GAUTENG PROVINCE

REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION

PREPARATORY EXAMINATION

2017

10841

PHYSICAL SCIENCES: PHYSICS

FIRST PAPER

TIME: 3 hours

MARKS: 150

15 pages + 4 data sheets and 1 answer sheet

PHYSICAL SCIENCES: Paper 1
1084E

10841E

X10

3

P.T.O.

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(First Paper)

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INSTRUCTIONS AND INFORMATION

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

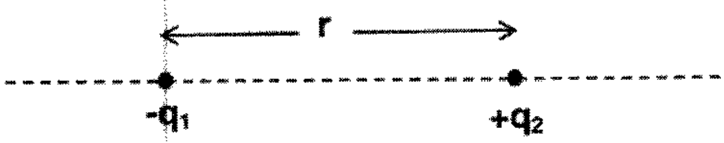
QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A – D) of your choice next to the question number (1.1 – 1.10) in the ANSWER BOOK, e.g. 1.11 D.

1.1 Passengers on a moving bus lean over to the right when the bus makes a sharp left turn. This is an example of ...

A Newton's first law.
B Newton's second law.
C Newton's third law.
D The Law of Universal Gravitation. (2)

1.2 Two point charges are a distance *r* apart and are positioned as shown in the diagram below. An electrostatic force of magnitude *F* exists between the two charges.



The distance between the two charges is reduced to $\frac{1}{3}r$. The new force between the charges is ...

A F
B 3 F
C 9 F
D $\frac{1}{9}F$ (2)

1.3 A half-brick is thrown vertically upwards and caught by a builder at a height *h* above the ground. A full brick is also thrown vertically upwards and is caught by the same builder at the same height. Ignore all effects of friction.

Which one of the following is TRUE concerning the bricks which were thrown?

A The half-brick will take a shorter time to reach the builder.
B Both bricks have the same kinetic energy when they are thrown.
C Both bricks have the same velocity when they are thrown.
D Both bricks have the same momentum when they are thrown. (2)

1.4 The impulse on a ball bouncing off a wall is equal to the ...

A average force of the ball on the wall.
B change in momentum.
C rate of change in momentum.
D product of the mass and the acceleration of the ball. (2)

1.5 Two spring-loaded trolleys of equal mass are "exploded" by releasing their springs simultaneously. Immediately after the explosion the trolleys move in opposite directions with equal velocity.

Which one of the following statements is correct regarding the moving apart of the trolleys?

A In an isolated system, the total momentum is conserved.
B The net force equals the product of mass and acceleration.
C Momentum equals the product of mass and velocity.
D Impulse equals the product of the nett force and collision time. (2)

1.6 A bird flies directly towards a speeding bus. It crashes head-on with the windscreen of the bus. Which one of the following statements is CORRECT?

A The force exerted by the bird on the windscreen is less than that exerted by the windscreen on the bird.
B The force exerted by the bird on the windscreen is greater than that exerted by the windscreen on the bird.
C The force exerted by the bird on the windscreen is equal in magnitude to the force that the windscreen exerts on the bird.
D The impulse acting on the bird is greater than the impulse acting on the windscreen. (2)

1.7 Which one of the following units is NOT equivalent to the Watt?

A $J \cdot s^{-1}$
B $A \cdot V^{-1}$
C $A \cdot V$
D $A^2 \cdot \Omega$ (2)

1.8 A model car has a motor with variable speed. Which ONE of the following modifications for the motor will NOT increase the speed of rotation of the motor?

A Increasing the number of turns in the coil of the motor
B Winding the armature coil around a zinc core
C Increasing the current flowing through the coil of the motor
D Increasing the strength of the magnet in the motor (2)

1.9 To see an absorption spectrum, dispersed light must …

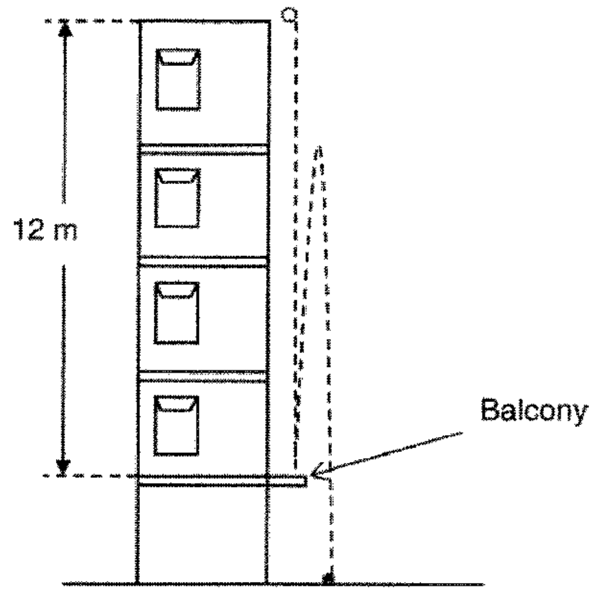
A come straight out of a white hot filament.
B have passed through a gas that is substantially cooler than the source of light.
C have passed through a gas that is substantially hotter than the source of light.
D have passed through a gas that is at the same temperature as the source of light. (2)

1.10 Which one of the following is TRUE concerning the photoelectric effect?

A Light of higher frequency emits electrons with lower kinetic energies.
B If we shine low intensity light with low energy photons on a clean metal surface long enough, electrons will eventually be emitted.
C If we shine high intensity light with low energy photons on a clean metal surface long enough, electrons will eventually be emitted.
D Most metals will emit electrons when ultraviolet light shines on them. (2)
[20]

QUESTION 2 **(Start on a new page.)**

A 120 g tennis ball is dropped from the top of a building. It bounces off a balcony 12 m below and finally falls to the ground. The diagram below shows the flight of the ball. Ignore all effects of friction as well as any horizontal motion of the ball.



2.1 Calculate the velocity with which the tennis ball strikes the balcony. (3)

2.2 The energy transformed to other forms when the ball strikes the balcony is 2 J.

Calculate:

2.2.1 The kinetic energy just before the bounce (2)

2.2.2 How high the ball rises above the balcony after the bounce (5)

2.3 The ball finally strikes the ground 3,16 s after the bounce. Calculate the height of the balcony. (3)

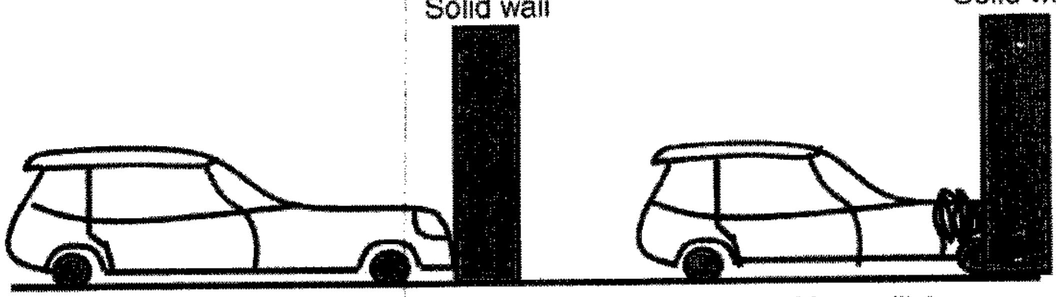
2.4 Sketch the velocity versus time graph of the ball's entire flight. Show the following points on your sketch:

- Velocity with which the ball hits the balcony
- Time of flight of the ball to reach the balcony (Mark as t_1 only.)
- Velocity with which the ball leaves the balcony
- Time the ball reaches maximum height after bouncing off the balcony (Mark as t_2 only.)
- Total time of flight of the ball (Mark as t_3 only.) (4)

[17]

QUESTION 3 **(Start on a new page.)**

Most modern cars incorporate safety features that are designed to protect the driver and passengers in the event of a head-on collision. In testing one of such safety features, a car is crashed into a rigid concrete wall and its front crumples as shown in the diagram below.



The results of one such test are shown below.

Data: Car mass = 1000 kg	Speed of car at impact = 120 $km{\cdot}h^{-1}$
Original length of car = d_1 = 2,8 m	Crushed length of car = d_2 = 2,0 m

Ignore the effects of friction. Assume that there is no loss in mass as a result of the collision.

3.1 Draw a labelled, free-body diagram of all the forces acting on the car during impact. (3)

3.2 Convert 120 $km{\cdot}h^{-1}$ to SI units. (1)

3.3 State the WORK-ENERGY theorem. (2)

3.4 Assume that the force acting on the car is constant throughout the collision.

3.4.1 Use the WORK-ENERGY theorem to calculate the nett force acting on the car during the collision. (5)

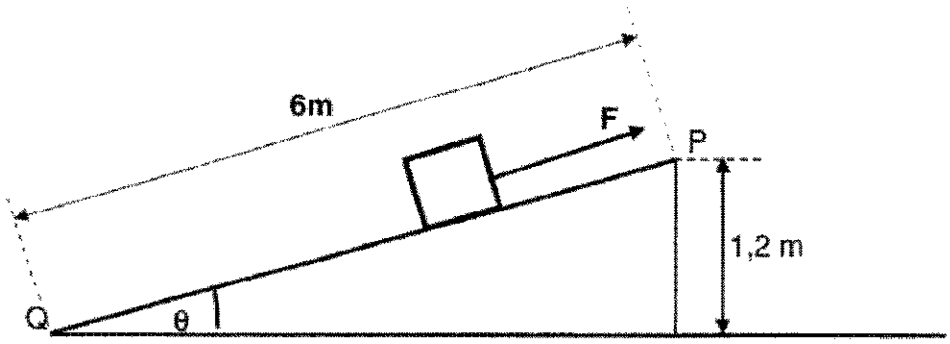
3.4.2 Calculate the time taken for the car to come to rest. (4)

3.4.3 Explain the purpose of a crumple zone in modern cars (3)

[18]

QUESTION 4 **(Start on a new page.)**

A 100 kg box slides down a rough inclined plane. A man applies a constant force **F** on the box such that it slides down the inclined plane at constant velocity.



4.1 Draw a labelled, free-body diagram showing all the forces acting on the box as it slides down the inclined plane. (4)

4.2 Write down the magnitude of the nett force acting on the box as it slides down the inclined plane. Give a reason for the answer. (2)

The frictional force between the box and the inclined plane is 60 N. The vertical height is 1,2 m.

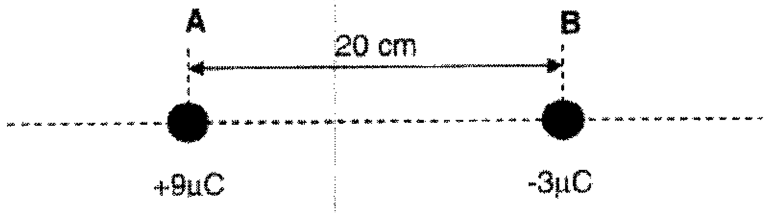
4.3 What is a *non-conservative force*? (2)

4.4 Calculate the work done by the man on the box. (6)

4.5 Calculate the magnitude of force **F** exerted by the man on the box. (4)
[18]

QUESTION 5 **(Start on a new page.)**

Two small identical metal spheres *A* and *B* carry charges of +9 μC and -3 μC respectively. They are placed 20 cm apart as shown in the diagram below.



5.1 What is meant by the statement, *the charge is quantised*? (1)

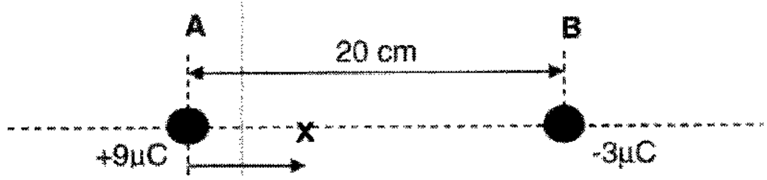
5.2 The spheres are brought into contact with each other, separated and placed at the same positions as before.

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

5.2.2 Calculate the change in charge for each sphere and the number of electrons that are transferred. (3)

5.2.3 What is the direction of electron transfer between the spheres. Write only A to B or B to A. (1)

The charged spheres A and B with original charges are now arranged as shown below. X is a point 4 cm to the right of sphere A.



5.3 State *Coulomb's Law* in words. (2)

5.4 Calculate the electrostatic force between the two spheres. (3)

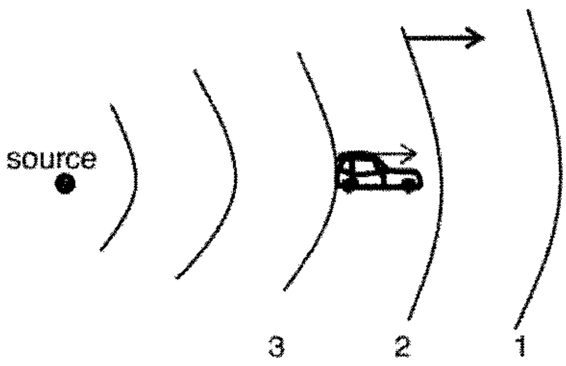
5.5 Calculate the magnitude of the nett electric field at point X as a result of the charged spheres A and B. (4)

[16]

QUESTION 6 **(Start on a new page.)**

Use the ANSWER SHEET at the end of the question paper to answer Question 6.2.

6.1 A fire truck has just stopped at an accident scene with its siren of frequency 380 Hz still on. The driver of an ambulance driving away from the accident scene hears the fire truck's siren as 360 Hz. This is shown in the diagram below. Take the speed of sound in air as 340 $m \cdot s^{-1}$.



6.1.1 Define the *Doppler effect.* (2)

6.1.2 Calculate the speed of the ambulance in $km \cdot h^{-1}$. (5)

6.2 The wave fronts 3,2,1 and others shown on the diagram above, originate from the sound source.

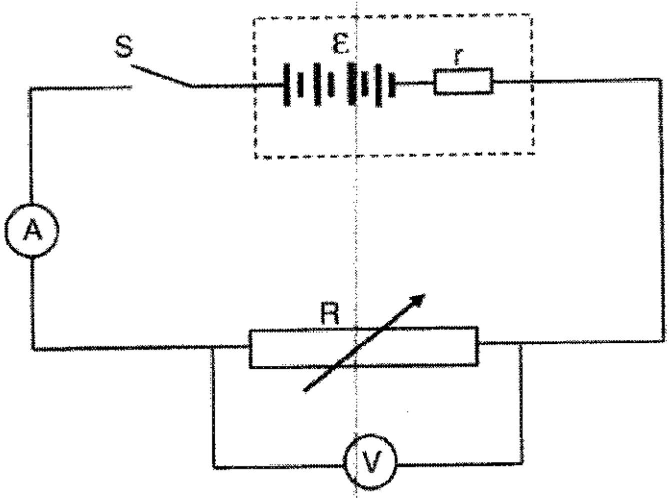
On the ANSWER SHEET provided, draw the new relative positions of the wave fronts 2 and 1 as encountered by the car's driver, which would explain why the driver hears a lower frequency. Hand in the ANSWER SHEET with your ANSWER BOOK. (4)

6.3 Give TWO real-life examples where the Doppler effect is applied. (2)

[13]

QUESTION 7 **(Start on a new page.)**

Learners set up a circuit, as shown below, to investigate the relationship between the potential difference across a variable resistor, R, and the current through the resistor.



7.1 In this experiment, name the ...

7.1.1 independent variable. (1)

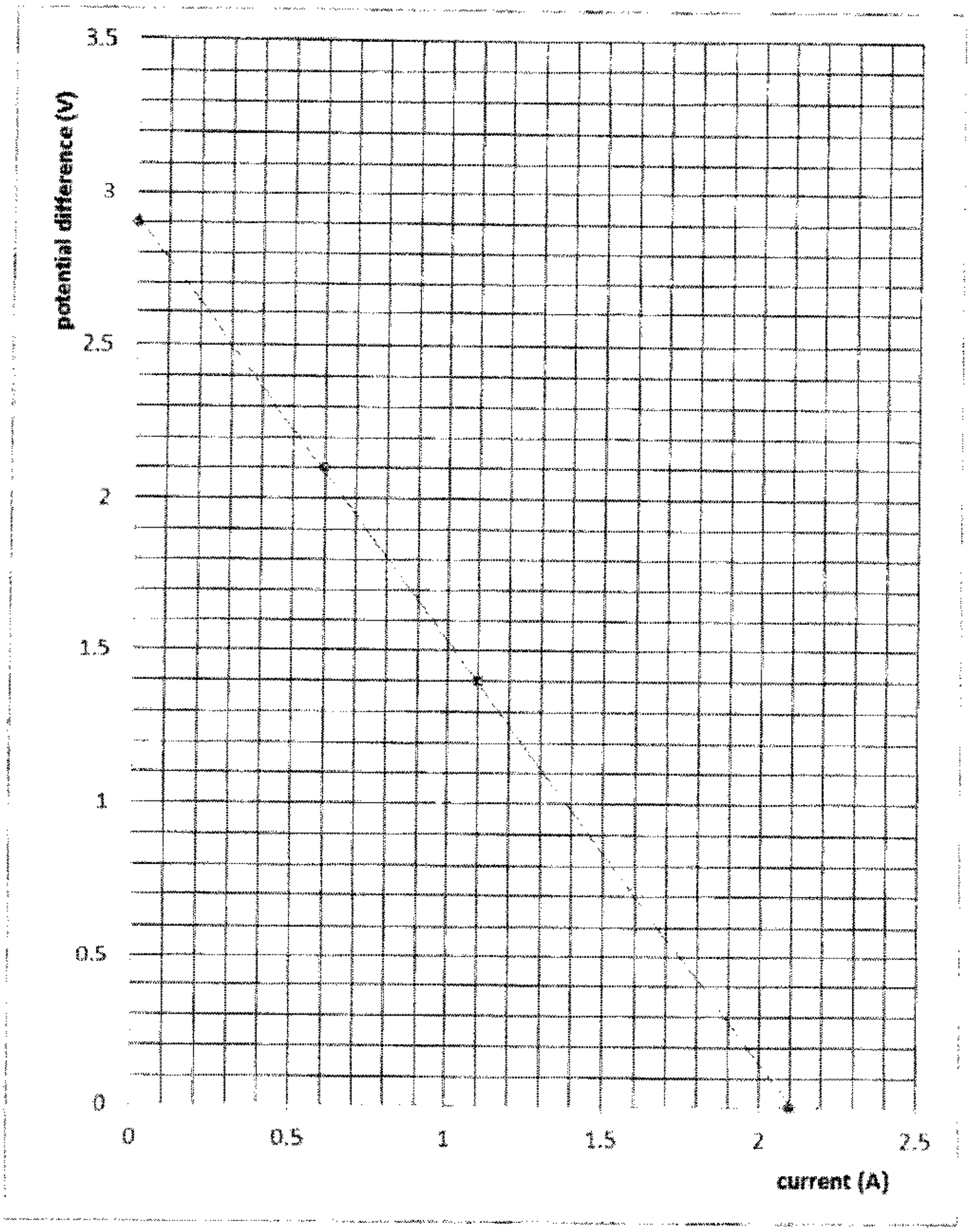
7.1.2 dependent variable. (1)

7.2 The learners obtain a set of corresponding readings of potential difference and current. Two of the readings are shown in the table below.

Reading number	**Current (A)**	**Potential difference (V) For external resistor**
1	0,3	2,52
2	1,6	0,71

By means of a calculation, determine the internal resistance of the battery. (3)

7.3 The learners now used their results to draw the following graph.



Use information from the graph to …

7.3.1 determine emf of the battery (no calculation is necessary). (2)

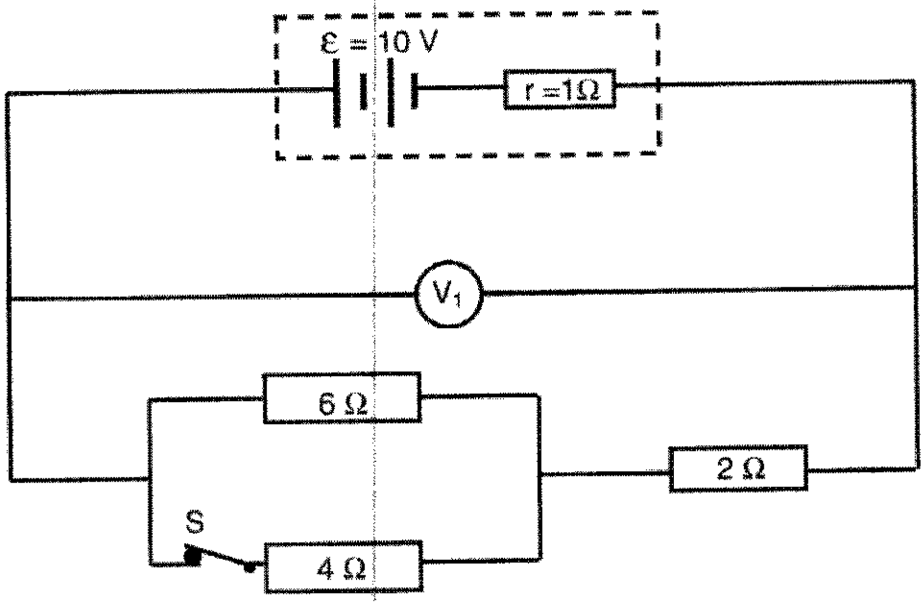
7.3.2 determine current *(I)* when the battery is short-circuited (no calculation is necessary). (2)

7.3.3 calculate the internal resistance of the battery. (2)

7.4 Give a reason for the slight deviation in the answers from Questions 7.2 and 7.3. (1)
[12]

QUESTION 8 **(Start on a new page.)**

A battery with an emf of 10 V and an internal resistance of 1 Ω is connected to three external resistors as shown in the circuit below.



Initially, switch S is closed.

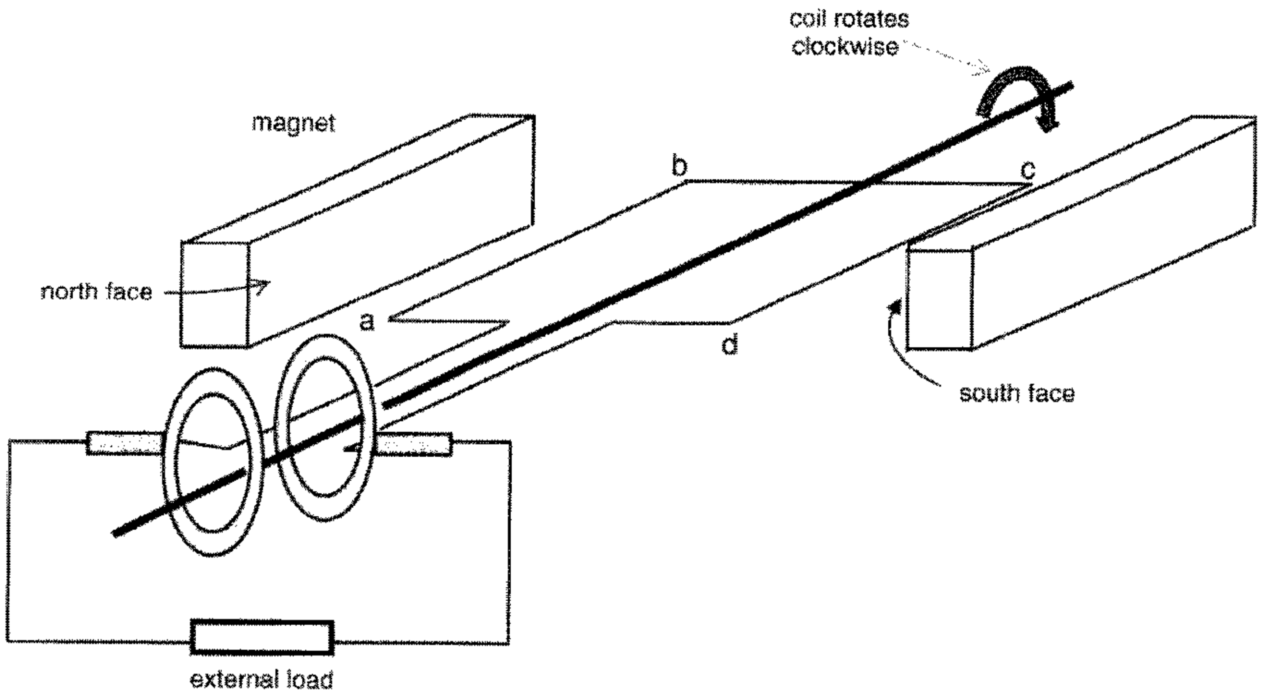
8.1 Calculate the current flowing in the circuit. (5)

8.2 Write down the reading of V_1. (2)

8.3 What happens to the reading of V_1 if switch S is opened? Choose from STAYS THE SAME, INCREASES or DECREASES. Explain the answer without any calculation. (3)
[10]

QUESTION 9 **(Start on a new page.)**

The diagram below shows the essential parts of a generator.



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

9.2 The coil **abcd** rotates clockwise within the magnetic field. Draw the shape of the voltage established across the external resistor for two cycles of the coil. Start with the coil in a horizontal position as shown. (2)

9.3 With the coil starting in the horizontal position as shown, what would be the direction of the induced current? Choose from **a to b** or **b to a.** (1)

9.4 The generator shown above delivers a maximum voltage of 6 V.

9.4.1 Define the term *rms current*. (2)

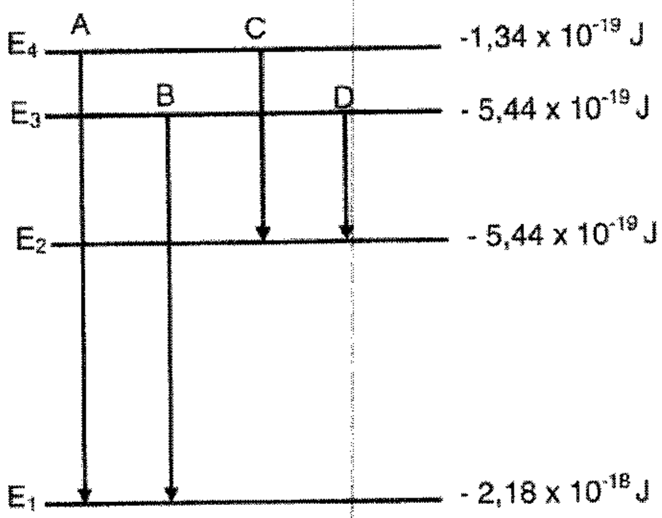
9.4.2 Calculate the rms current of this generator. (4)

9.4.3 Calculate the average power dissipated at the external load. (3)

[14]

QUESTION 10 (Start on a new page.)

The diagram below shows electron transitions between energy levels of an atom.



10.1 A photon of light is released when an electron moves from the E_3 state to the E_1 state. Calculate the frequency of this photon. (5)

10.2 How many different photons can be produced when excited electrons move from the E_3 state to the E_1 state? (1)

10.3 10.3.1 Define the *work function* of a metal. (2)

10.3.2 The photon in Question 10.1 is incident on a metal surface. The work function of the metal is 2×10^{-19} J. Calculate the maximum velocity of the ejected electron. (4)
[12]

TOTAL: 150

END

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	$9,11 \times 10^{-31}\ kg$
Mass of earth	M	$5,98 \times 10^{24}\ kg$
Radius of earth	R_E	$6,38 \times 10^6\ m$

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

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 $F = G\frac{m_1 m_2}{r^2}$	$g = G\frac{M}{d^2}$ or $g = G\frac{M}{r^2}$

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 $W_{nc} = \Delta E_k + \Delta E_p$	$P = \frac{W}{\Delta t}$
$P_{ave} = Fv_{ave}$ / $P_{gem} = Fv_{gem}$	

WAVES, SOUND AND LIGHT

$v = f\lambda$	$T = \frac{1}{f}$
$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$ $f_L = \frac{v \pm v_L}{v \pm v_b} f_b$	$E = hf$ or $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max)}$ or $E = W_o + K_{max}$ where $E = hf$ and $W_0 = hf_0$ and $E_{k(max)} = \frac{1}{2}mv^2_{max}$ or $K_{max} = \frac{1}{2}mv^2_{max}$	

ELECTROSTATICS

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

ELECTRIC CIRCUITS

$R=\frac{V}{I}$	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

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

ANSWER SHEET

NAME: ______________________ **GRADE 12:** ________

QUESTION 6.2