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DEPARTMENT OF EDUCATION

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DEPARTEMENT VAN ONDERWYS

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**PROVINCIAL COMMON QUESTION PAPER**

**GRADE 12**

**PHYSICAL SCIENCES: PHYSICS (P1)**

**SEPTEMBER: 2017**

**MARKS: 150**

**TIME: 3 hours**

**This question paper consists of 16 pages and 3 data sheets**

**INSTRUCTIONS AND INFORMATION**

1. Write your centre number and name in the appropriate spaces on the ANSWER BOOK.
2. Answer ALL the questions in the ANSWER BOOK.
3. You may use a non-programmable calculator.
4. You may use appropriate mathematical instruments.
5. Number the answers correctly according to the numbering system used in this question paper.
6. YOU ARE ADVISED TO USE THE ATTACHED DATA SHEETS.
7. Give brief motivations, discussions, et cetera where required.
8. Start EACH question on a NEW page.
9. Show the formulae and substitutions in ALL calculations.
10. Leave ONE line between two sub-questions, for example between QUESTION 2.1 and QUESTION 2.2.
11. Round off your final numerical answers to a minimum of TWO decimal places.

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

Four options are provided 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 The magnitude of the gravitational acceleration on Earth is  $g$ . What will the value of the gravitational acceleration be on planet X, which has the same mass as Earth, but half the radius?

- A  $\frac{1}{4}g$   
 B  $\frac{1}{2}g$   
 C  $2g$   
 D  $4g$

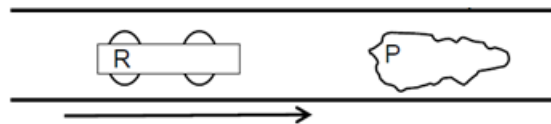
(2)

- 1.2 A ball with mass  $m$ , travelling west, hits a wall with a velocity of  $\vec{v}$ . It bounces back with a velocity  $0,75v$  in an easterly direction. The change in momentum of the ball will be ...

- A  $0,25 mv$  east  
 B  $0,25 mv$  west  
 C  $1,75 mv$  east  
 D  $1,75 mv$  west

(2)

- 1.3 The following diagram shows a racing car R driving along a straight line to the right.



The driver of the racing car applies the brakes when the car reaches position P. In which of the following directions will the racing car R accelerate?

- A   
 B   
 C   
 D 

(2)

- 1.4 A dove accidentally flies into the windscreen of an oncoming truck. In comparison with the magnitude of the force of the truck on the dove, the magnitude of the force of the dove on the truck during the crash is ...
- A zero
  - B the same
  - C smaller
  - D greater
- (2)
- 1.5 A ball is thrown vertically upwards. Which ONE of the following quantities will be zero when it reaches maximum height?
- A acceleration
  - B kinetic energy
  - C gravitational potential energy
  - D gravitational force
- (2)
- 1.6 A source of sound approaches a stationary listener. Which one of the following will occur?
- A The amplitude of the observed sound wave will be more than the amplitude of the sound wave emitted by the source.
  - B The frequency of the observed sound wave will be more than the frequency of the sound wave emitted by the source.
  - C The wavelength of the observed sound wave will be greater than the wavelength of the sound wave emitted by the source.
  - D The speed of the observed sound wave will be greater than the speed of the sound wave emitted by the source.
- (2)
- 1.7 Which ONE of the following combinations is CORRECT regarding the properties of electric field lines?

|   | Direction            | Strength of field                            |
|---|----------------------|--|
| A | Positive to negative | Strongest where the lines are the most dense |
| B | Negative to positive | Weakest where the lines are the least dense  |
| C | North to south       | Strongest where the lines are the most dense |
| D | North to south       | Weakest where the lines are the least dense  |

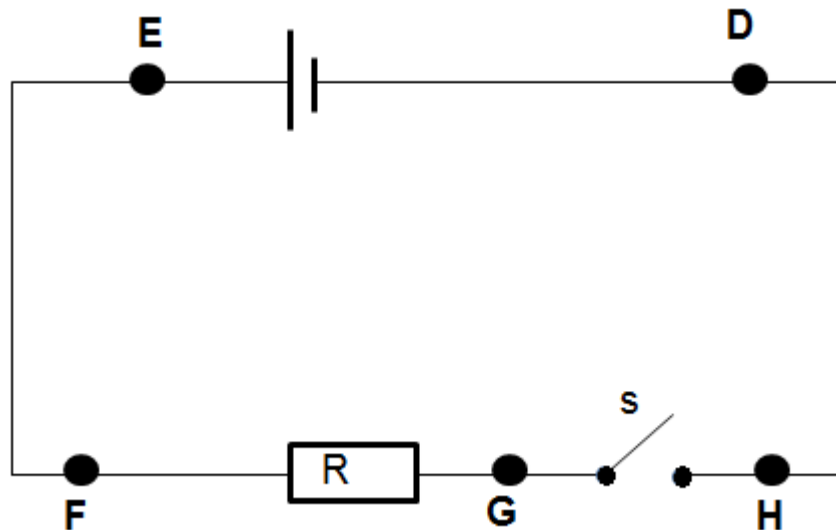
(2)

1.8 The device that uses electrical energy to produce mechanical energy is called.

- A Dynamo
- B Alternator
- C Electric motor
- D Generator

(2)

1.9 A cell is connected to a resistor and an open switch. Five points are labelled D, E, F, G and H respectively.

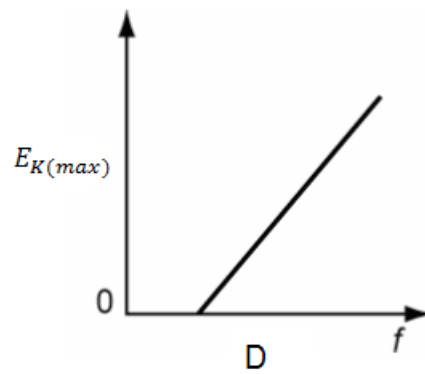
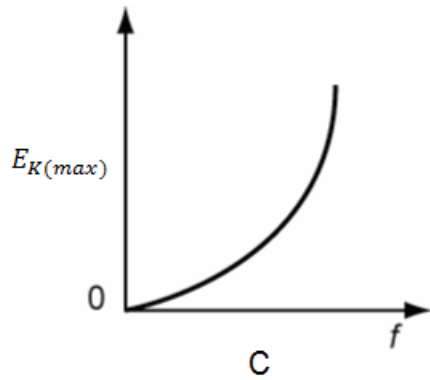
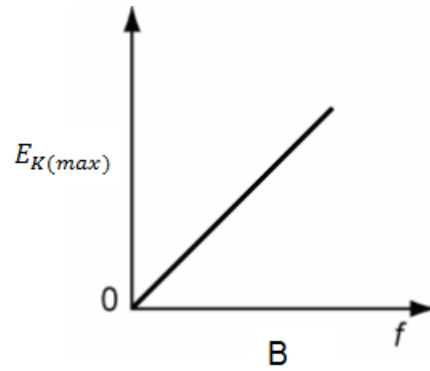
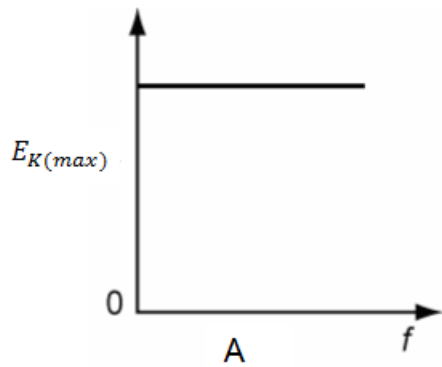


A voltmeter has a zero reading if it is connected across points ...

- A ED
- B FH
- C FG
- D GH

(2)

- 1.10 Which ONE of the following graphs best illustrates the relationship between maximum kinetic energy ( $E_{K(max)}$ ) of the emitted electrons from a metal surface and frequency ( $f$ ) of the incident light?

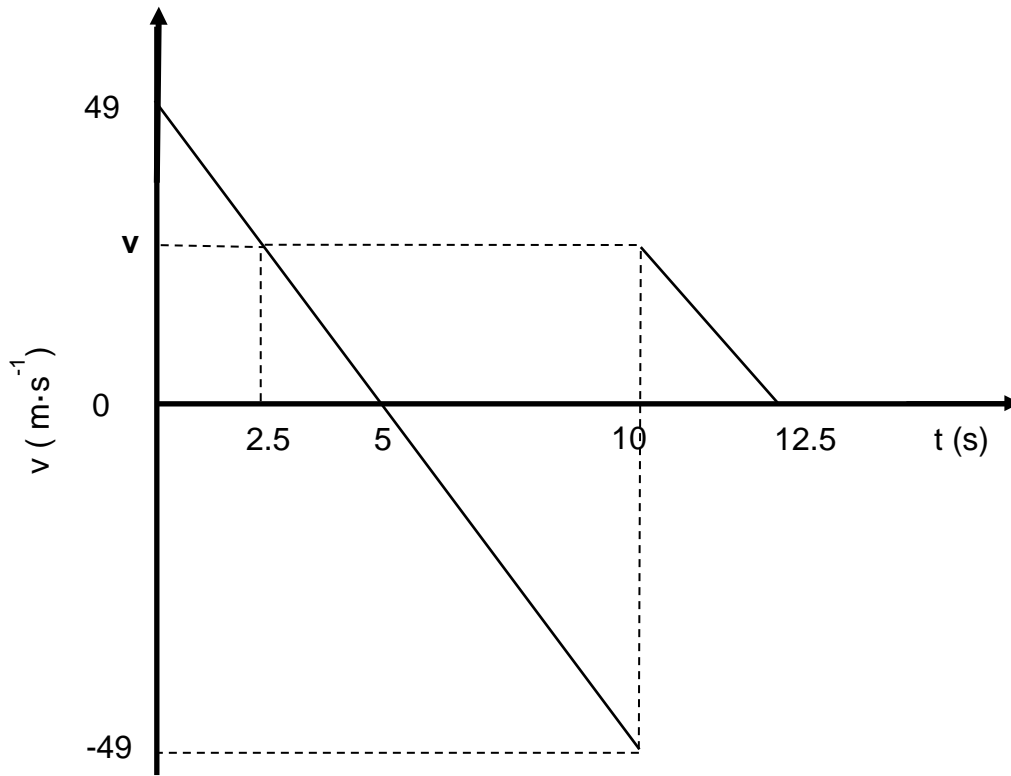


(2)

**[20]**

**QUESTION 2**

A velocity-time graph below shows the motion of a projectile. Study the graph and answer the following questions.



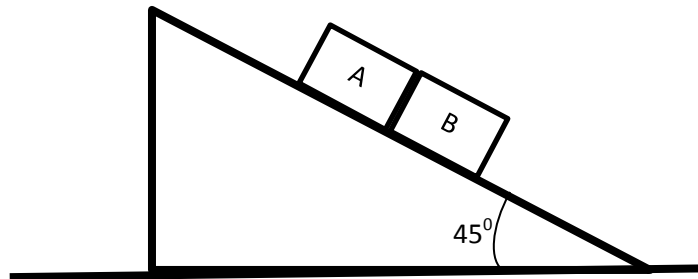
- 2.1 What is the physical quantity represented by the gradient of the graph? (1)
- 2.2 Calculate the value of  $v$  on the graph. (3)
- 2.3 Use the graph (NOT equations of motion) to calculate the following:
- 2.3.1 the magnitude of the maximum displacement of the projectile. (2)
- 2.3.2 the magnitude of the displacement of the projectile after 12,5 s. (2)
- 2.4 Draw the position time graph for the projectile during 12,5 s. In your graph indicate the following (Use point of projection as zero position):
- the position of the projectile at 5 s.
  - the time the projectile reaches the projection point.
  - position of the projectile at 12,5 s.

(5)

**[13]**

**QUESTION 3**

Two blocks A and B of equal mass 0,2 kg slide down on an inclined plane as shown in the sketch below. The coefficient of kinetic friction between block A and the inclined plane is  $\mu_A = 0,01$  and the coefficient of kinetic friction between block B and the inclined plane is  $\mu_B = 1,00$ .

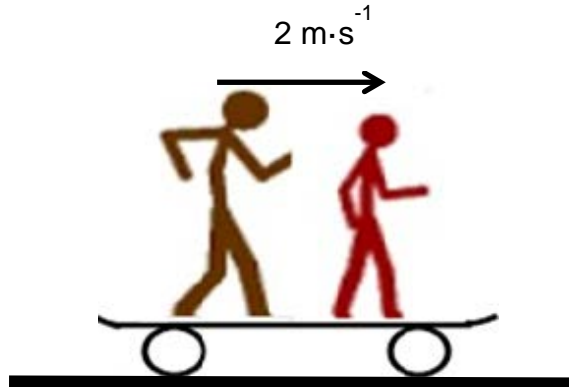


- 3.1 State Newton`s second law of motion in words. (2)
- 3.2 Draw a labelled free-body diagram showing ALL the forces acting on block A as it slides down the incline. (4)
- 3.3 Calculate the acceleration of the two blocks. (8)
- 3.4 Calculate the magnitude of the force exerted by block B on Block A. (3)
- 3.5 If the system is placed on the Moon where the magnitude of the acceleration due to gravity is  $1,62 \text{ m}\cdot\text{s}^{-2}$  . How will it affect the acceleration of the blocks calculated in question 3.3? Write down INCREASES, DECREASES OR REMAINS THE SAME. Explain the answer. (3)
- [20]**



**QUESTION 4**

Peter and John are standing on a trolley, which is moving to the right at  $2 \text{ m}\cdot\text{s}^{-1}$  as shown below. Peter has a mass of  $70 \text{ kg}$  and John a mass of  $60 \text{ kg}$ . The total mass of the trolley and both boys is  $160 \text{ kg}$ .



John jumps off the trolley at  $2.5 \text{ m}\cdot\text{s}^{-1}$  in the direction of the motion of the trolley. When he lands on the ground he falls forward.

- 4.1 Name the principle (law) of Physics which explains why he falls forward after landing on the ground. (1)
- 4.2 State *the principle of conservation of linear momentum* in words. (2)
- 4.3 Calculate the magnitude and the direction of the velocity of the combination of Peter and the trolley immediately after John has jumped off. (5)

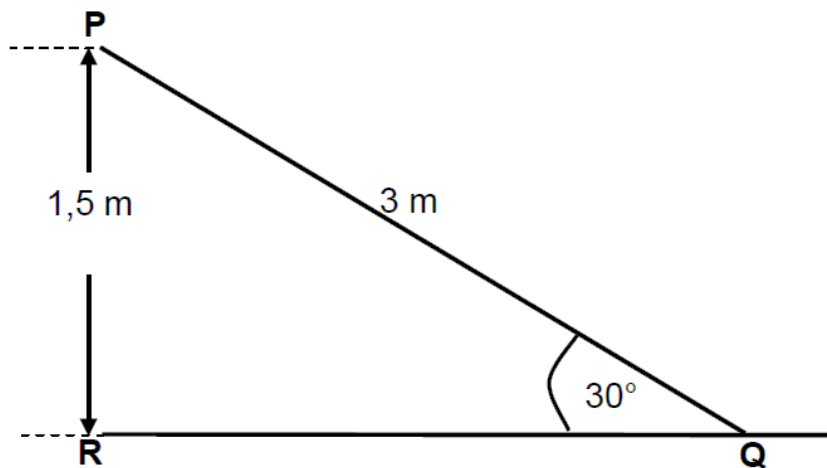
**[8]**

**QUESTION 5**

The simplified diagram below shows a slide **PQ** at a playground. The slide is 3 m long and 1,5 m high. A boy of mass 40 kg and a girl of mass 22 kg stand at the top of the slide at **P**.

The girl accelerates uniformly from rest down the slide. She experiences a constant frictional force of 1,9 N.

The boy falls vertically down from the top of the slide through the height **PR** of 1,5 m. Ignore the effects of air friction.



- 5.1 State the *principle of conservation of mechanical energy* in words. (2)
- 5.2 Use the principle of CONSERVATION OF MECHANICAL ENERGY to calculate the speed of the boy when he reaches the ground at **R**. (4)
- 5.3 Use the WORK-ENERGY THEOREM to calculate the speed of the girl when she reaches the end of the slide at **Q**. (5)
- 5.4 How would the velocity of the girl at **Q** compare to that of the boy at **R** if the slide exerts no frictional force on the girl? Write down only GREATER THAN, LESS THAN or EQUAL TO. (1)
- [12]**

**QUESTION 6**

The siren of a police car produces a sound of frequency 420 Hz. A man sitting next to the road notices that the pitch of the sound changes as the car moves towards and then away from him.

6.1 Name and state in words the phenomenon described above. (3)

6.2 Calculate the frequency of the sound of the siren observed by the man, when the car is moving towards him at a constant speed of  $16 \text{ m}\cdot\text{s}^{-1}$ . Assume that the speed of sound in air is  $340 \text{ m}\cdot\text{s}^{-1}$ . (5)

6.3 The police car moves away from the man at a constant velocity, then slows down and finally comes to rest.

6.3.1 How will the observed frequency **compare** with the original frequency of the siren when the police car moves away from the man at constant velocity? Write only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

6.3.2 How will the observed frequency **CHANGE** if the car moves at a lower speed away from the observer? Write only INCREASES, DECREASES or REMAINS THE SAME. (1)

6.4 Light from a star undergoes a red shift when observed from Earth.

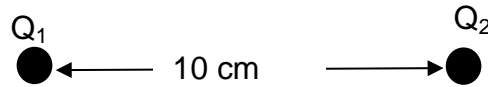
6.4.1 Explain the term *red shift*. (2)

6.4.2 What can be concluded about the Universe from this red shift? (1)

**[13]**

**QUESTION 7**

A positive point charge  $Q_1$  of magnitude  $5 \mu\text{C}$ , is placed 10 cm away from a negative point charge,  $Q_2$  of magnitude  $5 \mu\text{C}$ .



- 7.1 Draw the electric field lines for the two point charges. (3)
- 7.2 State *Coulomb's Law* in words. (2)
- 7.3 Calculate the magnitude of the electrostatic force exerted by point charge  $Q_2$  on point charge  $Q_1$ . (4)
- 7.4 How does the magnitude and direction of the force exerted by  $Q_2$  on  $Q_1$  compare with the magnitude and direction of the force exerted by  $Q_1$  on  $Q_2$ . (No calculations are necessary). (2)
- 7.5 How will the magnitude of the force exerted by  $Q_1$  on  $Q_2$  change if the distance between the two charges is increased three times. (1)
- 7.6 Calculate the net electric field at a point 2 cm from charge  $Q_1$  between the two charges. (6)

**[18]**

**QUESTION 8**

Two grade 12 learners built a battery for the science fair. They used potatoes as cells with zinc and copper plates as electrodes.

They were curious to find out how many potato cells connected in series were needed to make a penlight bulb glow.

8.1 Write down :

8.1.1 a suitable hypothesis for the investigation. (2)

8.1.2 the dependent variable for the investigation. (1)

They started with two potatoes connected in series. They connected a voltmeter directly across the outer electrodes and measured a potential difference of 1,6 V.

They then connected a 1,5 V penlight bulb between the electrodes. They observed that the bulb did not glow.

When they measured the potential difference across the bulb it was 0,02 V.

8.2 What is the emf of the battery with two potato cells connected in series? (1)

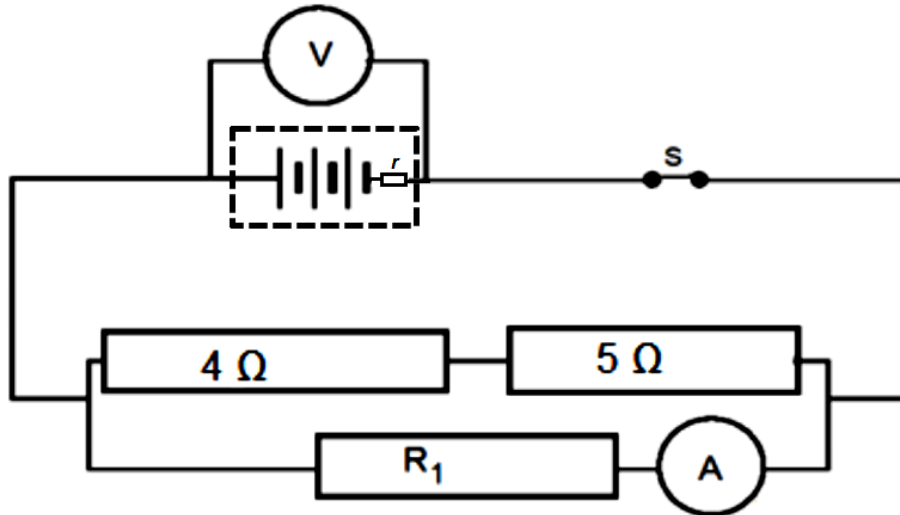
8.3 Give a reason why the potential difference across the bulb was only 0,02 V. (1)

8.4 The bulb has a resistance of  $2 \Omega$ . Calculate the power dissipated by the bulb even though it is not visibly glowing. (3)

**[8]**

**QUESTION 9**

The circuit diagram below shows two resistors of resistance  $4\ \Omega$  and  $5\ \Omega$  each connected in parallel to resistor  $R_1$  of unknown resistance. The battery has an emf of  $15\ \text{V}$  and an unknown internal resistance ( $r$ ).



9.1 State *Ohm's law* in words. (2)

The reading on the ammeter is  $1,5\ \text{A}$  and the voltmeter reading is  $12,9\ \text{V}$ .

Calculate:

9.2 the resistance of resistor  $R_1$ . (3)

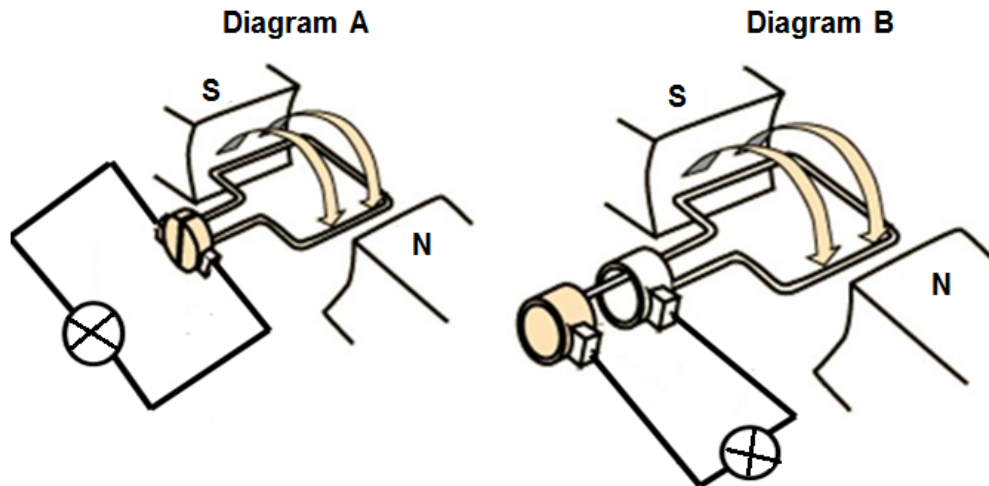
9.3 the equivalent resistance of the parallel connection (combination). (3)

9.4 the internal resistance of the battery. (4)

**[12]**

**QUESTION 10**

The following diagrams show two types of generators.

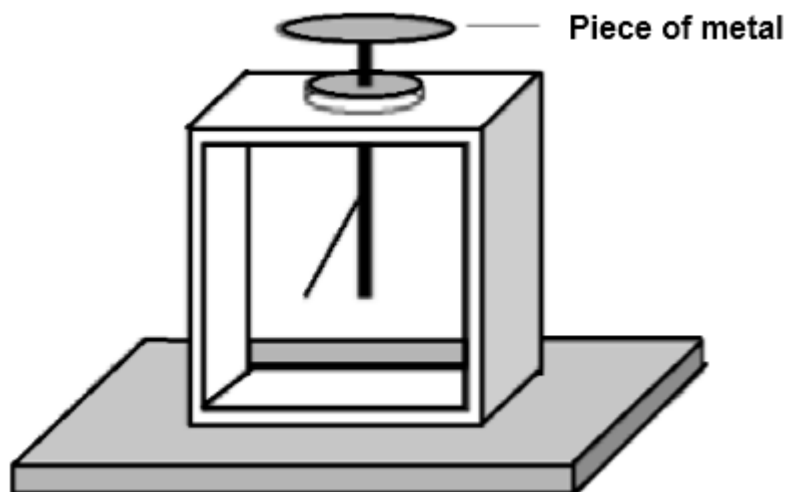


- 10.1 Which type of generator is represented by diagram A? (1)
- 10.2 Which type of generator is represented by diagram B? (1)
- 10.3 How do the generators shown above differ? Refer to the components they consist of. (2)
- 10.4. The generator in diagram **B** induces an rms voltage of 220 V. (3)
- 10.4.1 Calculate the maximum (peak) voltage induced.
- 10.4.2 Draw a graph of voltage versus time for one cycle (one complete rotation) in diagram B. Indicate in the graph the values of:
- rms voltage
  - maximum (peak) voltage
- 10.5 Write down two examples of the use of generators. (2)

**[13]**

**QUESTION 11**

Grade 12 learners investigate the effect of frequency of light on the emission of electrons from a metal. They use ultraviolet and red light respectively, together with an electroscope and a piece of metal that has been cleaned. First they used red light to see the effect on the deflection of the electroscope. After that they used ultraviolet light.



- 11.1 Name the phenomenon that the learners are investigating. (1)
- 11.2 Write down an investigative question for this investigation. (2)
- 11.3 For this investigation write down:
- 11.3.1 the independent variable. (1)
- 11.3.2 the dependent variable. (1)
- 11.3.3 a control variable. (1)
- 11.4 Light with a wavelength of  $7.8 \times 10^{-7}$  m shines on the metal. The metal has a work function of  $1,8 \times 10^{-19}$  J.
- 11.4.1 Define *work function* in words. (2)
- 11.4.2 Calculate the maximum kinetic energy of the ejected electrons. (5)

**[13]****GRAND TOTAL: 150**



**DATA FOR PHYSICAL SCIENCES GRADE 12****PAPER 1 (PHYSICS)****GEGEWENS VIR FISIESTE WETENSKAPPE GRAAD 12****VRAESTEL 1 (FISIKA)****TABLE 1: PHYSICAL CONSTANTS/TABEL 1: FISIESTE KONSTANTES**

| NAME/NAAM  | SYMBOL/SIMBOOL | VALUE/WAARDE  |
|--|----------------|---|
| Acceleration due to gravity<br><i>Swaartekragversnelling</i>             | g              | 9,8 m·s <sup>-2</sup>                                       |
| Universal gravitational constant<br><i>Universele gravitasiekonstant</i> | G              | 6,67 x 10 <sup>-11</sup> N·m <sup>2</sup> ·kg <sup>-2</sup> |
| Speed of light in a vacuum<br><i>Spoed van lig in 'n vakuum</i>          | c              | 3,0 x 10 <sup>8</sup> m·s <sup>-1</sup>                     |
| Planck's constant<br><i>Planck se konstante</i>                          | h              | 6,63 x 10 <sup>-34</sup> J·s                                |
| Coulomb's constant<br><i>Coulomb se konstante</i>                        | k              | 9,0 x 10 <sup>9</sup> N·m <sup>2</sup> ·C <sup>-2</sup>     |
| Charge on electron<br><i>Lading op elektron</i>                          | e              | 1,6 x 10 <sup>-19</sup> C                                   |
| Electron mass<br><i>Elektronmassa</i>                                    | m <sub>e</sub> | 9,11 x 10 <sup>-31</sup> kg                                 |
| Mass of the Earth<br><i>Massa van die Aarde</i>                          | M              | 5,98 x 10 <sup>24</sup> kg                                  |
| Radius of the Earth<br><i>Radius van die Aarde</i>                       | R <sub>E</sub> | 6,38 x 10 <sup>6</sup> m                                    |

**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**

|  |   |
|--|---|
| $F_{\text{net}} = ma$  | $p = mv$  |
| $f_s^{\text{max}} = \mu_s N$                                     | $f_k = \mu_k N$                                   |
| $F_{\text{net}} \Delta t = \Delta p$<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 $E_k = \frac{1}{2} mv^2$                                 | $W_{\text{net}} = \Delta K$ or/of $W_{\text{net}} = \Delta E_k$<br>$\Delta K = K_f - K_i$ or/of $\Delta E_k = E_{kf} - E_{ki}$ |
| $W_{\text{nc}} = \Delta K + \Delta U$ or/of $W_{\text{nc}} = \Delta E_k + \Delta E_p$ | $P = \frac{W}{\Delta t}$   |
| $P_{\text{ave}} = Fv_{\text{ave}}$ / $P_{\text{gemid}} = Fv_{\text{gemid}}$           |  |

**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 $E = h \frac{c}{\lambda}$ |

$$E = W_0 + E_{k(\max)} \quad \text{or/of} \quad E = W_0 + K_{\max} \quad \text{where/waar}$$

$$E = hf \quad \text{and/en} \quad W_0 = hf_0 \quad \text{and/en} \quad E_{k(\max)} = \frac{1}{2}mv_{\max}^2 \quad \text{or/of} \quad K_{\max} = \frac{1}{2}mv_{\max}^2$$

**ELECTROSTATICS/ELEKTROSTATIKA**

|  |                      |
|--|----------------------|
| $F = \frac{kQ_1Q_2}{r^2}$                                    | $E = \frac{kQ}{r^2}$ |
| $V = \frac{W}{q}$  | $E = \frac{F}{q}$    |
| $n = \frac{Q}{e} \quad \text{or/of} \quad n = \frac{Q}{q_e}$ |                      |

**ELECTRIC CIRCUITS/ELEKTRIESE STROOMBANE**

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

**ALTERNATING CURRENT/WISSELSTROOM**

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