GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

# GAUTENG DEPARTMENT OF EDUCATION

# PREPARATORY EXAMINATION

# 2019

## 10841

## PHYSICAL SCIENCES: PHYSICS

## PAPER 1

**TIME:** 3 hours
**MARKS:** 150
**19 pages + 3 information sheets**

**PHYSICAL SCIENCES: Paper 1**

10841E

X10

**GAUTENG DEPARTMENT OF EDUCATION**

**PREPARATORY EXAMINATION**

**PHYSICAL SCIENCES: PHYSICS (Paper 1)**

**TIME: 3 hours**

**MARKS: 150**

---

## INSTRUCTIONS AND INFORMATION

1. Write your name in the appropriate space on the ANSWER BOOK.
2. This question paper consists of 11 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.

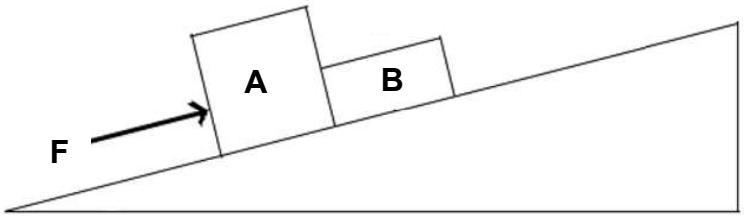
## QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Four options are given 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.

1.1 A learner is sitting on a chair. According to Newton's *Third Law of Motion*, the reaction force to the learner's weight, **w** is the force of the …

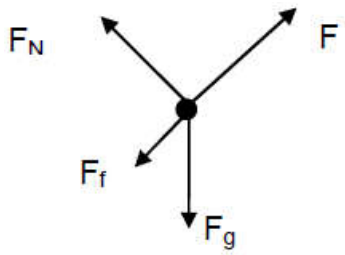
A learner on the chair.
B chair on the learner.
C earth on the learner.
D learner on the earth. (2)

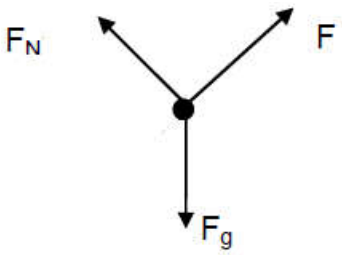
1.2 Two objects, **A** and **B**, are in contact with each other on an inclined plane. A horizontal force, **F**, is applied parallel to the incline, and pushes on the objects as shown in the diagram below.

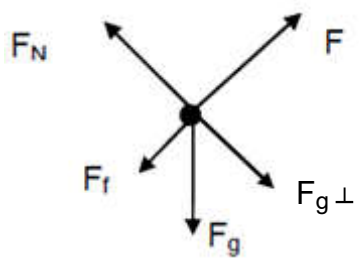


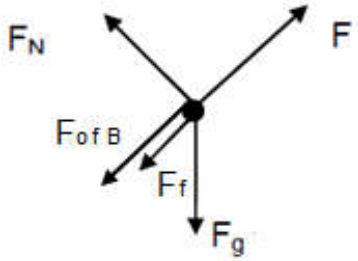

The magnitude of kinetic frictional force acting on the objects cannot be ignored.

Which ONE of the following is the correct free body diagram for block **A**?

A



B



C



D



(2)

1.3 Trolley **T**, mass 3m, moving to the right with a speed **v** collides head-on with trolley **R**, mass m, moving to the left with speed **v**. Immediately after the collision, trolley **R** moves to the right with a speed **2v** and trolley **T** is at rest. Refer to the diagram below.

Ignore the effects of friction.

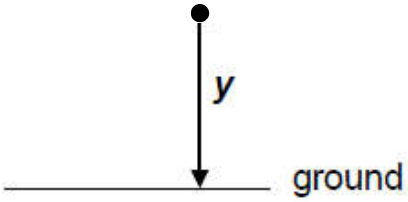



Which of the following combinations is CORRECT?

| | MECHANICAL ENERGY | MOMENTUM |
|---|---|---|
| A | Conserved | Conserved |
| B | Conserved | Not conserved |
| C | Not conserved | Not conserved |
| D | Not conserved | Conserved |

(2)

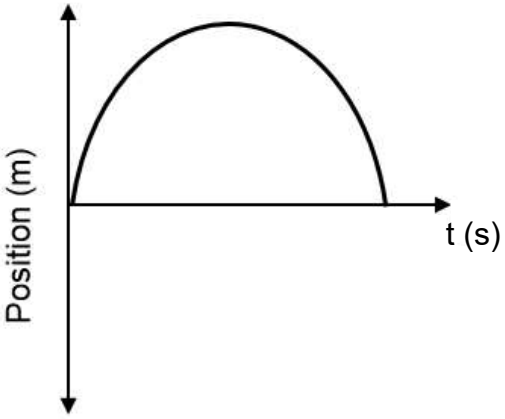
1.4 A small stone is dropped from a height **y** above the ground as shown in the diagram below. It strikes the ground after time **t**.



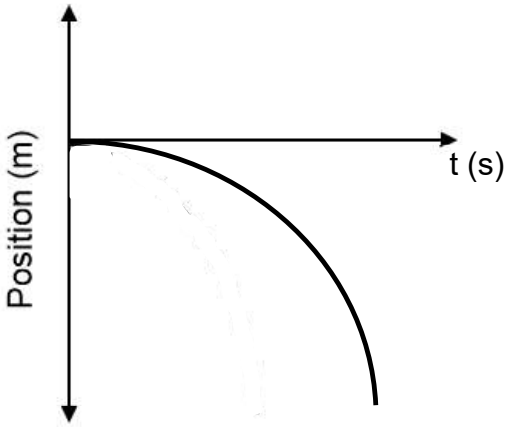

Take UPWARDS AS THE POSITIVE. Ignore the effects of air resistance.

Which of the following diagrams shows the correct position-time graph for the motion of the stone?

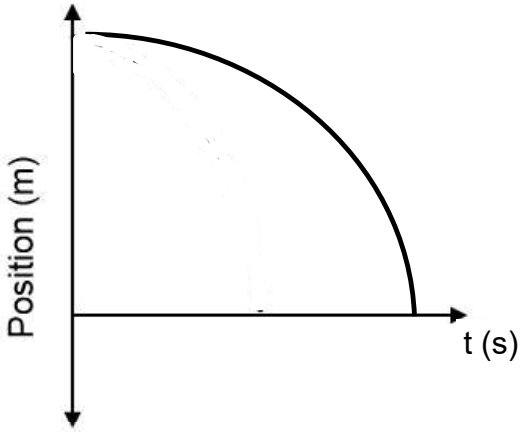
A



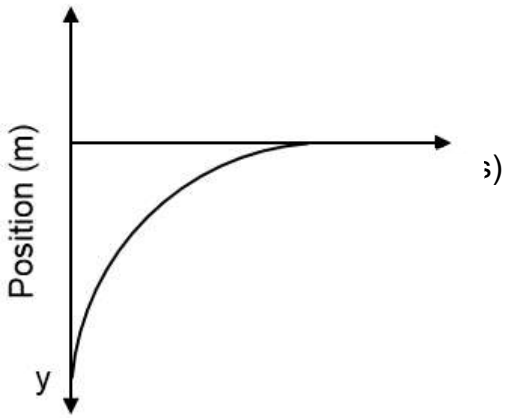

B




C



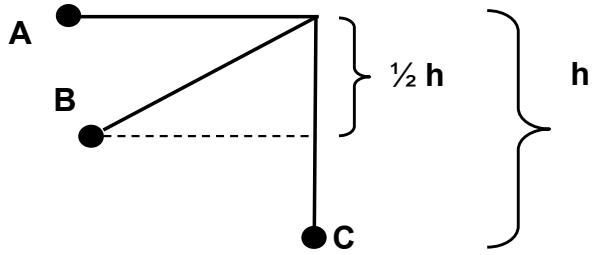

D




(2)

1.5 A pendulum bob is raised to position **A** at a height **h** above the lowest point of its swing, **C**. It is released from point **A**, and swings through points **B** with speed $\mathbf{v_B}$ and **C** with speed $\mathbf{v_C}$.

Ignore frictional effects.




What is the relationship between the speed $\mathbf{v_B}$ and speed $\mathbf{v_C}$?

A $v_B = \frac{v_C}{\sqrt{2}}$

B $v_B = \sqrt{0,5}\, v_C$

C $v_B = 0,5\, v_C$

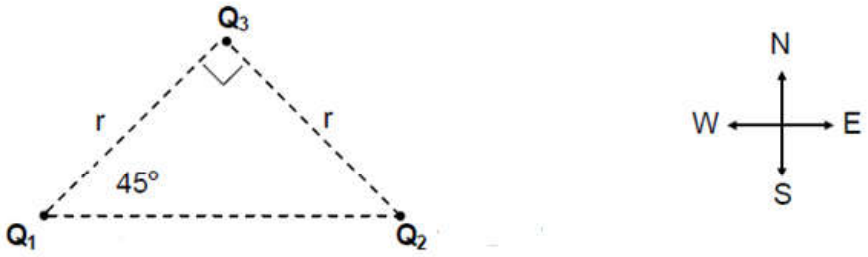
D $v_B = \frac{\sqrt{2}}{v_C}$ (2)

1.6 An astronomer views the line spectrum from a star. Which of the following describes the effect of the Doppler shift on the line spectrum if the star is moving *towards* earth?

The line spectrum …

A appears dimmer.
B appears larger.
C is shifted towards the red end of the spectrum.
D is shifted towards the blue end of the spectrum. (2)

1.7 Point charges $Q_1$, $Q_2$ and $Q_3$ are arranged at the corners of a right-angled triangle, as shown in the diagram below. The charges on $Q_1$, $Q_2$ and $Q_3$ are unknown. The distance between $Q_1$ and $Q_3$ is **r**. The distance between $Q_2$ and $Q_3$ is also **r**. Charge $Q_3$ experiences a resultant electrostatic force to the **WEST**.

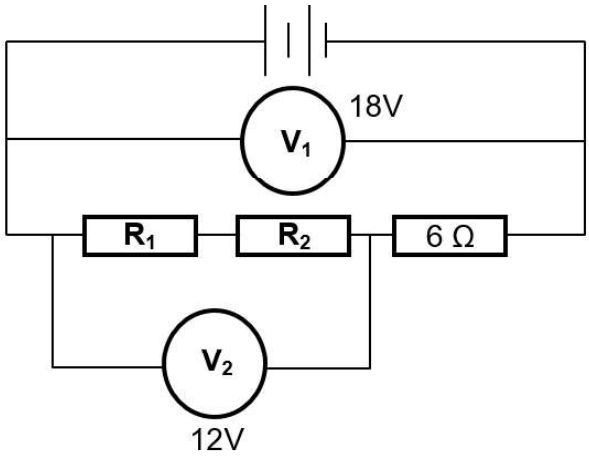



Which of the following combinations of charges could be possible for charges $Q_1$, $Q_2$ and $Q_3$?

| | $Q_1$ | $Q_2$ | $Q_3$ |
|---|---|---|---|
| A | NEGATIVE | POSITIVE | POSITIVE |
| B | POSITIVE | POSITIVE | POSITIVE |
| C | NEGATIVE | NEGATIVE | NEGATIVE |
| D | POSITIVE | NEGATIVE | POSITIVE |

(2)

1.8 In the circuit diagram below three resistors, $R_1$, $R_2$ and a 6 Ω are connected in series. $R_1 = R_2$ and the internal resistance of the cell and connecting wires may be ignored. $V_1$ reads 18V and $V_2$ reads 12V.

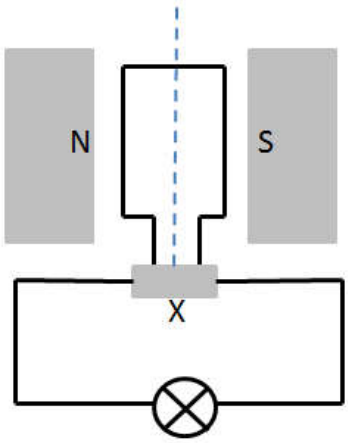



Which of the following is the possible values for $R_1$ and $R_2$?

A 4 Ω
B 6 Ω
C 12 Ω
D 18 Ω

(2)

1.9 The diagram below is a simplified version of an electric generator connected to a light bulb. Component **X** is either a split ring or slip rings.




Which of the following options for this generator is correct?

| | Energy conversion taking place | Type of current generated | Component X |
|---|---|---|---|
| A | mechanical to electrical | slip ring | AC |
| B | mechanical to electrical | split ring | AC |
| C | electrical to mechanical | slip ring | DC |
| D | electrical to mechanical | split ring | DC |

(2)

1.10 The diagram below shows some principle lines, **P**, **Q**, **R** and **S** in the line emission spectrum of helium with corresponding wavelengths in nm.



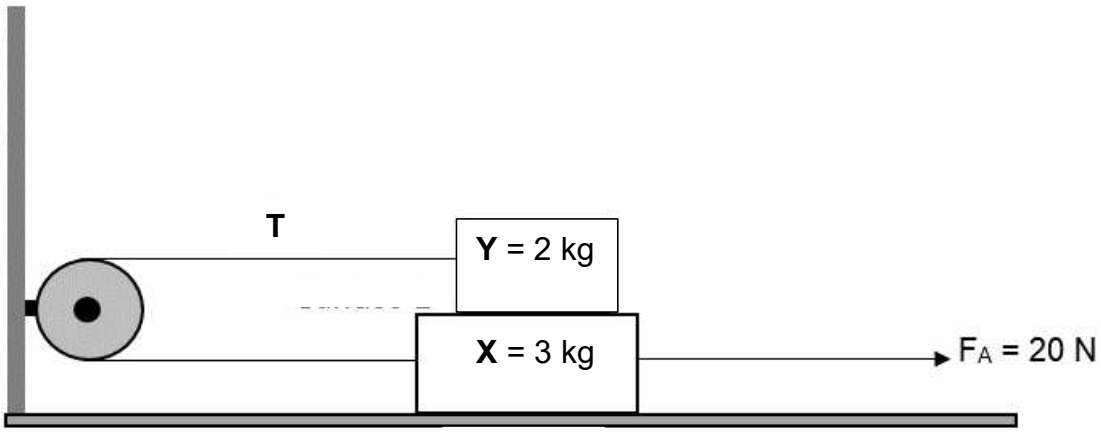

Which ONE of the spectral lines represents the *lowest energy* change of an electron within a helium atom?

A **P**
B **Q**
C **R**
D **S**

(2)
**[20]**

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

2.1 A horizontal force $\mathbf{F_A}$ of magnitude 20 N is applied to block **X**, mass 3 kg on a table. Block **Y**, mass 2 kg, is resting on block **X**. The two blocks are joined by a thin inextensible string of negligible mass which runs over a frictionless pulley, fixed to the wall. Block **X** experiences a kinetic frictional force of 1,2 N with the surface of the table. There is no friction between block **X** and block **Y**. The tension in the string is **T** when block **X** accelerates to the right.

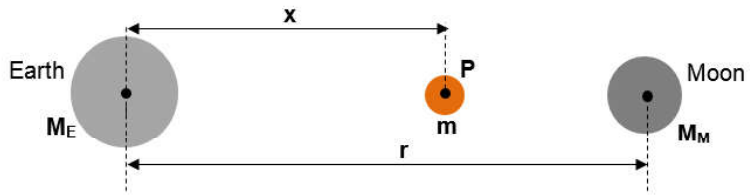



2.1.1 State Newton's *Second Law of Motion* in words. (2)

2.1.2 Draw a labelled, free-body diagram showing ALL the forces acting on block **X**. (6)

2.1.3 Calculate the magnitude of the tension **T** in the string. (6)

2.2 A learner wants to calculate the distance between the Earth (mass $\mathbf{M_E}$ = 5,97 x $10^{24}$ kg) and the Moon (mass $\mathbf{M_M}$ =7,35 x $10^{22}$ kg) where the net gravitational force is zero. To achieve this, the learner placed a third mass '**m**' at point '**P**' as shown in the diagram below. The distance between the centres of the Earth and the Moon is '**r**'.




2.2.1 State Newton's *Law of Universal Gravitation* in words. (2)

2.2.2 Use the law of gravitation to show that **r** and **x** are related by the following equation:

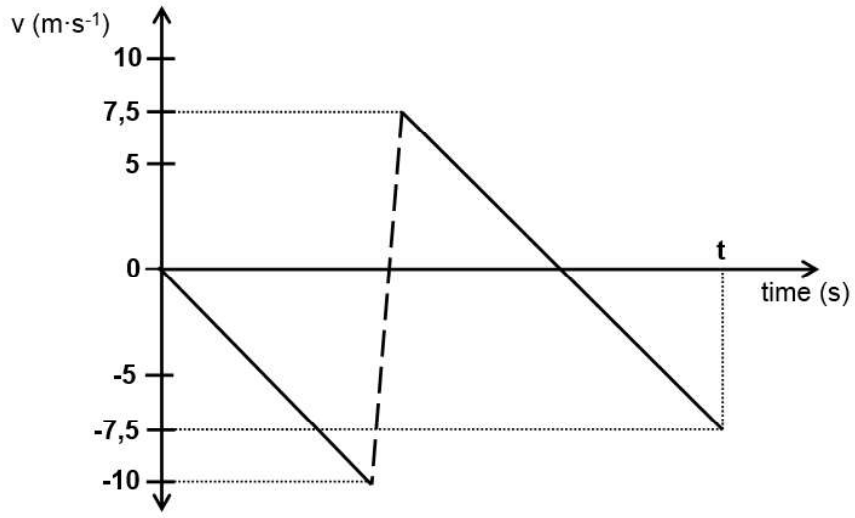
$$\mathbf{r}^2 - 2\,\mathbf{rx} + 0{,}988\mathbf{x}^2 = 0$$ (4)

**[20]**

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

A ball of mass 0,2 kg is dropped vertically from the top of a building to a concrete floor below. The ball bounces off the floor. The velocity versus time graph below shows the motion of the ball. Ignore the effects of air friction.

DOWNWARD MOTION IS TAKEN AS NEGATIVE.




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

Use the graph to answer the following questions.

3.2 Write down the number of times the ball hits the floor. (1)

3.3 Calculate the height:

3.3.1 From which the ball was dropped (4)

3.3.2 Reached by the ball after the first bounce (3)

3.4 Determine the magnitude of the displacement of the ball from the moment it was dropped until time **t**. (1)

**[11]**

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

The table below shows how the momentum of a single train coach **A** changes with time just before and just after a head-on collision with another coach **B**.

| p ($kg \cdot m \cdot s^{-1}$) of coach **A** | 30 000 | 30 000 | 14 000 | 14 000 |
|---|---|---|---|---|
| time (s) | 20 | 20,1 | 20,2 | 20,3 |

Coach **B** has a mass of 9 000 kg and was initially travelling at 1,5 $m \cdot s^{-1}$ west.
You may assume that the net external force acting on the system is zero.

4.1 Write down a word / term for the underlined words above. (1)

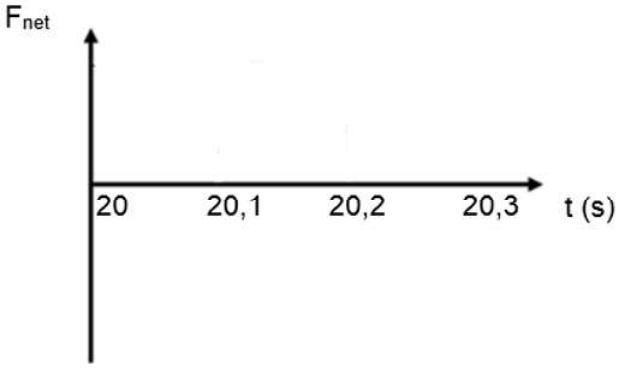
Use the information in the table to answer the following questions.

4.2 Calculate the magnitude of the:

4.2.1 Net average force acting on engine coach **A** during the collision (4)

4.2.2 Velocity of coach **B** just after collision (4)

4.3 Redraw the net force vs time graph below in your answer book and complete the graph for coach **A**. The time values are on the graph.

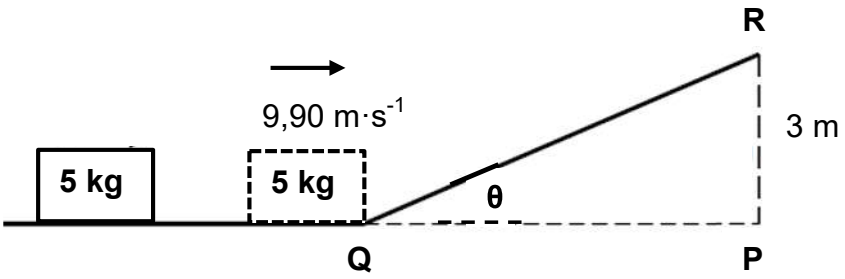



(3)
**[12]**

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

5.1 In an experiment, a rough inclined plane **QR** has been constructed to stop a moving
5 kg block. The block reaches point **Q** with a speed 9,90 m·s$^{-1}$. The block comes to a stop at point **R** which is 3 m above level **QP**.

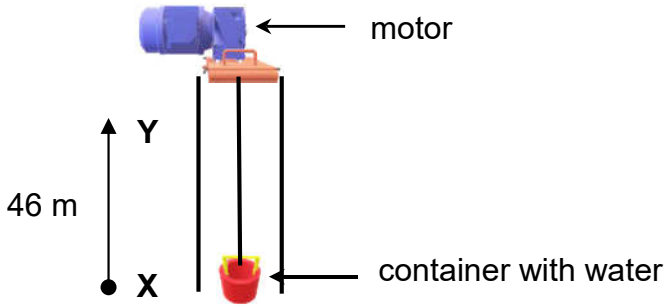
The frictional force between the surface **QR** and the block is 18 N.




5.1.1 Define a *non-conservative force*. (2)

5.1.2 Use energy principles and calculate the angle **θ** of slope **QR**. (7)

5.2 A motor is used to lift a container of water up a vertical shaft with a steel cable. The total mass of the container and the water is 987 kg. The container is lifted from rest from point **X** and passes point **Y** at a height 46 m. At point **Y** the container has a speed of 0,9 m·s$^{-1}$.
You may ignore frictional effects and the mass of the steel cable.

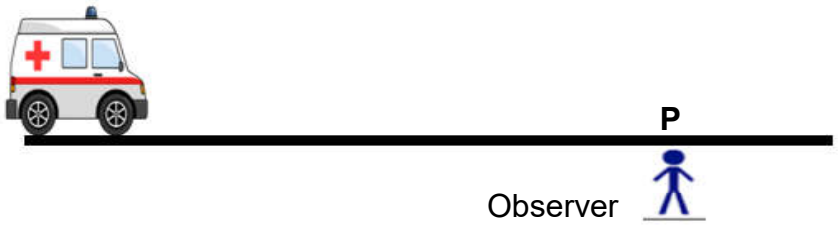



5.2.1 State the *work-energy theorem* in words. (2)

5.2.2 Use the work-energy theorem to calculate the work done by the motor in lifting the container from point **X** to **Y**. (4)
**[15]**

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

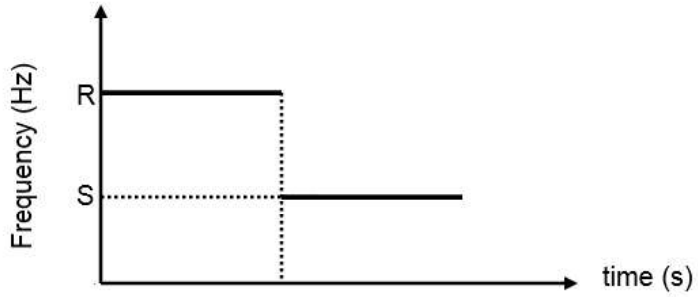
An ambulance is travelling at a constant speed along a straight horizontal road with its siren emitting a sound of frequency 800 Hz. A stationary observer standing at point **P** next to the road, hears the siren frequency of 910 Hz as the ambulance approaches. The ambulance passes point **P** and continues at the same speed. Take the speed of sound in air to be 340 $m \cdot s^{-1}$.




6.1 State the *Doppler effect.* (2)

6.2 Calculate the speed of the ambulance. (5)

6.3 A detector at point **P** measures the siren's frequency and the results are shown in the graph below.




6.3.1 Write down frequency **R**. (1)

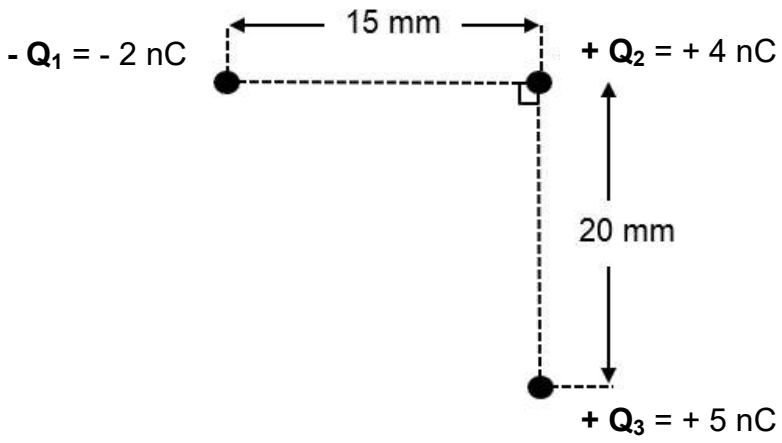
6.3.2 Calculate the value of **S** on the graph. (4)

6.4 What frequency will the observer hear when the ambulance is at point **P**? (1)

**[13]**

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

7.1 Point charges **- $Q_1$**, **+ $Q_2$** and **+ $Q_3$** are arranged at the corners of a right-angled triangle, as shown in the diagram below.

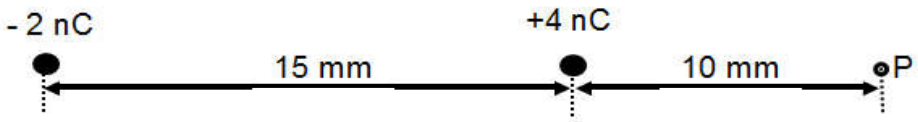



7.1.1 State *Coulomb's law* in words. (2)

7.1.2 Draw a force diagram to show the forces acting on charge **+ $Q_2$** due to charge **- $Q_1$** and **+ $Q_3$**. (2)

7.1.3 Calculate the magnitude of the net force acting on **$Q_2$** due to **$Q_1$** and **$Q_3$** if **$Q_1$** = - 2 nC, **$Q_2$** = + 4 nC and **$Q_3$** = +5 nC. (5)

7.2 A – 2 nC charge is 15 mm to the left of a + 4 nC charge as shown in the diagram below. Point **P** is 10 mm to the right of the + 4 nC charge.

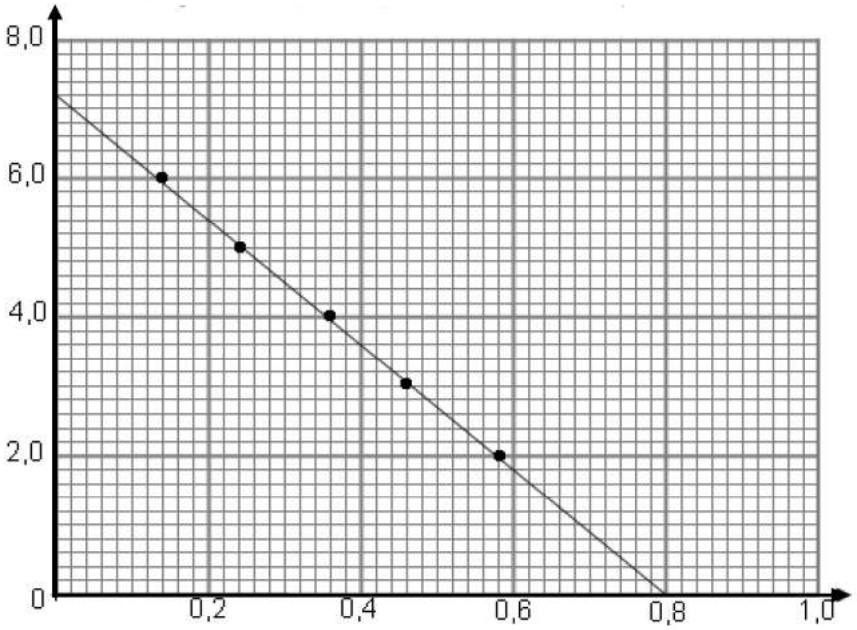



Calculate the net electric field at point **P**. (5)

**[14]**

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

A group of learners conduct an experiment to determine the emf (ε) and internal resistance (r) of a battery. The data obtained from the experiment is used to plot points on graph paper and draw a line of best fit. The graph of one of the learners is given below. The x and y axes have not been labelled.




8.1 Explain the term *internal resistance*. (1)

8.2 Write down ONE factor which must be kept constant during this experiment. (1)

Using the graph:

8.3 Provide a label for the y-axis. (1)

8.4 Write down the quantity represented by the gradient? (1)

8.5 Write down the emf of the battery. (1)

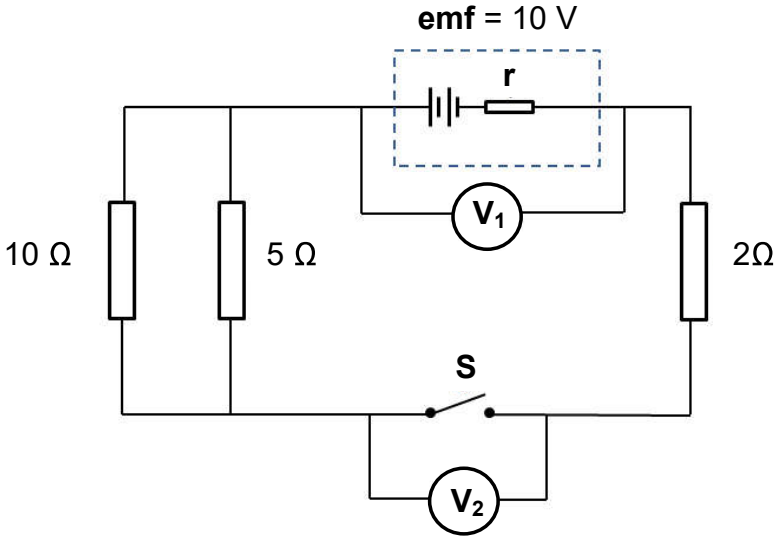
8.6 Calculate the internal resistance of the battery. (4)

8.7 Determine the value of $V_{int}$ when the graph reaches 0,8 on the x-axis. (1)

**[10]**

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

9. A circuit is connected as shown below. The battery has an **emf** of 10 V and an unknown internal resistance **r**. A voltmeter $\mathbf{V_1}$ is connected across the battery and another voltmeter $\mathbf{V_2}$ is connected across the switch **S**. The connecting wires have negligible internal resistance.




Switch **S** is initally open.

9.1 Write down the reading on voltmeter $\mathbf{V_2}$. (1)

Switch **S** is now **closed**. The reading on voltmeter $\mathbf{V_1}$ is 8 V.

9.2 What is the reading on $\mathbf{V_2}$? (1)

9.3 Calculate the total external resistance of the circuit. (3)

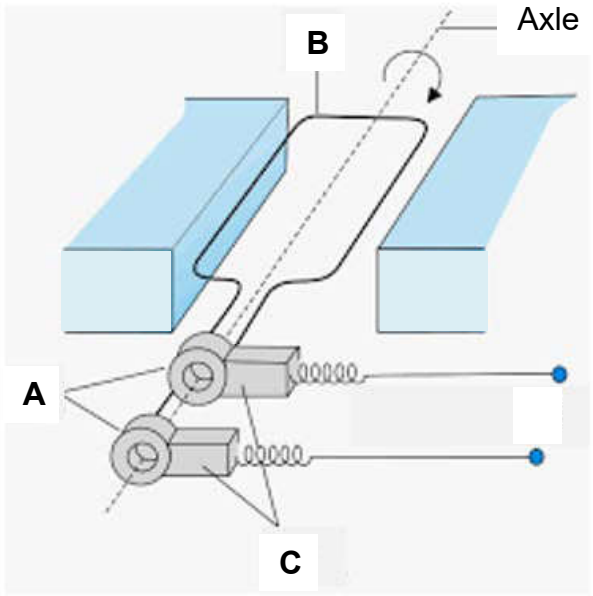
9.4 Calculate the internal resistance, **r**, of the battery. (5)

9.5 How will the reading on the voltmeter $\mathbf{V_1}$ be affected if the 5 Ω resistor was removed? (Choose from: INCREASES, DECREASES or STAYS THE SAME.) (1)

9.6 Explain your answer to Question 9.5. (3)
**[14]**

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

The diagram below shows an AC generator. The main components are labelled **A**, **B** and **C**.



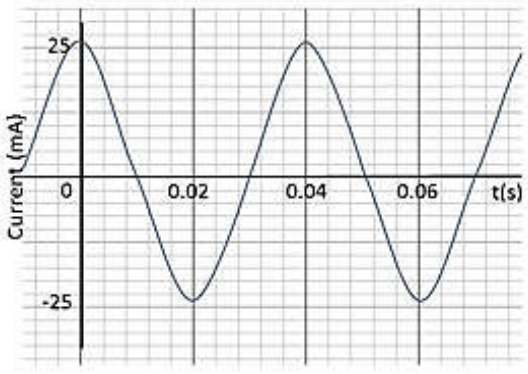

10.1 Write down the name of the components labelled:

10.1.1 **A** (1)

10.1.2 **B** (1)

10.2 Write down the function of component **C**. (1)

The graph below represents the output current vs time for an AC generator.




Use the graph above to answer the following questions.

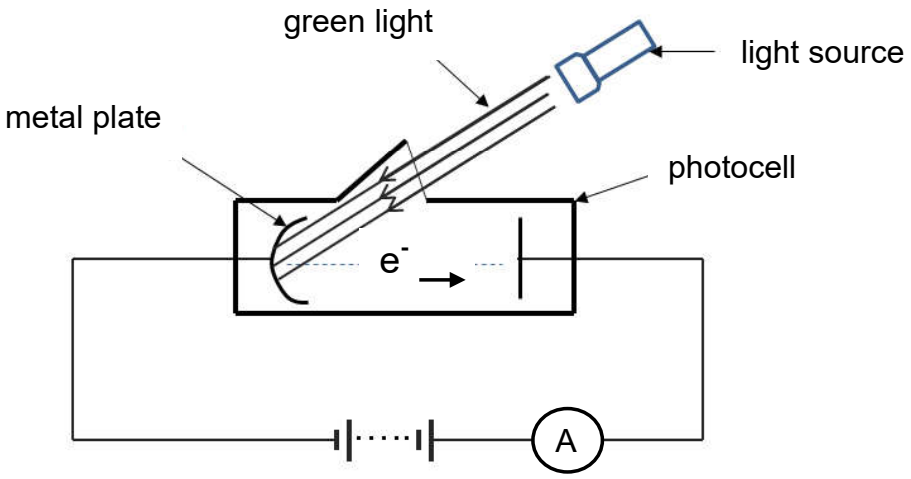
10.3 At what position was the coil relative to the magnetic field of the generator for the current output to be a maximum?
(Choose from: PERPENDICULAR or PARALLEL.) (1)

10.4 Calculate the rms current ($I_{rms}$) for this generator. (3)

10.5 Calculate the average power dissipated by a 100 Ω resistor connected across the terminals of the generator. (3)
**[10]**

**QUESTION 11 (Start on a new page.)**

In an investigation, the metal plate of a photocell, shown below, is irradiated with green, blue and violet light.




The results of the investigation are shown in the table below.

| Colour | Wavelength (nm) | Reading on ammeter |
|---|---|---|
| green | 560 | No |
| blue | 500 | Yes |
| violet | 430 | Yes |

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

11.2 Explain why no current is registered when green light is used. (2)

11.3 What effect will increasing the **intensity** of light have on the reading of the ammeter when blue light is used? (Choose from INCREASES, DECREASES or STAYS THE SAME.) (1)

11.4 Explain your answer to Question 11.3. (2)

11.5 Calculate the energy of a photon of blue light. (4)
**[11]**

**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 | $m_e$ | $9,11 \times 10^{-31}\ kg$ |
| Mass of the earth | $M_E$ | $5,98 \times 10^{24}\ kg$ |
| Radius of the 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

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

## 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 ( $\varepsilon$ ) = 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

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

**END**