education

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# NATIONAL SENIOR CERTIFICATE




## GRADE 12

## PHYSICAL SCIENCES: PHYSICS (P1)

## SEPTEMBER 2022




**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 20 pages and 3 data sheets**

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**INSTRUCTIONS AND INFORMATION**

1. Write your name on the ANSWER BOOK.

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

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 open between sub questions, e.g. 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, etc. where required.

12. Write neatly and legibly.

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## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are given 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 E.

1.1 Which ONE of the following is a conservative force?

A Frictional force

B An applied force

C Gravitational force

D Tension in a rope (2)

1.2 An object with mass **m** moves with a constant velocity**.** It undergoes a displacement **fx** in **t** seconds in the presence of a frictional force **F**. How much power is required to keep the body in motion at this constant velocity?

A $\frac{fx}{t}$

B $\frac{Fx}{2}$

C $\frac{F(fx)2}{t}$

D $F(\frac{fx}{t})$ (2)

1.3 Two forces, each of magnitude 300 N are simultaneously applied to a crate at rest on a frictionless horizontal surface as shown in the diagram below.




Work will be done by the net force on the crate and the crate will...

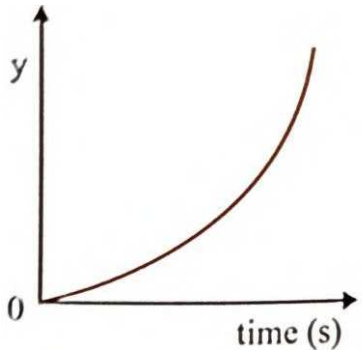
A accelerate to the left

B be lifted off the surface

C accelerate to the right

D remain rest (2)

1.4 A stone falls freely from rest from a certain height. Which one of the following quantities could be represented on the y-axis of the graph?



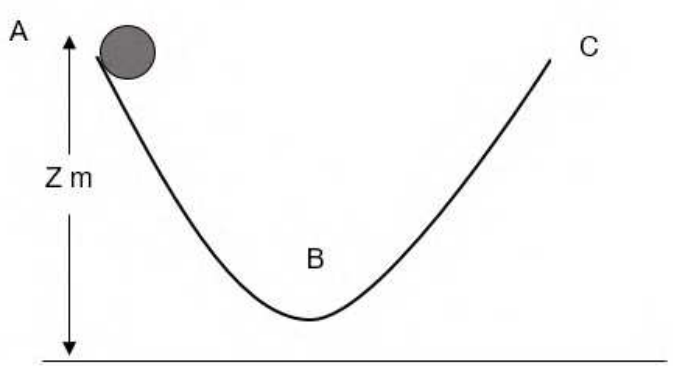

A Velocity

B Acceleration

C Momentum

D Position (2)

1.5 The ball is released from rest at point **A**, h meters above the ground. It slides down and up on a smooth frictionless track ABC. See the diagram below.




As the ball slides on the track ABC, it will …

A have maximum kinetic energy and zero potential energy at B

B roll up to a height of 'z' m on the opposite slope at C

C lose mechanical energy as it rolls up the opposite slope towards point C

D experience a gain in kinetic energy which is equal to its potential energy at C (2)

1.6 A source of sound moves away from a stationery observer. The frequency of the sound detected by the observer is different from the source frequency because:

A the volume of the sound decrease as the source moves away from the observer

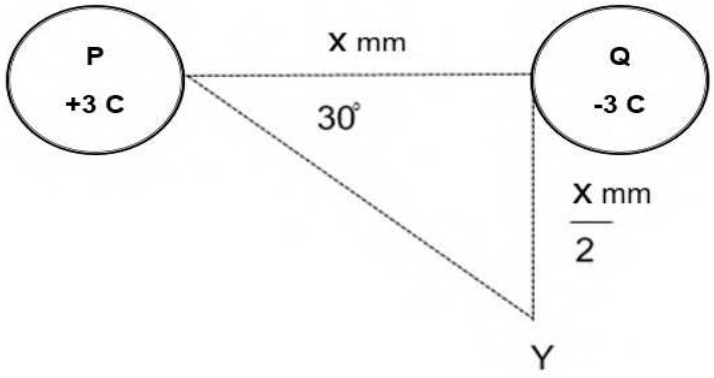
B the speed of sound becomes smaller

C the wave fronts received by the observer are further apart than the wave front from the source

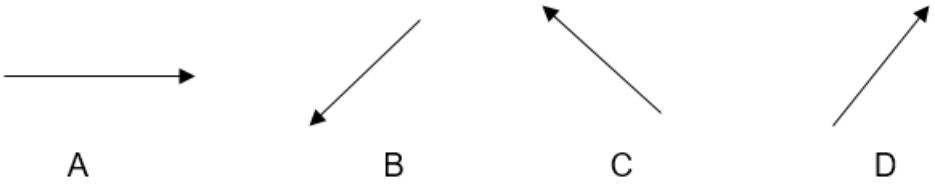
D the wave fronts received by the observer are closer than the wave front from the source (2)

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1.7 Two oppositely charged spheres P and Q carry charges of +3 C and -3 C respectively. An object is placed at point Y as indicated in the diagram below.

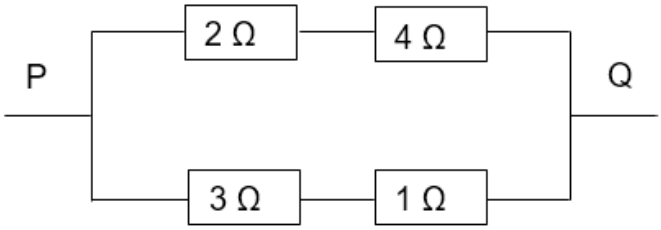



The vector diagram representing the net electric field at point **Y** is:




(2)

1.8 The diagram below represents part of a circuit. The potential difference across **P** and **Q** is V




Which ONE of the following gives the current through the 3 Ω resistor?

A $\frac{V}{4}$

B $\frac{V}{6}$

C $\frac{V}{2}$

D $\frac{V}{3}$

(2)

1.9 A multi plug enables us to plug many appliances in at the same time so they can function simultaneously. If a multi plug adaptor connected in parallel is overloaded with too many appliances, a trip switch cuts off the electrical supply.

Which ONE of the following statements best explains the situation?

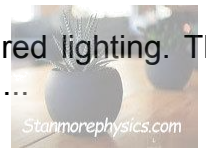
A The effective resistance increases and the current becomes too high

B More current is required that can be supplied

C The effective resistance decreases, resulting in a larger current being drawn

D The current is divided among all the appliances and is not enough for them all to operate (2)

1.10 Fluorescent lights are used for signage, advertising and coloured lighting. The fluorescent tubes consists of mainly argon, neon or krypton gas ...




The type of spectrum formed by these types of lights is…

A an absorption spectrum

B a line emission spectrum

C continuous spectrum

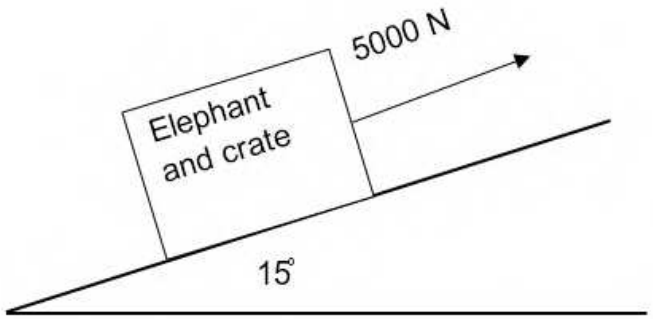
D a transmission spectrum (2)

**[20]**

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

Elephants are being transported from Kruger National Park to Eastern Cape. They are loaded into crates that are pulled up an inclined plane on frictionless rollers.

The diagram below shows a crate with an elephant being held stationery on the ramp by means of a rope parallel to the ramp. The angle of inclination is 15 ° and the tension of the rope is 5000 N.




2.1 Draw a labelled free-body diagram of all the forces acting on the elephant and crate. (consider crate and elephant as one object) (3)

2.2 The crate has a mass of 800 kg. Determine the mass of the elephant. (4)

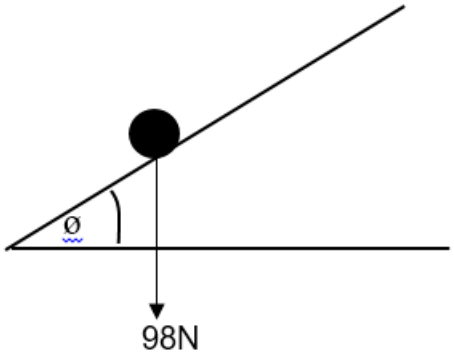
2.3 The crate is now being pulled up the ramp at CONSTANT ACCELERATION.

2.3.1 What effect does it have on the net force acting on the elephant and the crate?
Choose from INCREASE, DECREASE OR REMAINS SAME. (1)

2.3.2 Explain your answer in QUESTION 2.3.1 (1)

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2.4 In another experiment, learners investigated the forces acting on an object on an inclined plane. The object had a gravitational force of 98 N. The ratio of the NORMAL force to that of parallel component force was **7:4**




2.4.1 Define *normal force* in words. (2)

2.4.2 Calculate the angle of inclination ø of the ramp (3)

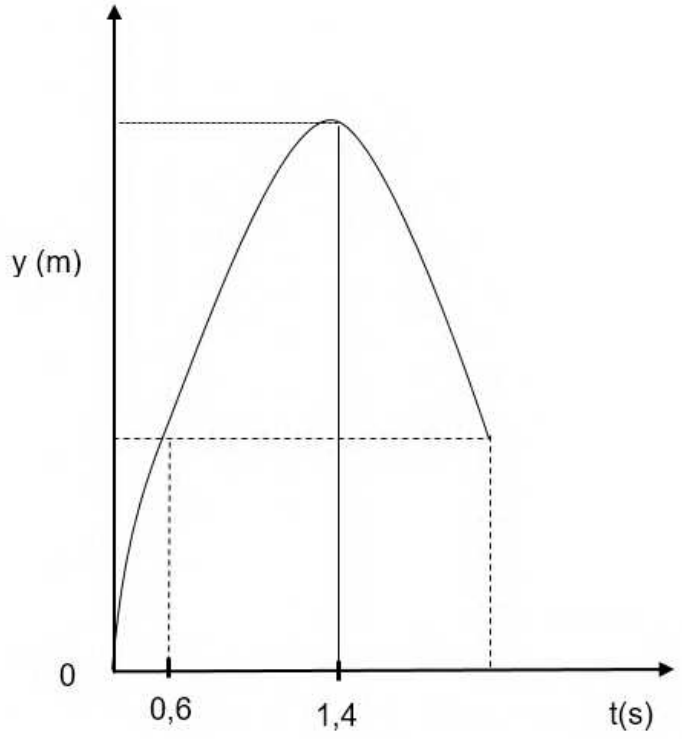
**[14]**

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

Nomsa is standing on the ground floor of a building. She throws a pencil case vertically towards Mekwe, who is standing on the balcony of the first floor of the building, with an initial velocity, **v**.

Mekwe fails to catch the pencil case as it moves upwards but catches it on its way back. Ignore the effects of air friction.

The position time graph below, not drawn to scale, represents the motion of the pencil case when it was thrown up till it reaches Mekwe's hand. Choose **upwards** as positive.




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

3.2 Use the graph and determine the:

3.2.1 Time in which pencil case's velocity is 0 $m \cdot s^{-1}$ (1)

3.2.2 Acceleration of the pencil case at 1,4 s? (2)

3.2.3 Time it takes for the pencil case to reach Mekwe's hand from the moment Nomsa threw it upwards. (2)

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3.3 Use equations of motion and information from the graph to calculate the:

3.3.1 Initial velocity **v** of the pencil case. (3)

3.3.2 Height of the pencil case above the ground when Mekwe caught it. (3)



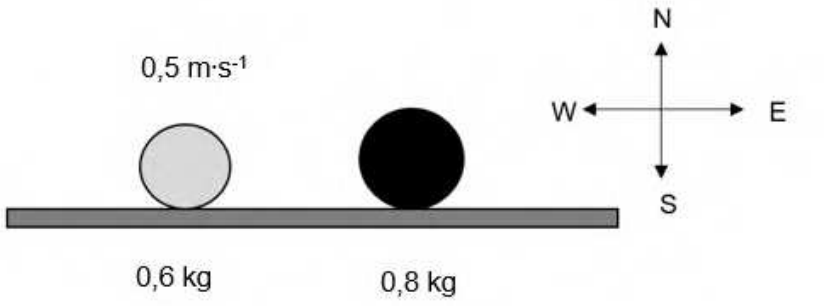

3.4 Draw an acceleration-time graph for the entire motion of the pencil case. Indicate the value of acceleration and time on the graph. (2)

3.5 What does the area under the acceleration time graph represents? (1)

**[16]**

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

Tim is playing snooker and positions his cue so that the white ball is lined up with the black ball. A 0,6 kg white ball moving at a velocity 0,5 $m \cdot s^{-1}$ collides with a stationery black ball of mass 0,8 kg. On contact, the black ball exerts a force of 1,2 N on the white ball.




4.1 State Newton's Second Law of motion *in terms of momentum.* (2)

4.2 If the change in momentum of the white ball is -0,24 $kg \cdot m \cdot s^{-1}$, calculate the time that the white ball is in contact with the black ball. (3)

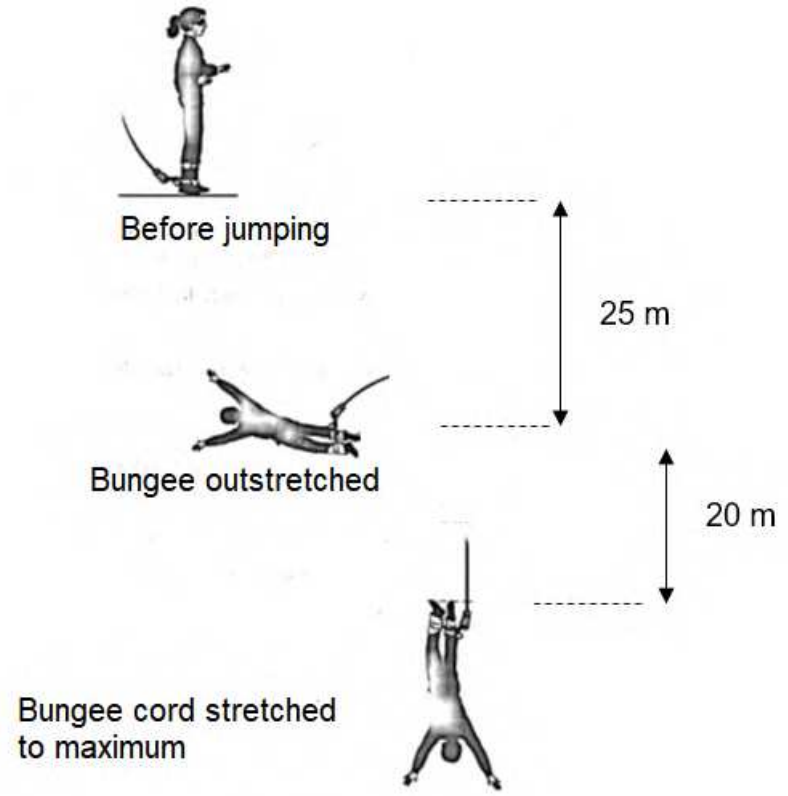
4.3 Calculate the velocity of the white ball after the collision. (3)

4.4 On being struck, the black ball moves forward towards the bumper cushion on the sides of the snooker table and collided elastically with the bumper cushion. After collision, the kinetic energy of the black ball is 0,042 J. Calculate its velocity. (3)
**[11]**

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

Vickey a 75 kg learner, jumps off a bridge 60 m above the ground. She has a bungee cord tied to her ankles. She falls 25 m before the bungee cord begins to stretch, slowing down her fall. The cord stretches 20 m, before the jumper come to rest. Ignore air friction.




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

5.2 Using energy principles calculate the kinetic energy of the jumper when she has fallen 25 m. (4)

5.3 Calculate the work done by the cord to bring her to rest. (3)

5.4 How much energy is transferred from the jumper to the cord? (1)

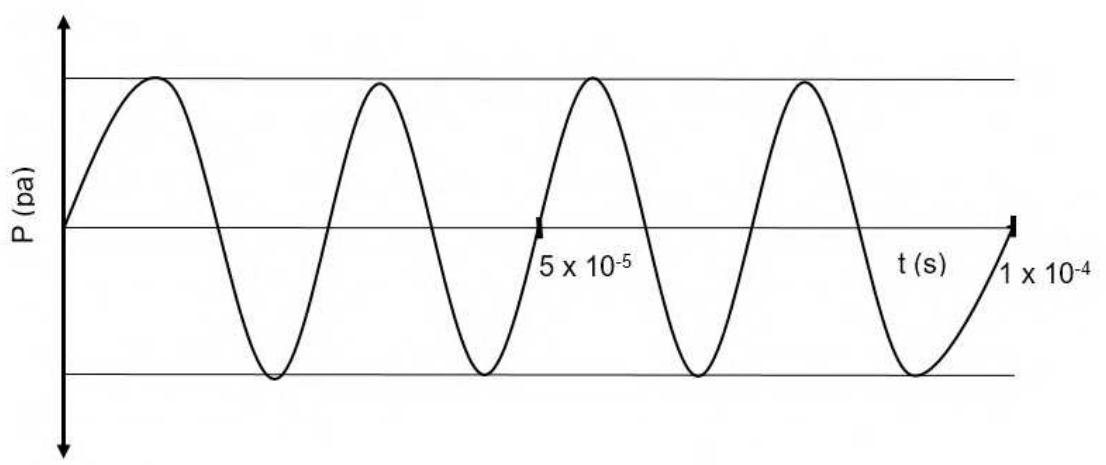
5.5 Calculate the average force exerted by the cord on the jumper if the cord stretches for 20 m before she comes to rest. (4)

**[14]**

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

Scientists studying the social interaction of dolphins in captivity connected an underwater sound recorder to an oscilloscope and immersed it in the dolphin tank at an aquarium.

They recorded the sound waves emitted by the dolphins as they approached the microphone. The waves they recorded on the oscilloscope are represented below:




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

6.2 The average frequency of the social vocalisations of these dolphins is 38 kHz. Show by calculation that the frequency recorded is 2 kHz higher than the actual frequency. (2)

6.3 Explain why the recorded frequency is higher than the actual frequency. (2)

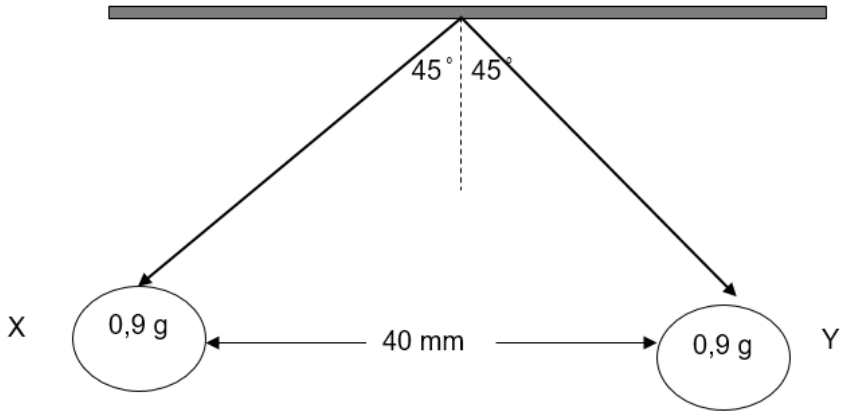
6.4 Calculate the speed at which the dolphins are approaching the recorder. The speed of sound in water is 1500 $m \cdot s^{-1}$. (5)

6.5 Astronomers have used *Doppler effect* to conclude that galaxies are moving away from the Earth. Write a reason to support their conclusion. (2)

**[13]**

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

Two small identical metal spheres, X and Y, each with a mass of 0,9 g hang from the same fixed point from threads of equal length. When the spheres receive equal charges, they repel each other and come to rest with their centres 40 mm apart and the threads making an angle of 45° with the vertical.




7.1 State *Coulomb's law* in words. (2)

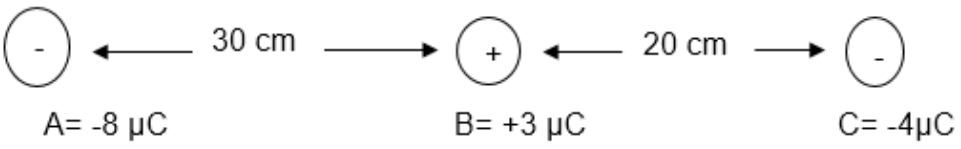
7.2 Draw a force diagram to show all the forces acting on Y. (3)

7.3 Calculate the:

7.3.1 Magnitude and direction of electrostatic force that X exerts on Y. (3)

7.3.2 Charge on each sphere. (3)

7.4 Three charged particles A, B and C are arranged in a line as shown in the diagram.

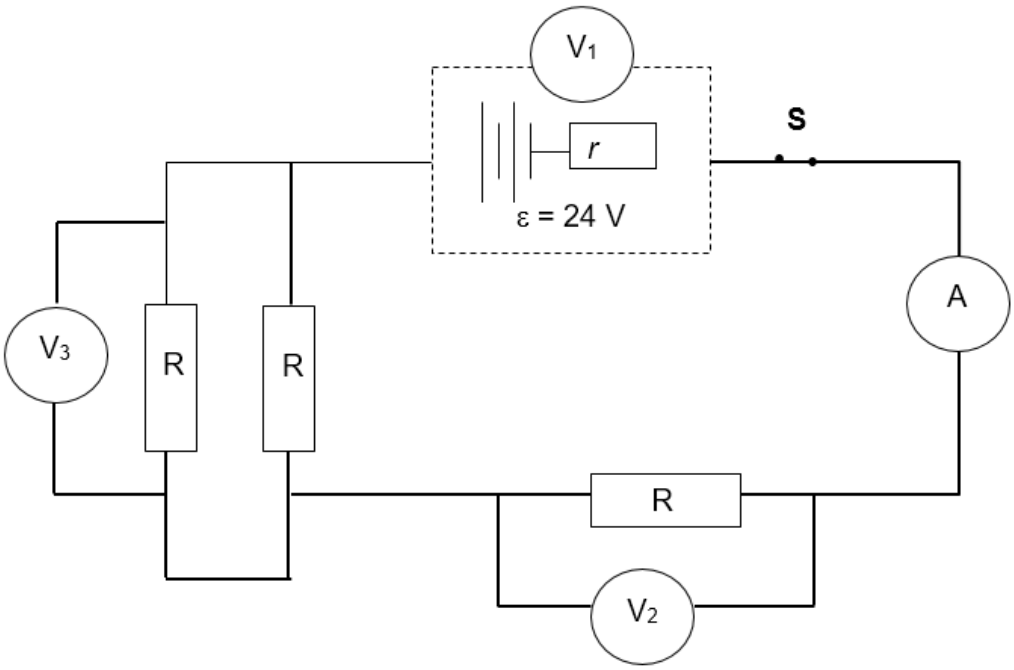



7.4.1 Calculate the magnitude and direction of net electrostatic force on particle C due to the other two charges. (3)

**[14]**

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

Three identical unknown resistors each of resistance R are connected in circuit to a battery of emf 24 V and unknown internal resistance '**r**'. An ammeter registers a current of 3 A and voltmeter $V_1$ reads 21 V when the switch '**S**' is closed.




8.1 Explain the term *internal resistance*. (2)

8.2 Write down a mathematical expression/formula which relates the voltmeter readings of $V_2$ and $V_3$. (1)

8.3 What will be the reading on $V_2$ and $V_3$? (2)

8.4 Calculate the:

8.4.1 Internal resistance of the battery. (4)

8.4.2 Resistance of the resistor **R**. (3)

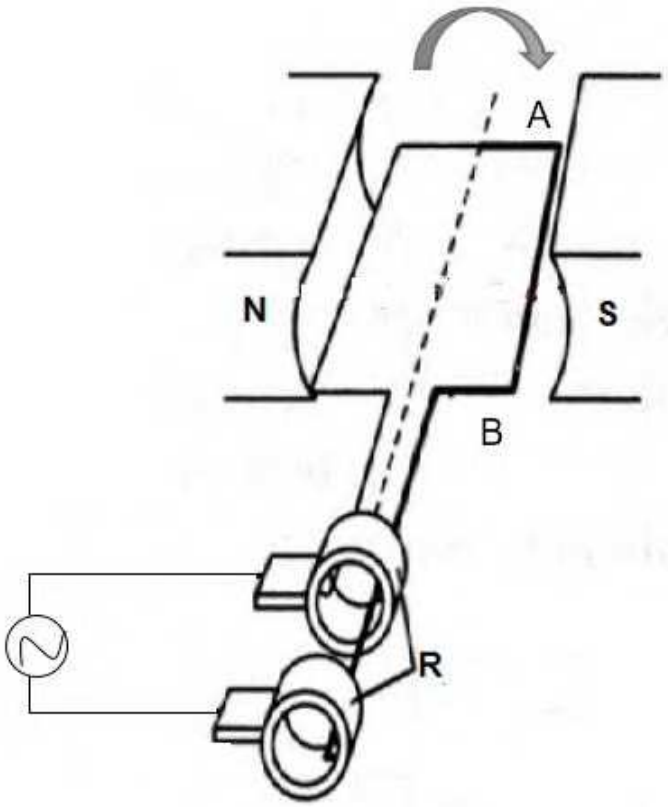
8.5 A car lamp is marked '12 V, 60 W'. Calculate the quantity of electric charge that passes through any point in the lamp in 2 minutes when operating according to the above mentioned specifications. (4)

**[16]**

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

The diagram given below is a schematic representation of an AC generator.




9.1 Write down the:

9.1.1 Name of the part labelled 'R'. (1)

9.1.2 Function of part labelled 'R'. (2)

9.2 State ONE principle on which an AC generator works. (2)

9.3 If the armature is rotated in the direction as indicated in the diagram, which way will the current flow in the armature?

Choose from **A to B** or **B to A** (1)

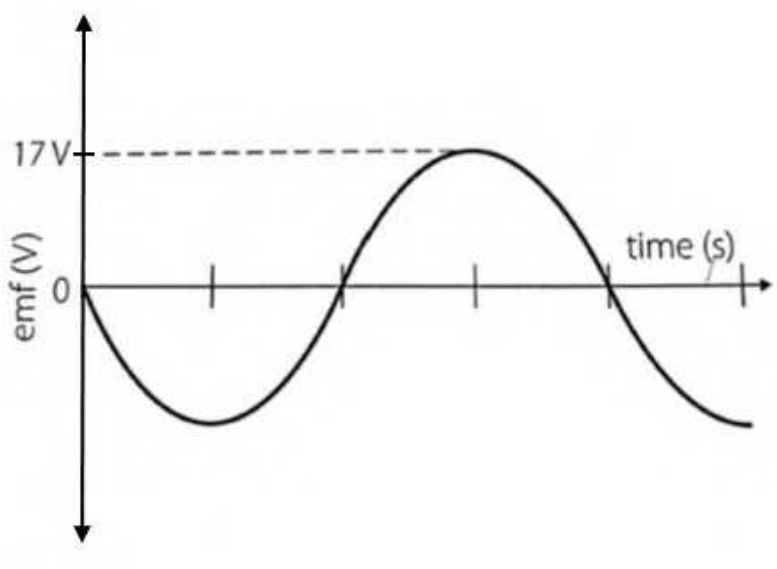
9.4 What effect does changing the polarity of the magnets have on the output voltage?

Choose from INCREASES, DECREASES OR REMAINS THE SAME. (1)

9.5 What is the position of the coil, relative to the magnetic field, when the output voltage is at a minimum? (2)

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9.6 The graph shows the potential delivered by an AC source to a light bulb which is dissipating 15 W.




9.6.1 What DC voltage would have to be supplied to keep the bulb burning at the same brightness? (3)

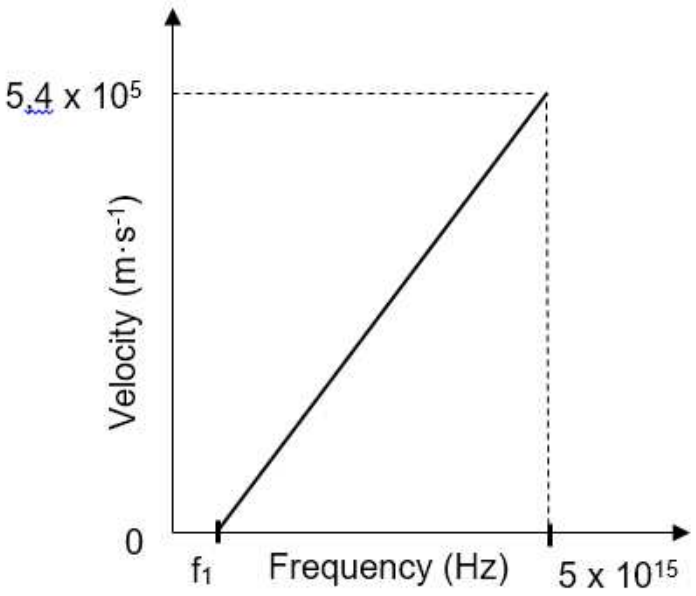
9.6.2 What is the peak current through the bulb while it is connected to the AC source? (4)

9.6.3 Draw a graph of current versus time for the same time period as the above graph. Indicate the values of $I_{max}$ and $I_{rms}$ on the graph. (2)
**[19]**

**QUESTION 10 (Start on a new page)**

When ultraviolet light shines on the surface of an electrode of a photoelectric cell, electrons are ejected. The velocity of the ejected electrons is measured against the frequency.

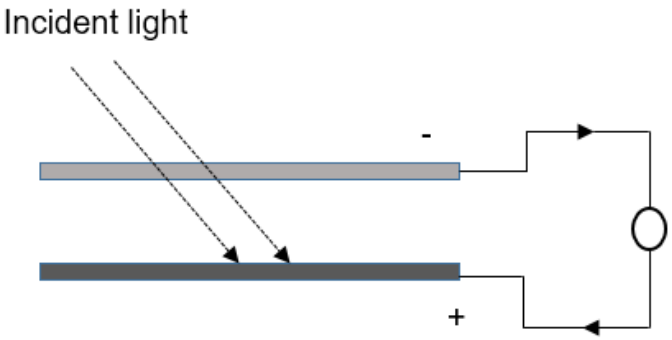
The graph below represents the results obtained.




10.1 Name the physical quantity represented by **'$f_1$'** on the graph? (1)

10.2 Use the information from the graph to calculate the value of **$f_1$** (5)

10.3 A grade 12 learner has a calculator that is powered by a photoelectric cell. The photoelectric cell consists of two conductive plates that are connected in a circuit as shown below. The lower plate consists of selenium.




10.3.1 Define the term *work function* in words. (2)

A learner shone a blue light on the photoelectric cell and found that the calculator did not work. He finds that the calculator works in day light.

Use the information given below and answer the questions that follow:

| **Frequency of blue light** | **Frequency of ultraviolet light** | **Work function of selenium** |
|---|---|---|
| 3,32 X $10^{14}$ Hz | 1,54 X $10^{16}$ Hz | 9,44 X $10^{-19}$ J |

10.3.2 Calculate threshold frequency of selenium? (3)

10.3.3 Write a reason why does the photoelectric cell work in day light and not in blue light. (2)
**[13]**

**TOTAL: 150**

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# 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<br>*Swaartekragversnelling* | g | $9,8\ m{\cdot}s^{-2}$ |
| Universal gravitational constant<br>*Universele gravitasiekonstant* | G | $6,67 \times 10^{-11}\ N{\cdot}m^2{\cdot}kg^{-2}$ |
| Speed of light in a vacuum<br>*Spoed van lig in 'n vakuum* | c | $3,0 \times 10^8\ m{\cdot}s^{-1}$ |
| Planck's constant<br>*Planck se konstante* | h | $6,63 \times 10^{-34}\ J{\cdot}s$ |
| Coulomb's constant<br>*Coulomb se konstante* | k | $9,0 \times 10^9\ N{\cdot}m^2{\cdot}C^{-2}$ |
| Charge on electron<br>*Lading op elektron* | e | $1,6 \times 10^{-19}\ C$ |
| Electron mass<br>*Elektronmassa* | $m_e$ | $9,11 \times 10^{-31}\ kg$ |
| Mass of the Earth<br>*Massa van die Aarde* | M | $5,98 \times 10^{24}\ kg$ |
| Radius of the Earth<br>*Radius van die Aarde* | $R_E$ | $6,38 \times 10^6\ m$ |

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## 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*

| | |
|---|---|
| $F_{net} = ma$ | $p = mv$ |
| $f_s^{\ max} = \mu_s N$ | $f_k = \mu_k N$ |
| $F_{net}\Delta t = \Delta p$<br>$\Delta p = mv_f - mv_i$ | $w = mg$ |
| $F = G\frac{m_1 m_2}{d^2}$ 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* $W_{net} = \Delta E_k$<br>$\Delta K = K_f - K_i$ 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* $E = h\frac{c}{\lambda}$ |
| $E = W_o + E_{k(max)}$ or/*of* $E = W_o + K_{max}$ where/*waar*<br>$E = hf$ and/*en* $W_0 = hf_0$ and/*en* $E_{k(max)} = \frac{1}{2}mv_{max}^2$ or/*of* $K_{max} = \frac{1}{2}mv_{max}^2$ | |

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## 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 $(\varepsilon) = I(R + r)$<br>emk $(\varepsilon) = I(R + r)$ |
| $R_s = R_1 + R_2 + ...$<br>$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + ...$ | $q = I\,\Delta t$ |
| $W = Vq$<br>$W = VI\,\Delta t$<br>$W = I^2R\,\Delta t$<br>$W = \frac{V^2\Delta t}{R}$ | $P = \frac{W}{\Delta t}$<br>$P = VI$<br>$P = I^2R$<br>$P = \frac{V^2}{R}$ |

## ALTERNATING CURRENT/*WISSELSTROOM*

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

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