GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

PREPARATORY EXAMINATION

2024

10841

PHYSICAL SCIENCES: PHYSICS

(PAPER 1)

PHYSICAL SCIENCES: Paper 1

10841E

TIME: 3 hours

MARKS: 150

18 pages + 3 information sheets

X05

P.T.O.

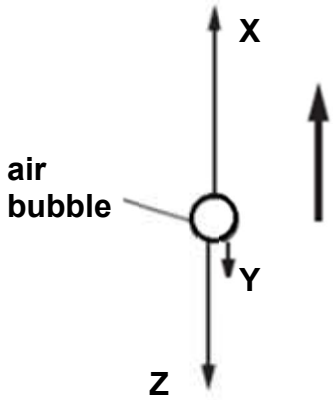
INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of TEN questions. Answer ALL the questions.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. You are advised to use the attached DATA SHEETS.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Start EACH question on a NEW page in the ANSWER BOOK.
8. Leave ONE line between two sub-questions, e.g. 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.
11. Give brief motivations, discussions, etc. where required.
12. Write neatly and legibly.

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 An air bubble in a tank of water is rising vertically at a CONSTANT VELOCITY. The forces acting on the bubble are **X**; **Y** and **Z** as shown below. (Diagram NOT to scale).



X = upward force

Y = friction force

Z = weight of bubble

Which option is INCORRECT with respect to the three forces acting on the air bubble? Take upward as positive direction.

A $X = Y + Z$

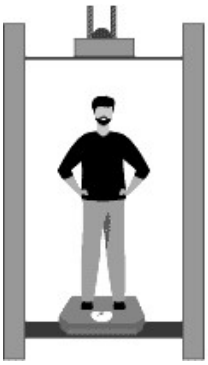
B $Z = X + Y$

C $Y = X – Z$

D $X > Z > Y$ (2)

1.2 A person stands on a scale in a lift. The motion of the lift is given in terms of its acceleration. Which situation represents WEIGHTLESSNESS?

A



Constant speed

$a = 0\ m \cdot s^{-2}$

B



Upward acceleration

$a = 9{,}8\ m \cdot s^{-2}$

C



Downward acceleration

$a = 9{,}8\ m \cdot s^{-2}$

D

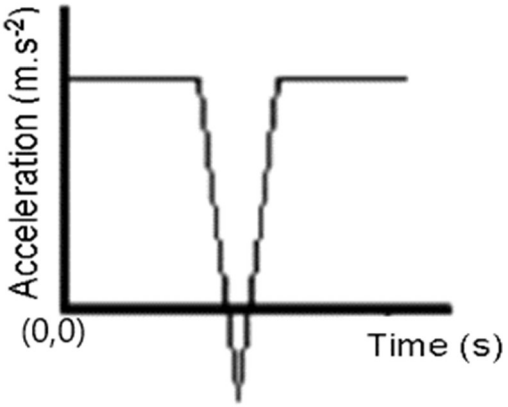


Downward acceleration

$a = 5\ m \cdot s^{-2}$

(2)

1.3 A golf ball falls vertically downwards from rest in air and bounces back to the same height from which it was dropped. The graph below shows the acceleration of the golf ball with time. (ALL effects of friction are ignored.)



The following statements are made about the golf ball's motion:

(i) It experiences maximum speed at the minimum height.

(ii) Its displacement falling is equal to its displacement rising.

(iii) It experiences minimum speed at the maximum height.

Which ONE of the combinations below is CORRECT?

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

D (i), (ii) and (iii) (2)

1.4 A ball of mass M, moving with a velocity V collides head-on ELASTICALLY with another body of the same mass M, moving with a velocity V in the opposite direction.

After the collision, …

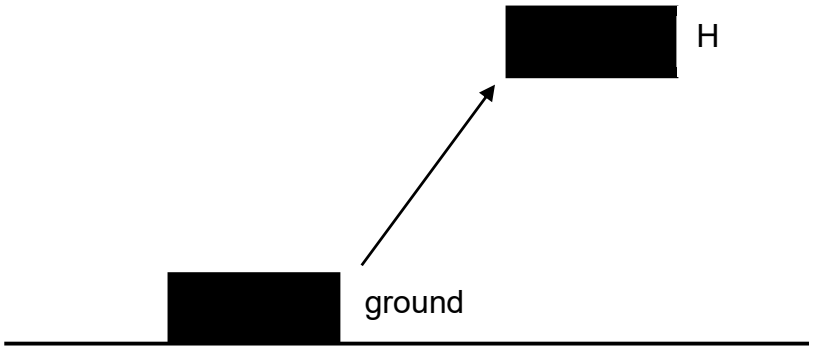
A both balls move with velocity V.

B both balls travel in the opposite direction with a speed V.

C both balls move at right angles to their original direction of motion.

D one ball comes to rest and the other ball travels back with a velocity 2V. (2)

1.5 A mass is lifted from rest on the ground to point **H** as shown below.



P is the increase in gravitational potential energy of the mass.

K is the kinetic energy of the mass at point **H**. (Ignore the effects of friction.)

Which expression is equal to the mechanical work done on the mass to move it from the ground to point **H**?

A P + K

B P – K

C K – P

D P x K (2)

1.6 To what does the term "redshift" refer?

A An object's speed in space

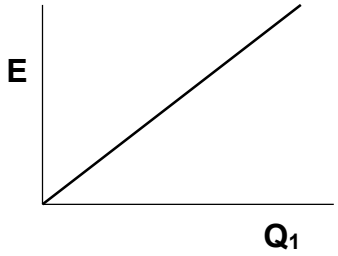
B The colour of a distant galaxy

C The expansion of the universe

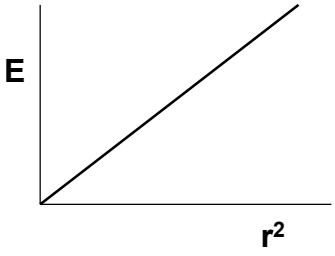
D The increase in an object's temperature (2)

1.7 Which of the following graphs has a slope equal to Coulomb's constant, **k**?

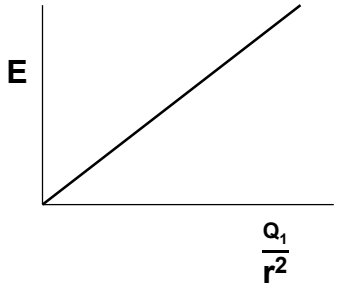
A



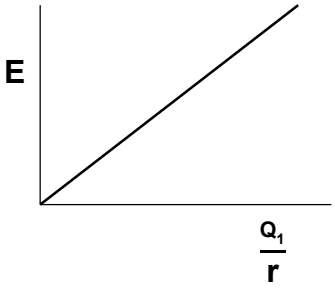
B



C

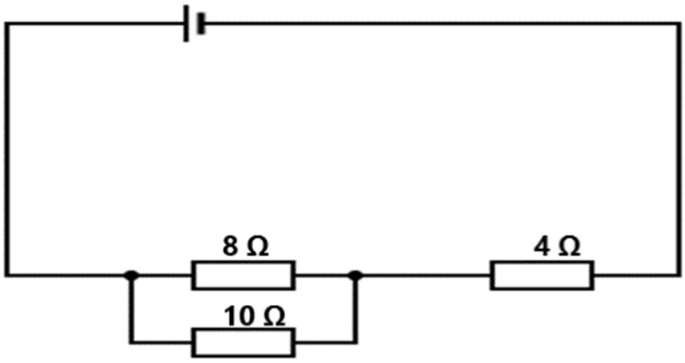


D



(2)

1.8 Three resistors are connected in a circuit as shown in the diagram below.



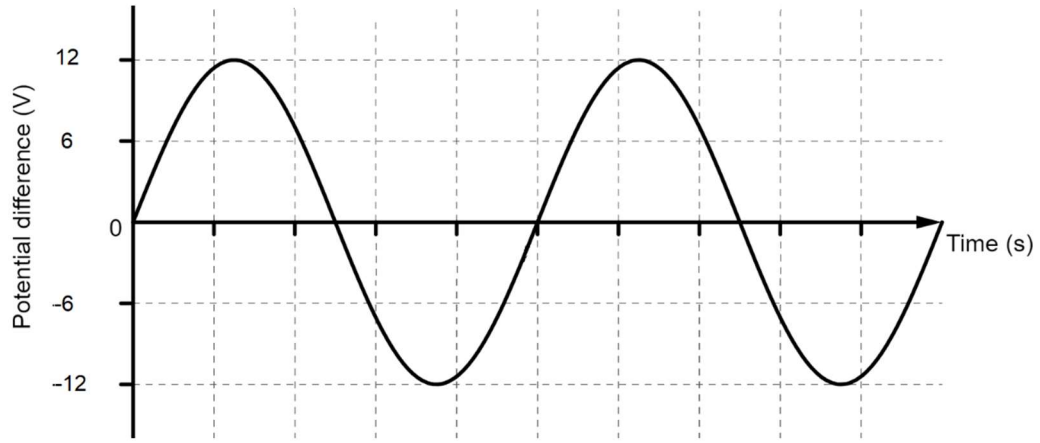
A fourth resistor is connected parallel to the 4 Ω resistor.

Compared to the original circuit, how will the power dissipated by the 8 Ω and 4 Ω resistors change?

	Power of 8 Ω resistor	**Power of 4 Ω resistor**
A	Decreases	Decreases
B	Decreases	Increases
C	Increases	Increases
D	Increases	Decreases

(2)

1.9 An immersion heater can be operated either from an AC power supply or a DC source. The graph below represents the potential difference when an AC power supply is used.



What DC supply voltage would produce the same rate of heating?

A 6 V

B 12 V

C $\frac{12}{\sqrt{2}}$V

D $12\sqrt{2}$V (2)

1.10 The work function of a metal is $W_o = hf_o$. If this metal is illuminated with light of frequency $3f_o$, the maximum kinetic energy of the photoelectrons will be …

A hf_o.

B $2hf_o$.

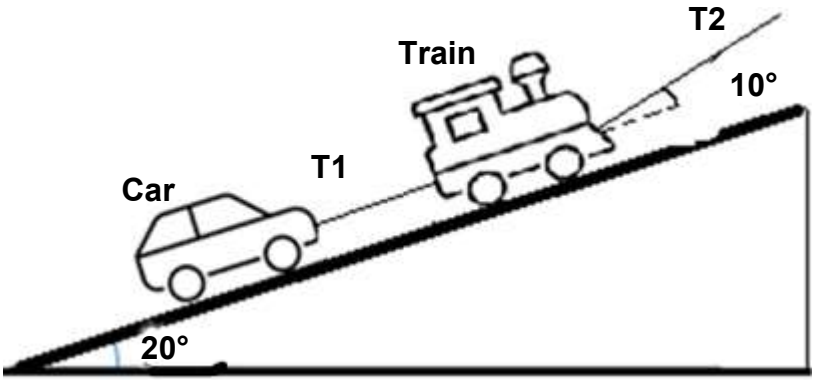
C $3hf_o$.

D $9hf_o$. (2)

[20]

QUESTION 2 (Start on a new page.)

A toy train of mass 2 kg and a toy car of mass 1 kg are attached by a light inextensible string. The car-train system is pulled up a rough slope at a constant velocity by the rope with a force T_2 acting on the rope at a 10° angle to the inclined plane.



2.1 Explain the term *net force* or *resultant force*. (2)

2.2 Draw a labelled, free-body diagram for the toy train. (5)

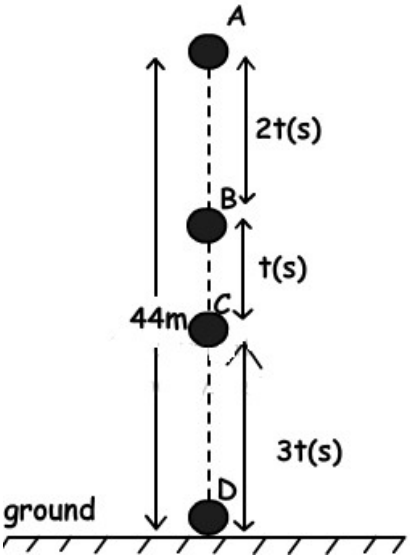
2.3 The tension force T_2 is increased to 20 N, causing the system to accelerate up the slope. Calculate the magnitude of the acceleration of the system if the friction force acting on the car is 1,5 N and that on the train is 2 N. (5)

2.4 Halfway up the slope, the string T_1 breaks, and the car rolls down the slope. Does the friction force on the train INCREASE; DECREASE or REMAIN THE SAME while still moving up the slope? Explain the answer. (3)

[15]

QUESTION 3 (Start on a new page.)

A tennis ball falls freely from rest from point **A** which is 44 m above the ground. The time taken to fall to the different positions **B**; **C** and **D** is given in terms of time *t* as shown below. (Ignore all effects of friction.)



3.1 Define the term *free fall*. (2)

3.2 Calculate the value of *t*. (4)

3.3 Calculate the height of the ball at point **C**. (4)

3.4 If, after the first bounce, the ball reaches point **C**, sketch the position-time graph for the ball from the moment it is dropped until it reaches point **C** after the bounce.

Show the following on the graph:

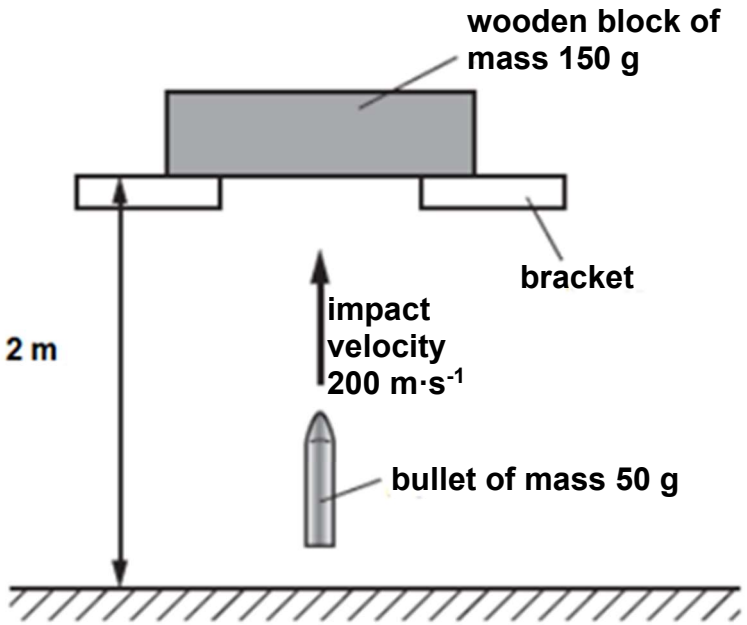
- The time values at points **D** and **C** (before the bounce) in terms of *t*
- The heights at **A** and **C**

Take the ground as point of ZERO reference (5)

[15]

QUESTION 4 (Start on a new page.)

A wooden block of mass 150 g is freely supported on brackets at a height of 2 m when a bullet of mass 50 g is fired vertically into the block, as shown below.



The bullet embeds itself into the block and the bullet-block system rises vertically into the air for a few seconds and then falls back to its original position.

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

4.2 Calculate the magnitude of the velocity of the bullet-block system after the bullet becomes embedded in it. (4)

4.3 Is the collision between the bullet and the block an ELASTIC or INELASTIC collision? Explain by using a calculation to justify your answer. (4)

4.4 On a different occasion, a bullet is fired closer to the wooden block at the same velocity, and it exits the block with an upwards velocity of 195 $m \cdot s^{-1}$.

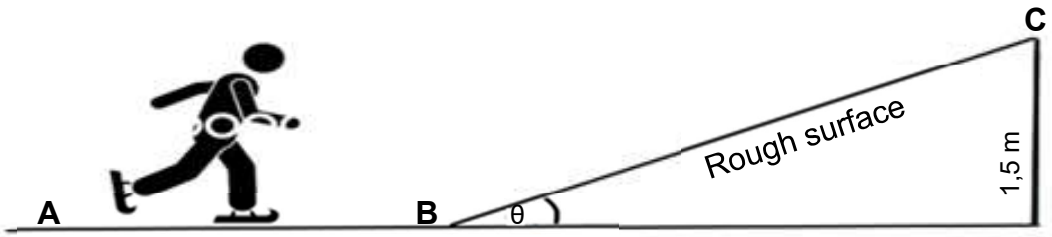
If the net force exerted by the block on the bullet is 5 N downwards, calculate the time it takes the bullet to exit the block. (3)

[13]

QUESTION 5 (Start on a new page.)

An ice skater of mass 53 kg moves on a frictionless surface **AB** with a velocity of 6 $m \cdot s^{-1}$ and then slides up a rough inclined surface **BC** until coming to a stop at point **C**, 1,5 m above the horizontal.

The angle between the incline and the horizontal is θ.



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

5.2 Draw a labelled, free-body diagram showing ALL the forces acting on the skater at point **C**. (3)

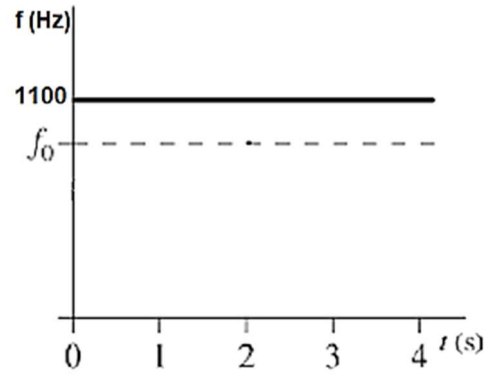
5.3 Explain the term *non conservative force*. (2)

5.4 Calculate the angle θ of the slope if the skater experiences a frictional force of 20 N while skating up the slope. (6)
[13]

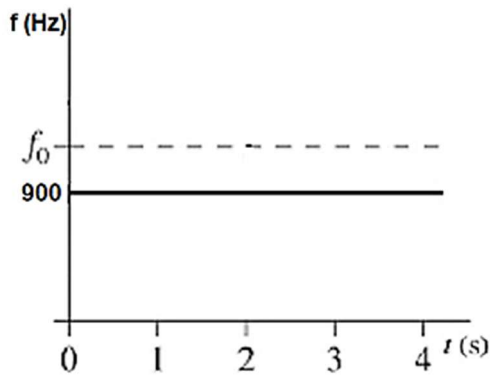
QUESTION 6 (Start on a new page.)

An observer with a detector, standing on the side of a straight road, records the frequency of a police car siren moving in a straight line on two separate occasions. The police car moves at the same CONSTANT SPEED on both occasions. The results are shown on graphs **A** and **B** drawn below.

GRAPH A



GRAPH B



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

6.2 Which graph, **A** or **B**, shows the police car moving away from the observer? Give a reason for your answer. (2)

P.T.O.

6.3 Calculate the speed of the police car.

(Take the speed of sound in air to be 340 $m \cdot s^{-1}$.) (5)

6.4 Study the emission spectra **A**, **B** and **C** of a distant star as observed from Earth. Spectrum **A** is the laboratory reference spectrum of the same star.



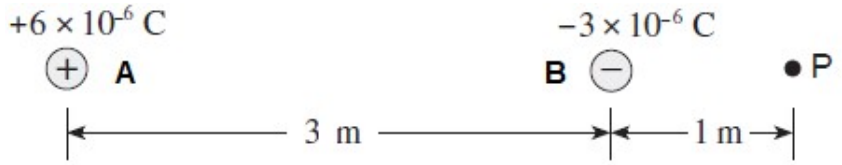
6.4.1 Which spectrum **B** or **C** indicates that the star is moving away from earth? (1)

6.4.2 If the blue part of a star spectrum is being observed from Earth, describe the frequency and wavelength of this light. (2)

[12]

QUESTION 7 (Start on a new page.)

Two point charges, **A** and **B**, are placed 3 m apart. The charge on **A** is $+6 \times 10^{-6}$ C and the charge on **B** is -3×10^{-6} C. **P** is a point 1 m to the right of charge **B**.



7.1 Define the term *electric field at a point*. (2)

7.2 Calculate the net electric field at point **P**. (5)

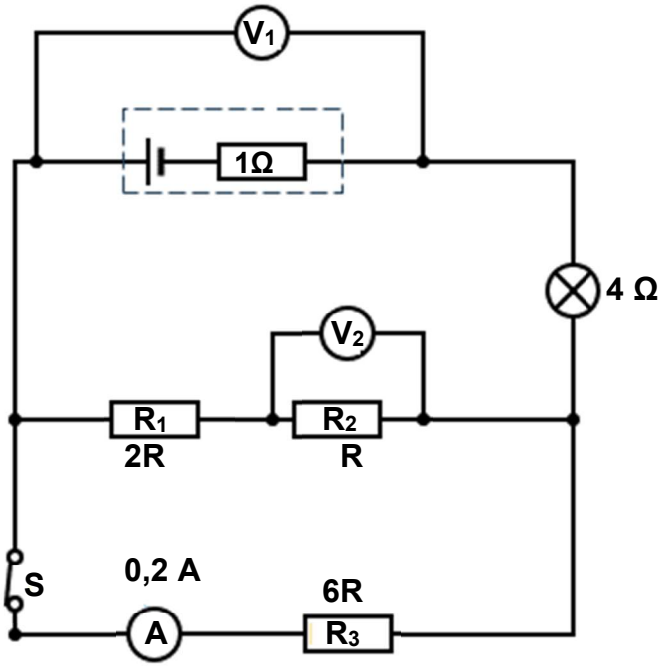
7.3 A proton is placed at point **P**. Calculate the magnitude of the initial acceleration of the proton if the mass of a proton is $1{,}67 \times 10^{-27}$ kg. (4)

7.4 If an electron was placed at point **P** instead of a proton, how would the acceleration of the electron compare to that of the proton? (2)

[13]

QUESTION 8 (Start on a new page.)

A battery with unknown emf and an internal resistance of 1 Ω is connected to three resistors, a lightbulb, a high-resistance voltmeter, a switch, and an ammeter of negligible resistance, as shown below. The resistance of the lightbulb is 4 Ω and the resistance of the three resistors are 2R, R and 6R respectively.



8.1 Define the term *emf*. (2)

8.2 When switch **S** is closed, the current through the ammeter is 0,2 A and the potential difference across R_1 is 6 V.

Write down the value of:

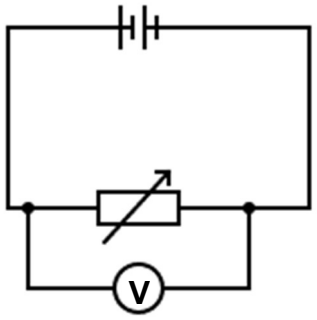
8.2.1 V_2 (1)

8.2.2 The current through R_2 (1)

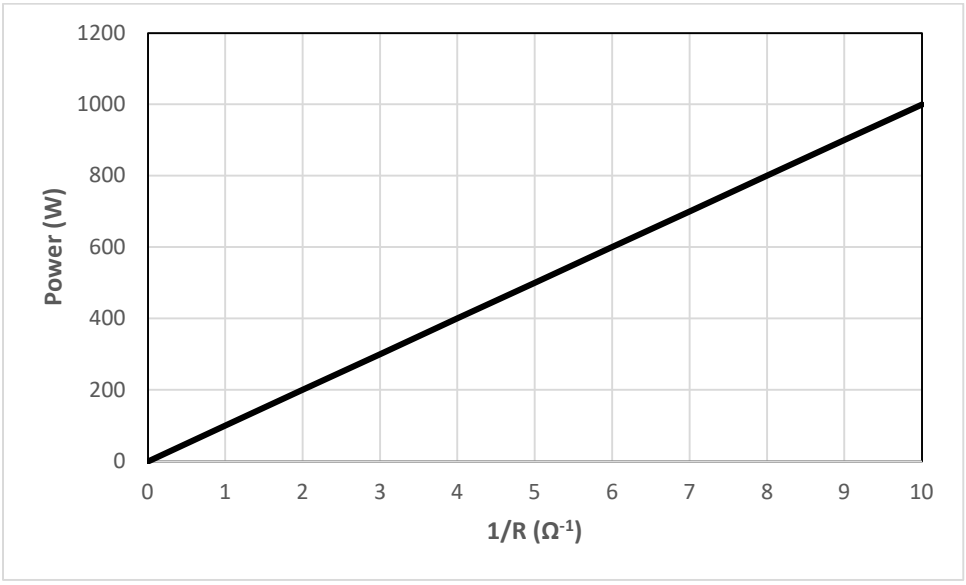
8.3 Calculate the resistance of R_3. (3)

8.4 Calculate the value of the emf. (6)

8.5 In a separate circuit, a variable resistor is connected to a battery with an unknown potential difference, as seen in the following diagram.



The graph below shows the relationship between the power dissipated in the resistor and the resistance of the resistor.

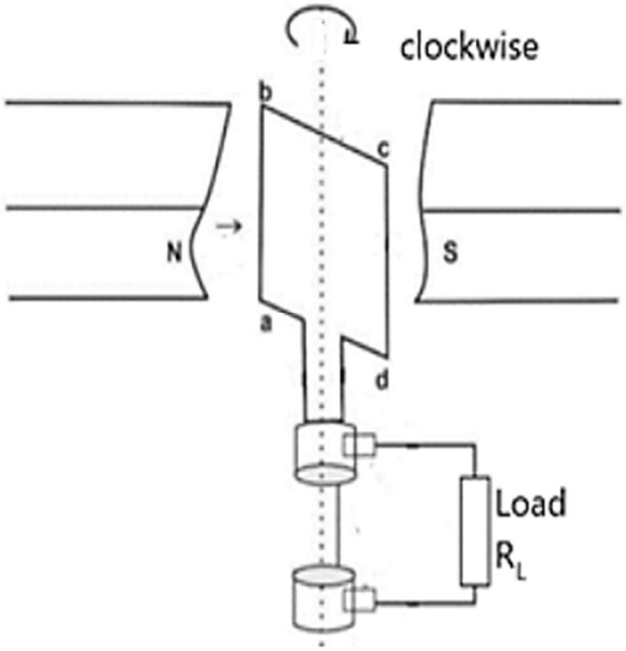


Use the graph to calculate the potential difference across the resistor. (4)

[17]

QUESTION 9 (Start on a new page.)

Study the diagram of a simple generator below and answer the questions that follow.

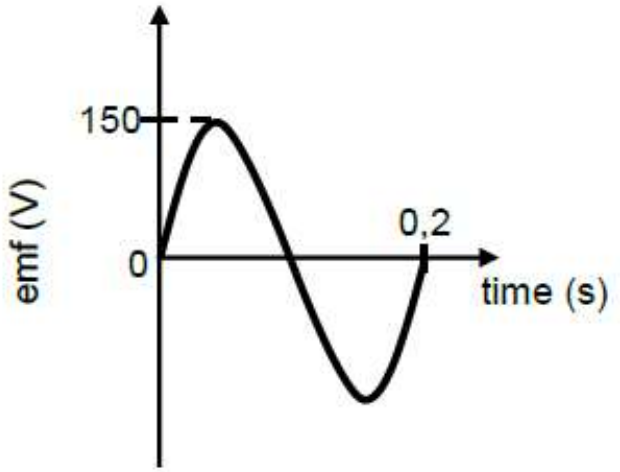


9.1 Is this an AC or a DC generator? Give a reason for the answer. (2)

9.2 State the energy conversion that takes place in this generator. (1)

9.3 In which direction will the induced current flow? State only from **a to b** or from **b to a**. (1)

The diagram below shows the emf time graph for one complete rotation of the coil.



9.4 Calculate the resistance of the load, $\mathbf{R_L}$, if the value of I_{rms} is 4,55 A when the V_{max} is 150 V. (4)

9.5 Load $\mathbf{R_L}$ is now replaced with a bulb with a power consumption of 400 W. Assume that the bub is 100% effective and calculate the light energy emitted by the bulb in 3 minutes. (3)

9.6 The speed of rotation of the coil is now DOUBLED.

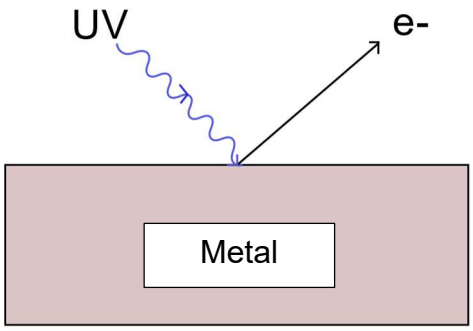
9.6.1 Redraw the above diagram in your ANSWER BOOK. On the same set of axes, indicate the old and the new pattern obtained. Label the new pattern B. (2)

9.6.2 With what factor will the energy emitted change if the speed of rotation of the coil is doubled (two times faster)? Explain the answer. (4)

[17]

QUESTION 10 (Start on a new page.)

In an experiment, different light sources are shone onto the surface of an unknown metal.

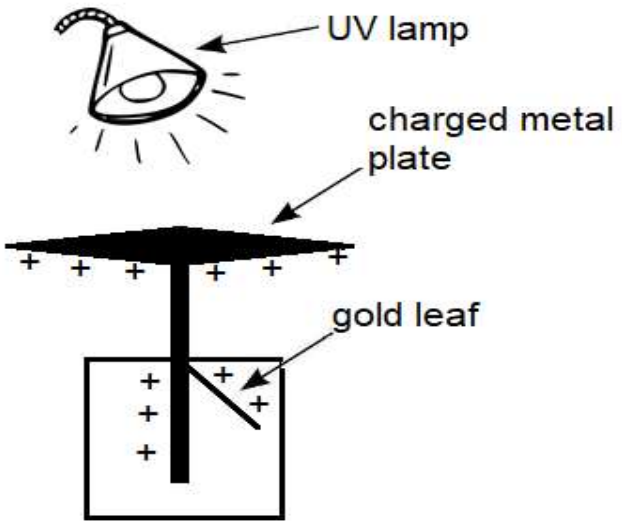


10.1 Explain the term *work function*. (2)

10.2 Electrons with a maximum kinetic energy of 1,2 x 10^{-19} J are emitted from the surface of the metal when ultraviolet light with a frequency of 6,3 x 10^{14} Hz is incident on it. Calculate the work function of the metal. (4)

10.3 Will electromagnetic radiation with a frequency of 3 x 10^{16} Hz emit electrons from the surface of this metal? Choose from YES or NO. Support the answer with suitable calculations. (6)

10.4 When the photoelectric effect is demonstrated, a negatively charged plate is used. Explain why, when ultraviolet light is shone on a positively charged plate, no charge is lost by the plate. (3)



[15]

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 x 10^{-11} $N \cdot m^2 \cdot kg^{-2}$
Radius of the Earth *Radius van die Aarde*	r_E	6,38 x 10^6 m
Mass of the Earth *Massa van die Aarde*	m_E	5,98 x 10^{24} kg
Speed of light in a vacuum *Spoed van lig in 'n vakuum*	c	3,0 x 10^8 $m \cdot s^{-1}$
Planck's constant *Planck se konstante*	h	6,63 x 10^{-34} J·s
Coulomb's constant *Coulomb se konstante*	k	9,0 x 10^9 $N \cdot m^2 \cdot C^{-2}$
Charge on electron *Lading op electron*	e	-1,6 x 10^{-19} C
Electron mass *Elektronmassa*	m_e	9,11 x 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* $E = h\frac{c}{\lambda}$
$E = W_o + E_{k(max/maks)}$ or/*of* $E = W_o + K_{max/maks}$ where/*waar* $E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max/maks)} = \frac{1}{2}mv^2_{max/maks}$ or/*of* $K_{max/maks} = \frac{1}{2}mv^2_{max/maks}$	

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*

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