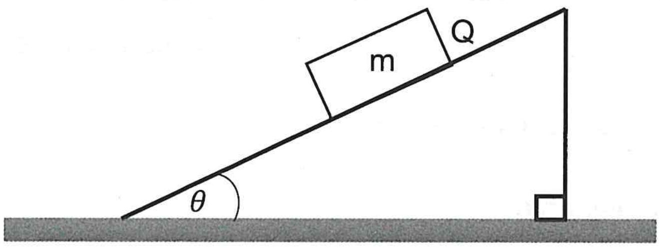


7.1.1 Draw a labelled free-body diagram for the **left-hand** sphere. (3)

7.1.2 State, in words, *Coulomb's law of electrostatics*. (2)

7.1.3 Show, by means of an appropriate calculation, that the magnitude of the charge on each sphere is 4,42 x 10^{-8} C. (7)

7.2 A small block of mass m = 5,40 g and charge Q = -7,00 C is placed on an insulated, frictionless, inclined plane of angle θ = $25{,}0^{0}$°, as shown in the diagram below.



An electric field is applied parallel to the incline.

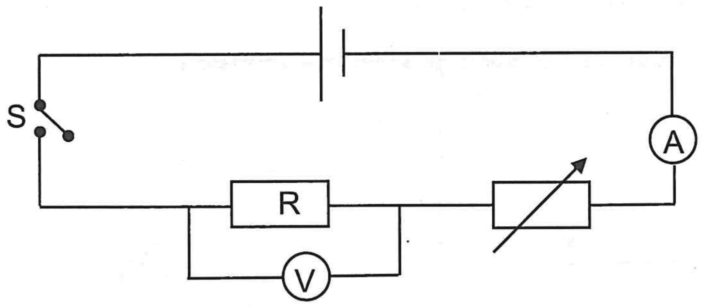
7.2.1 Define, in words, the term *electric field* at a point. (2)

7.2.2 Calculate the electric field that enables the block to **remain at rest** on the incline. (6)

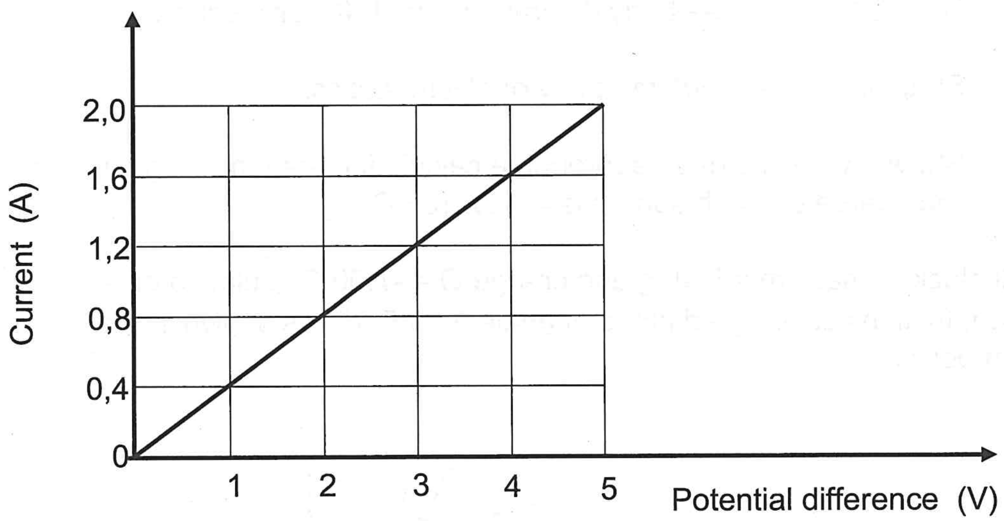
[20]

QUESTION 8 (Start on a new page)

8.1 The circuit diagram represented below is used to investigate the relationship between the **current in** and the **potential difference across** resistor **R**.



The results obtained are used to draw the graph below.



For this investigation, write down the:

8.1.1 Dependent variable (1)

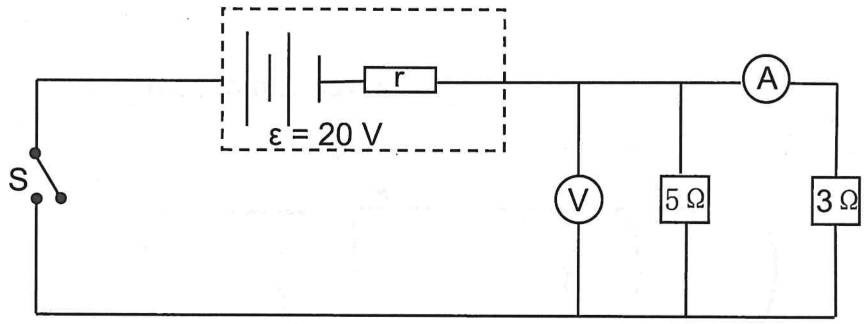
8.1.2 Control variable (1)

8.1.3 Conclusion that can be drawn from the graph (1)

The resistance of resistor **R** must be determined.

8.1.4 Calculate the resistance of resistor **R** by using the *gradient of the graph.* (3)

8.2 The circuit diagram below shows a battery, with an internal resistance r, connected to a voltmeter and two resistors, of resistances 3 Ω and 5 Ω respectively. The emf of the battery is 20 V.



8.2.1 *The emf of the battery is 20 V*. Explain the meaning of the statement. (2)

8.2.2 Write down the voltmeter reading when the switch is **open**. (1)

The switch is **closed** and the reading on the ammeter is **6 A**.

Calculate the:

8.2.3 Voltmeter reading, V (3)

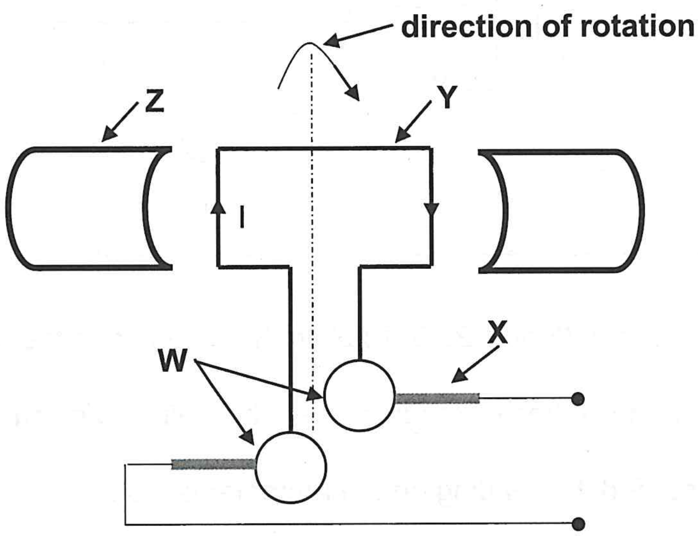
8.2.4 Internal resistance of the battery, r (3)

The 3 Ω resistor is **removed** from the circuit.

8.2.5 Briefly explain why the voltmeter reading **increases**. (3)
[18]

QUESTION 9 (Start on a new page)

9.1 The simplified sketch below represents an AC generator. **W**, **X**, **Y** and **Z** are labels of the main components.



9.1.1 Write down the NAME of the component labelled **W**. (1)

9.1.2 State the *function* of the component labelled **X**. (1)

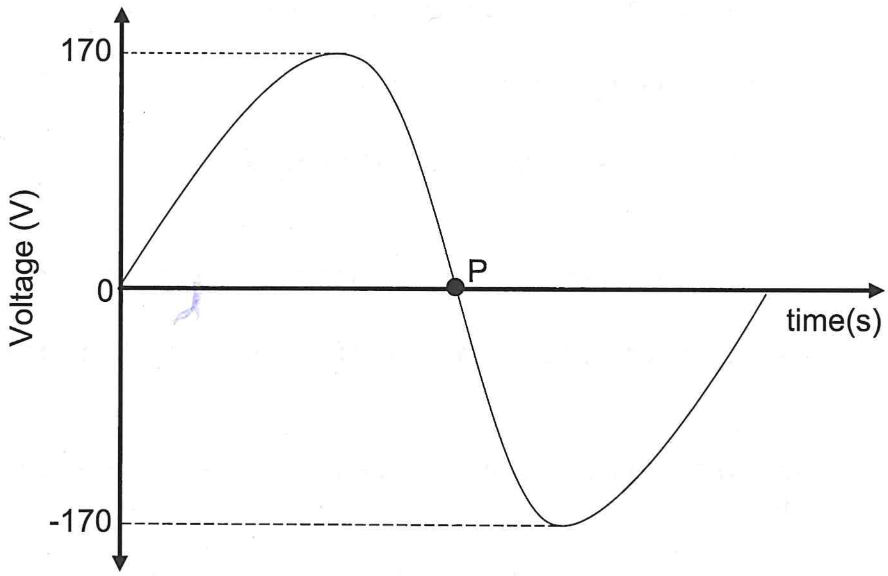
9.1.3 Use the direction of the current in the diagram to *identify* the magnetic pole **Z**. (1)

9.1.4 Suggest a reason as to why the pole pieces are curved as shown on the diagram. (1)

9.1.5 Write down ONE use of AC generators **in electrical power plants**. (1)

9.2 The mains voltage supplied to homes changes direction constantly at 50 cycles per second.

The graph below shows the change *over one cycle*.



9.2.1 Calculate the time (**P**) shown on the graph. (2)

9.2.2 Use the information given to determine the **rms current** delivered to an appliance with resistance 200 Ω. (4)

9.2.3 Explain why it is of greater value to use **rms current** than the **average current**. (1)
[12]

QUESTION 10 (Start on a new page)

10.1 A certain metal is irradiated with light of wavelength 400 nm. The photoelectric effect is observed.

10.1.1 Describe the term *photoelectric effect* in words. (2)

10.1.2 Calculate the energy of a single photon. (3)

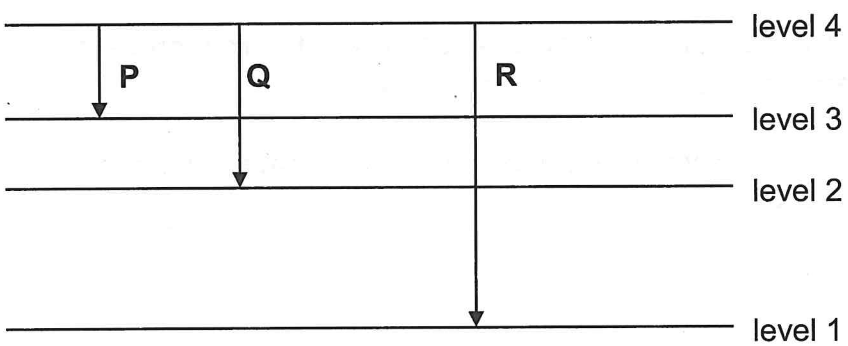
1,5% of the power of the **600 W lamp** is used to release photoelectrons from the metal surface.

10.1.3 Calculate the number of the electrons produced per second. (3)

10.2 Line emission spectra are produced as a result of electron transitions between energy levels of the atom.

10.2.1 Explain the formation of emission spectra by referring to energy transition. (2)

The diagram below shows some of the outer energy levels of the mercury atom.



The three energy transitions produce three different spectral lines.

Which ONE of the transitions (**P**, **Q** or **R**) will produce the spectral line with the:

10.2.2 Longest wavelength (1)

10.2.3 Highest energy (1)
[13]

TOTAL: 150

DATA FOR PHYSICAL SCIENCES GRADE 12
PAPER 1 (PHYSICS)

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	$9{,}8\ m\cdot s^{-2}$
Universal gravitational constant	G	$6{,}67 \times 10^{-11}\ N\cdot m^2\cdot kg^{-2}$
Speed of light in a vacuum	c	$3{,}0 \times 10^{8}\ m\cdot s^{-1}$
Planck's constant	h	$6{,}63 \times 10^{-34}\ J\cdot s$
Coulomb's constant	k	$9{,}0 \times 10^{9}\ N\cdot m^2\cdot C^{-2}$
Charge on electron	e	$-1{,}6 \times 10^{-19}\ C$
Electron mass	m_e	$9{,}11 \times 10^{-31}\ kg$

TABLE 2: FORMULAE

MOTION

$v_f = v_i + a\Delta t$	$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2$ OR $\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta x$ OR $v_f^2 = v_i^2 + 2a\Delta y$	$\Delta x = \left(\frac{v_f + v_i}{2}\right)\Delta t$ OR $\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

FORCE

$F_{net} = ma$	$p = mv$
$F_{net}\Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$
$F = \frac{Gm_1m_2}{r^2}$	$g = \frac{Gm}{r^2}$

WORK, ENERGY AND POWER

$W = F\Delta x \cos\theta$	$U = mgh$ OR $E_P = mgh$
$K = \frac{1}{2}mv^2$ OR $E_k = \frac{1}{2}mv^2$	$W_{net} = \Delta K$ OR $W_{net} = \Delta E_k$ $\Delta K = K_f - K_i$ OR $\Delta E_k = E_{kf} - E_{ki}$
$W_{nc} = \Delta K + \Delta U$ OR $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$	

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$	$E = hf$ OR $E = h\frac{c}{\lambda}$
$E = W_o + K_{max}$ OR $E = W_o + E_{k(max)}$ where $E = hf$ and $W_o = hf_o$ and $K_{max} = \frac{1}{2}mv^2_{max}$ OR $E_{k(max)} = \frac{1}{2}mv^2_{max}$	

ELECTROSTATICS

$F = \frac{kQ_1Q_2}{r^2}$	$E = \frac{kQ}{r^2}$
$E = \frac{F}{q}$	$V = \frac{W}{q}$
$n = \frac{Q}{e}$ OR $n = \frac{Q}{q_e}$	

ELECTRIC CIRCUITS

$R = \frac{V}{I}$	emf (E) = 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

$I_{rms} = \frac{I_{max}}{\sqrt{2}}$ $V_{rms} = \frac{V_{max}}{\sqrt{2}}$	$P_{average} = V_{rms}I_{rms}$ $P_{average} = I^2_{rms}R$ $P_{average} = \frac{V^2_{rms}}{R}$