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Physical Sciences

Trials exams – August 2018

Physics – Paper I

Examiners: Mrs van Wyk and Mr Jeffrey

Time: 3 hours

Moderators: Mrs Ballard

Total marks: 200

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This paper consists of:
 - a question paper of 16 pages.
 - a Data and Formulae Sheet of 2 pages.
 - Graph paper AND answersheet

Please make sure that your question paper is complete.
2. **Write your name on the Answer Booklet.**
3. There are 7 questions. Answer **ALL** questions on the foolscap paper and answer sheets provided in your Answer Booklet. Do **NOT** answer any questions on the question paper.
4. Write on **BOTH SIDES** of the paper.
5. Read the questions carefully. Use the data and formulae whenever necessary.
6. QUESTION 1 consists of 10 multiple-choice questions. There is only one correct answer to each question. An answer sheet has been provided for this question.
7. Graph paper has been provided for question 2.2.6.
8. It is in your own interests to write legibly and set your work out neatly.
9. Show your working in all calculations.
10. Units need not be included in the working of calculations, but appropriate units should be shown in the answer.
11. Where necessary, round off your FINAL answer to **2 decimal places**.

Acknowledging the following school's: Kearsney College 2009 + 2016, St Mary's Kloof 2016, St Anne's 2016, Redhill 2015, Woodridge 2015, St John's 2015, Kingsmead 2009
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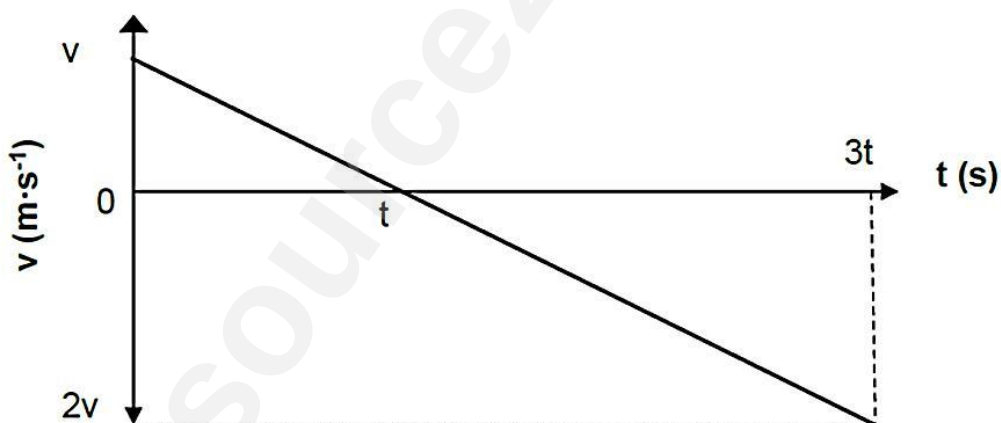
Question 1: Multiple Choice

Select the answer which you consider to be the most correct, and draw a **cross** next to the correct question on the **answer sheet provided**.

1.1 When an object falls freely in a vacuum near the surface of the earth

- A The terminal velocity will be greater than when dropped in air.
- B The velocity will increase but the acceleration will be zero.
- C The acceleration will constantly increase.
- D The acceleration will remain constant.

1.2 The velocity versus time graph below represents the movement of an object under the influence of gravitational force ONLY.



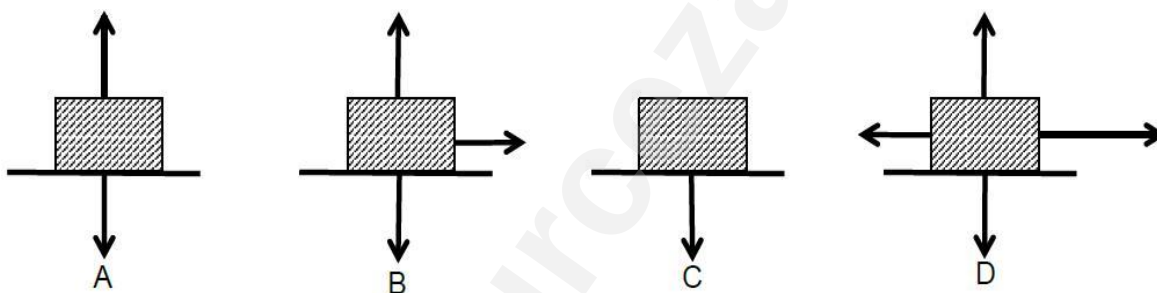
The displacement of the object at time $3t$ is ...

- A $\frac{5}{2} vt$
- B $7 vt$
- C $\frac{7}{2} vt$
- D $-\frac{3}{2} vt$

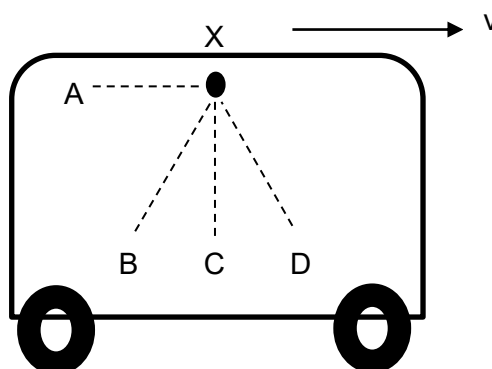
1.3 A person stands on a scale in an elevator. He notices that the scale reading is lower than his usual weight. Which of the following could possibly describe the motion of the elevator?

- A It is moving downwards at constant speed
- B It is moving downwards and slowing down
- C It is moving upwards and slowing down
- D It is moving upwards and speeding up

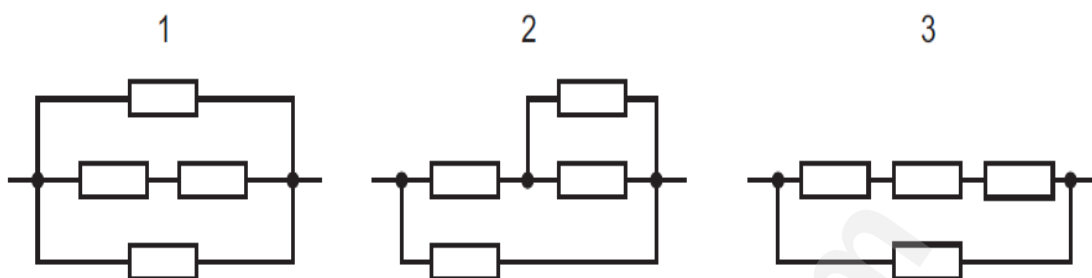
1.4. A block is moving with constant velocity to the right on a frictionless surface. Which sketch below correctly illustrates all the forces acting on the block?



1.5 A ball is dropped from point X near the ceiling of a railway coach travelling at constant speed v . The ball will most probably land at point



1.6 Four identical resistors are connected in the three networks below.



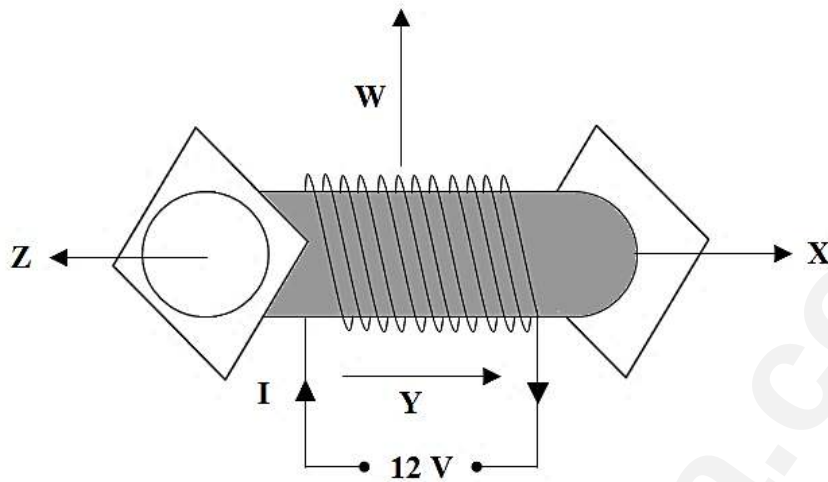
Which arrangement has the highest total resistance and which has the lowest?

	Highest	Lowest
A	1	2
B	1	3
C	3	1
D	3	2

1.7 Which of the following is true concerning Newton's Law of Universal Gravitation?

- A The force between two masses can be attractive or repulsive
- B The magnitude of the force between two masses is directly proportional to the sum of the masses
- C The magnitude of the force between the two masses is inversely proportional to the square of the distance between the masses' centres
- D $G = 6,67 \times 10^{-11} \text{ N.m}^2.\text{kg}^{-2}$ only on earth

- 1.8 Which of the four arrows indicates the correct direction of the magnetic field around the solenoid when current flows in the solenoid as shown below?



- A W
- B X
- C Y
- D Z

- 1.9 The acceleration due to gravity on the Earth is g . What is the acceleration due to gravity on a planet which has double the mass of the Earth and half the radius of the Earth?

- A $8g$
- B $4g$
- C $2g$
- D $\frac{1}{2}g$

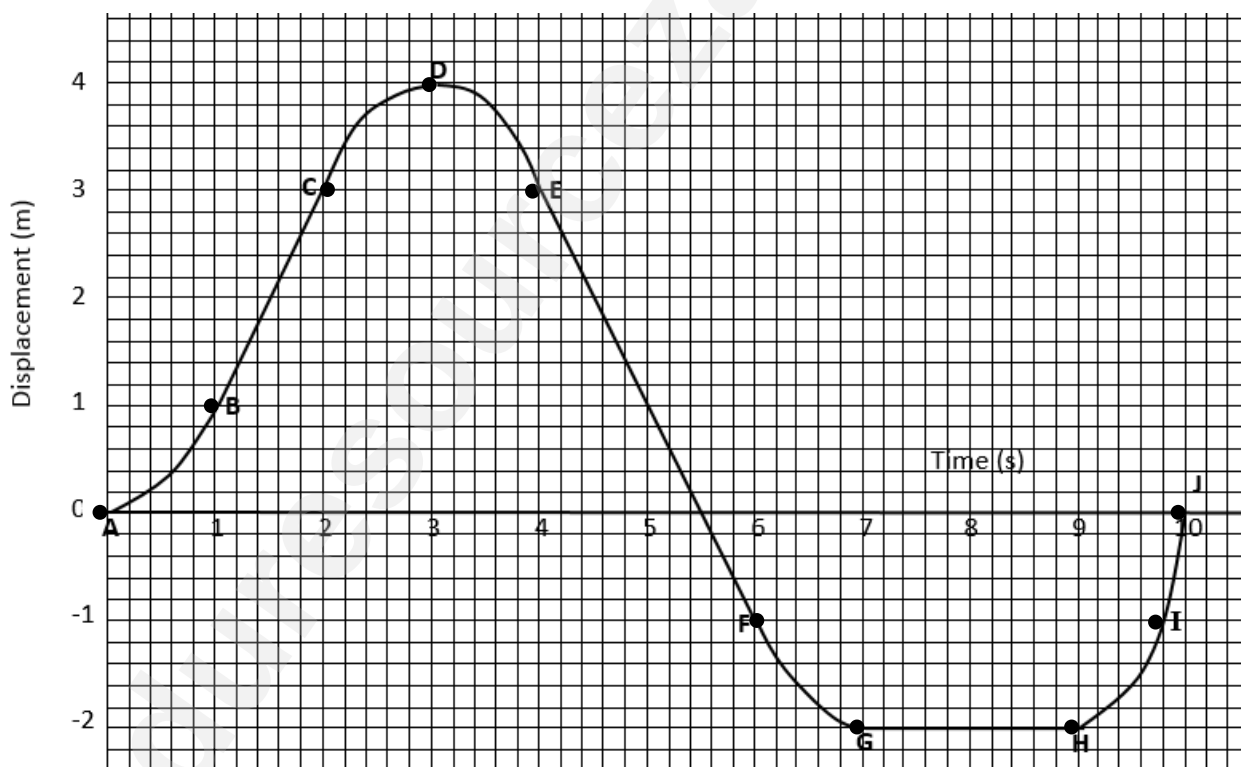
- 1.10 A resistor is connected to a 3,0 V battery; the power dissipated in the resistor is 1,0 W. The battery is replaced by a 6,0 V battery. The power dissipated, when a constant current flows through the resistor is now

A 1,0 W
 B 2,0 W
 C 3,0 W
 D 4,0 W

[10 X 2 = 20]

Question 2: Kinematics

- 2.1. The graph shows the **displacement** of an object to the **right** of its initial position as a function of time.



- 2.1.1 Make use of the letters on the graph to indicate between which times the object is...

2.1.1.1 stationary for a length of time (2)

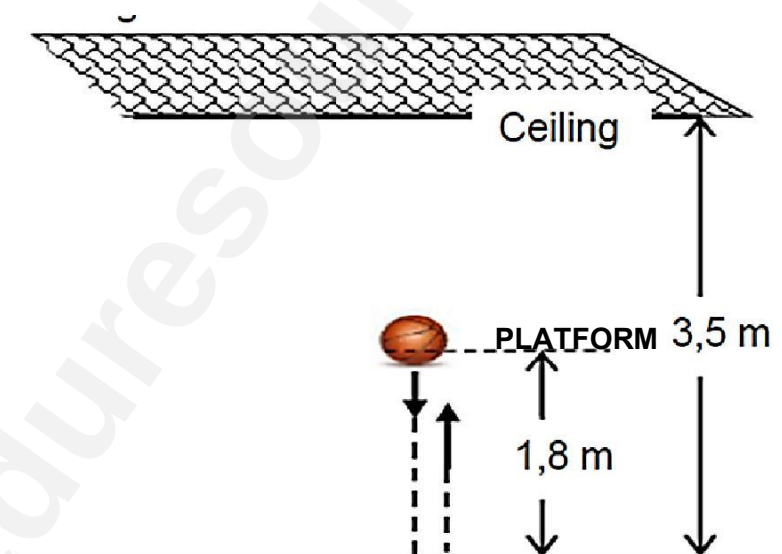
2.1.1.2 moving with greatest speed (2)

2.1.1.3 slowing down to the left (2)

2.1.2. Use the graph to determine the following:

- 2.1.2.1 The total distance travelled by the object from A to J
($t = 0 \text{ s}$ to $t = 10 \text{ s}$) (3)
- 2.1.2.2 The displacement of the object from D to J
($t = 3 \text{ s}$ to $t = 10 \text{ s}$) (3)
- 2.1.3 The instantaneous velocity of the object at position D. (2)
- 2.1.4 Whether the acceleration of the object at position D is zero or non-zero. Give a reason for your answer. (3)
- 2.1.5 The velocity of the object between E and F ($t = 4 \text{ s}$ to $t = 6 \text{ s}$). (3)

- 2.2. A girl stands on a platform in a classroom. She throws a ball vertically downwards to the floor hoping that the ball, after it bounced on the floor, will hit the ceiling of the classroom. She throws the ball with a velocity of 8 m.s^{-1} from the height of $1,8 \text{ m}$ above the floor. **Ignore the effects of friction.**



- 2.2.1 Write down the magnitude and direction of the acceleration of the ball immediately after the ball left her hand. (2)
- 2.2.2 Is the motion of the ball, while moving downwards towards the floor, in free fall? Answer YES or NO. Explain your answer (2)
- 2.2.3 Calculate the magnitude of the velocity with which the ball hits the floor. (4)

2.2.4 How long does it take the ball to hit the floor? (4)

The ball bounces inelastically on the floor and the velocity of the ball decreases by 20%

2.2.5 Determine by means of calculations, whether the ball will reach the ceiling after its first bounce on the floor. (5)

2.2.6 Sketch a velocity-time graph for the motion of the ball, from the time the ball is thrown until it reaches the maximum height after the bounce. (Use graph paper provided)

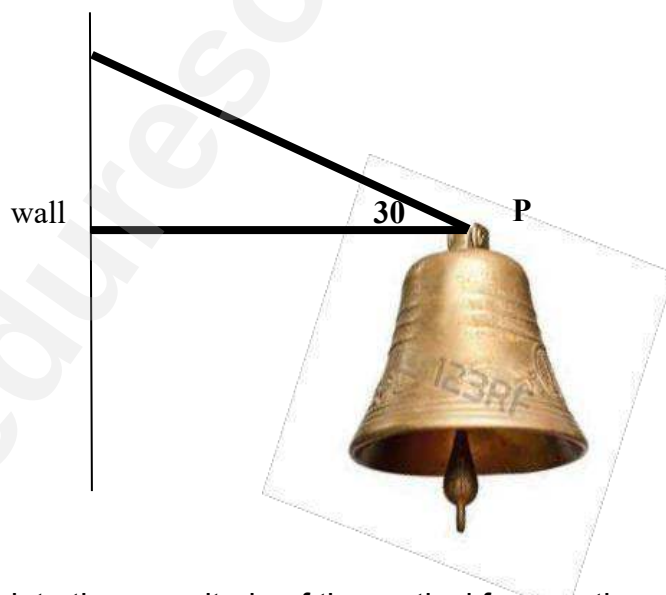
Clearly show the following on the graph:

- The initial velocity of the ball
 - The velocity and time when the ball hits the floor
- (4)

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Question 3: Forces and Newton's Laws

3.1. The "Bell and Anchor", a seaside restaurant, has a large brass bell, of mass 7,5 kg, that hangs on a bracket outside the entrance. The bell hangs 2,8 m above the pavement.

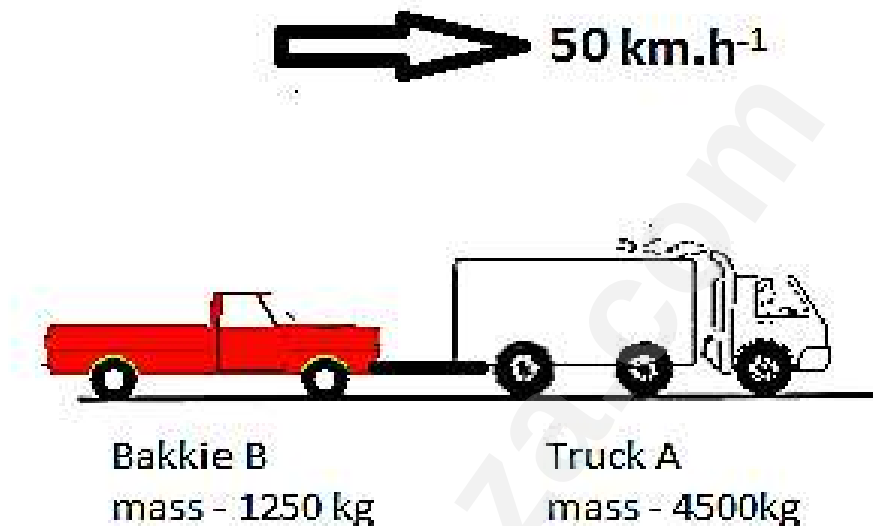


3.1.1 Calculate the magnitude of the vertical force acting on the bell. (4)

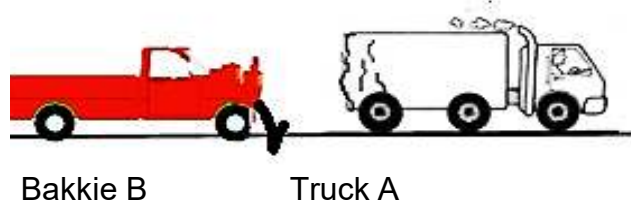
3.1.2 Explain why the forces acting on this system at rest, are in equilibrium. (2)

3.1.3 Calculate the force exerted by the horizontal supporting rod on the system (4)

- 3.2 Truck A, of mass 4 500 kg travels at a CONSTANT VELOCITY OF 50 km.h^{-1} while towing a Bakkie B, of mass 1 250 kg. The engine of truck A produces a force of 11 270 N. The road surface exerts a friction force of 8 820 N on truck A.



- 3.2.1 State *Newton's Second Law*. (2)
- 3.2.2 Explain the term maximum static frictional force. (2)
- 3.2.3 Calculate the maximum static frictional force, for Bakkie B, just before it starts moving, if the co-efficient for rubber on tar is 0,7. (4)
- 3.2.4 Calculate the tension in the tow rope. (3)
- 3.3 Truck A suddenly stops. Unfortunately Bakkie B has no brakes and slams into the rear of a stationary truck A. Bakkie B comes to an immediate stop. As a result of the collision, the tow rope breaks.



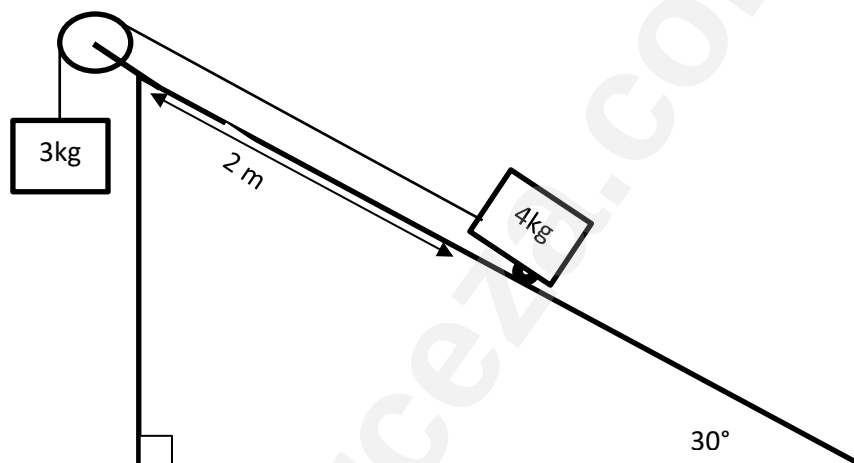
- 3.3.1 State the *Law of Conservation of Linear Momentum*. (2)
- 3.3.2 Assuming all frictional forces can now be ignored, calculate the speed of truck A immediately after the collision. (5)

- 3.3.3 With reference to Newton's First Law of motion, explain why it is always advisable to tow with a solid bar instead of a towing rope. (3)

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Question 4: Work, Energy and Power

In the diagram shown below, ignore all frictional forces. Consider the string attaching the mass block and the trolley to be inextensible and to have negligible mass.



The system is initially held stationary. When the suspended 3 kg mass is released, it falls and accelerates the 4 kg trolley 2 m up the slope.

- 4.1 Draw labelled free body diagrams showing all the forces acting on the 3 kg mass and the 4 kg trolley while the system is moving. The lengths of the arrows should be representative of the relative magnitudes of the forces. (6)
- 4.2 Calculate the magnitude of the component of the force of gravity acting on the trolley parallel to the slope ($F_{g//}$). (2)
- 4.3 Set up separate force equations for each mass and then solve simultaneously for the tension in the string and the acceleration of the system. (7)
- 4.4 Prove that the vertical rise in height of the trolley is equal to 1 m. (2)
- 4.5 Calculate the gain in potential energy of the trolley. (3)
- 4.6 Calculate the total work done on the trolley by the string. (3)
- 4.7 State the Work-Energy Theorem. (2)
- 4.8 Make use of the Work-Energy Theorem to calculate the speed of the trolley after travelling the 2 m up the ramp. (5)

[30]

Question 5: Gravitational and Electric Fields

5.1 State Newton's Law of Universal Gravitation (2)

5.2 Refer to the diagram below. The mass of the Earth is $5,96 \times 10^{24}$ kg and the mass of the Moon is $7,37 \times 10^{22}$ kg. The distance between the centres of the Earth and Moon is $3,85 \times 10^8$ m.



Diagram: Not to scale

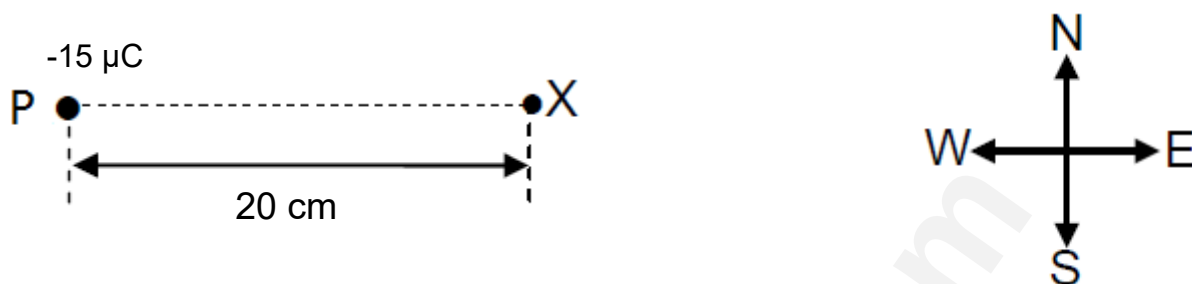
5.2.1 Calculate the gravitational force of attraction between the **Moon** and the **Earth**. (4)

5.2.2 Using your knowledge of Physics and compare the gravitational force of attraction between the **Sun** and **Earth** compared to your answer in Question 5.2.1. Use only these descriptors:
Greater than/Same as/ Less than (1)

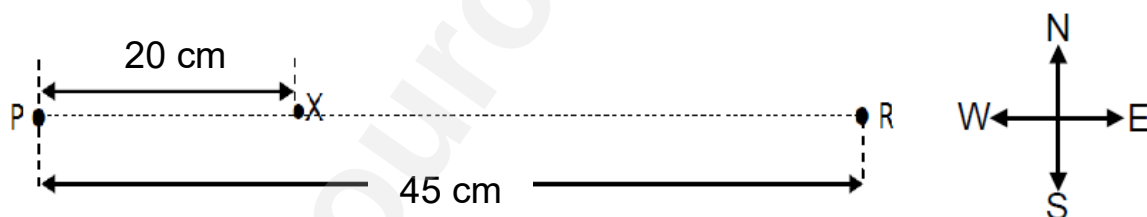
5.3 Compare numerically the proportionality constant of Coulomb's law to the proportionality constant in Newton's law of Universal Gravitation. (3)

5.4 Define the electric field at a point. (2)

- 5.5 In the diagram below, point charge P has a charge of $-15\ \mu\text{C}$. X is a point 20 cm from point charge P.



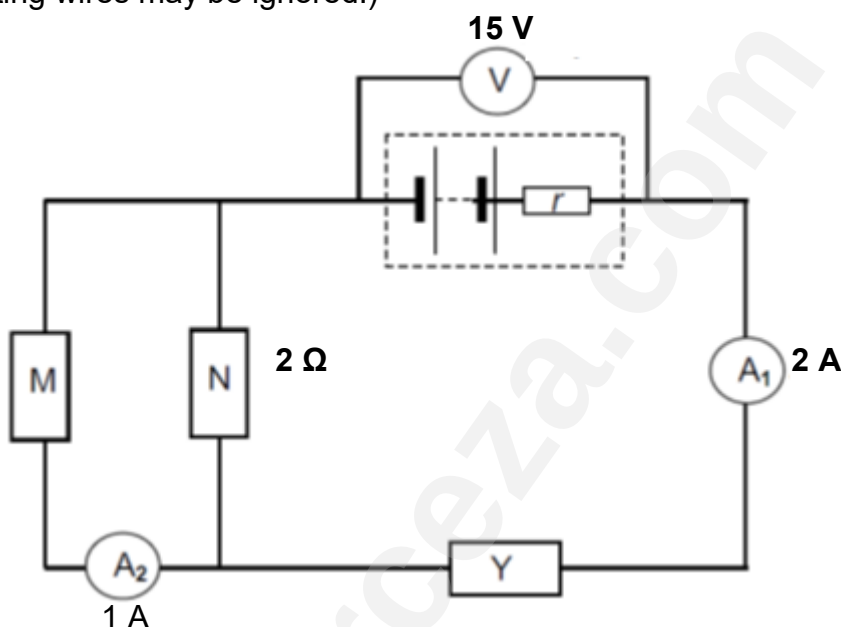
- 5.5.1 Draw the electric field pattern produced by point charge P. (2)
- 5.5.2 Calculate the magnitude and direction of the electric field at point X due to point charge P. (4)
- 5.6 Another point charge R is now placed at a distance of 45 cm from point charge P as shown below. The **RESULTANT** electric field at point X due to point charges P and R is $6 \times 10^6\ \text{N}\cdot\text{C}^{-1}$ east.



- Calculate the magnitude of point charge R. (5)
- [23]

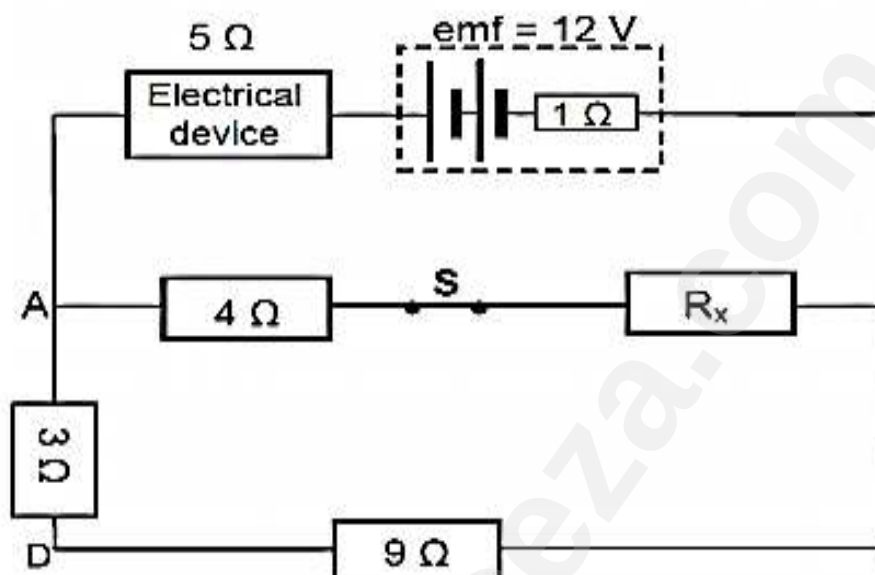
Question 6: Electric Circuits

- 6.1 The circuit diagram below shows a battery, with an internal resistance r , connected to three resistors, M, N, and Y. The resistance of **N is $2\ \Omega$** and the reading on voltmeter **V is $15\ \text{V}$** . The reading on ammeter A_1 is $2\ \text{A}$ and the reading on ammeter A_2 is $1\ \text{A}$. (The resistance of the ammeters and the connecting wires may be ignored.)



- 6.1.1 State Ohm's Law in words. (2)
- 6.1.2 If the emf of the battery is $17\ \text{V}$, calculate the internal resistance of the battery. (3)
- 6.1.3 Calculate the potential difference across resistor N. (3)
- 6.1.4 Calculate the resistance of Y. (3)

- 6.2 A learner wants to use his 12 V car battery with an **internal resistance of $1\ \Omega$** to operate an electrical device. He uses the circuit below to obtain the desired potential difference for the device to function. The resistance of the device is $5\ \Omega$. When switch S is **closed** as shown, the device functions at its maximum power of 5 W.

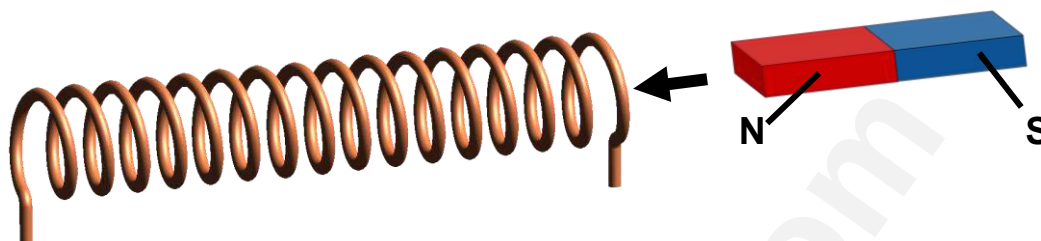


- 6.2.1. Explain, in words, the meaning of an EMF of 12 V. (2)
- 6.2.2. Define Electrical current. (2)
- 6.2.3 Calculate the current that passes through the electrical device. (3)
- 6.2.4. Calculate the resistance of resistor R_x . (6)
- 6.2.5. The learner connects the battery back into the car engine circuit. He notices that the headlamps of the car go dim when the starter motor is used. Explain his observation. (2)
- 6.2.6 The learner got his clothes soiled whilst working on his car. He decides to use his parents' washing machine to wash his soiled clothes, which takes him 25 minutes. The washing machine operates at a potential difference of 240 V and a current of 9,5 A. Eskom charges energy usage at R1,50 per kW.h.
- Calculate the cost of operating the washing machine for the 25 minutes.
(1 unit = 1 kW.h) (5)

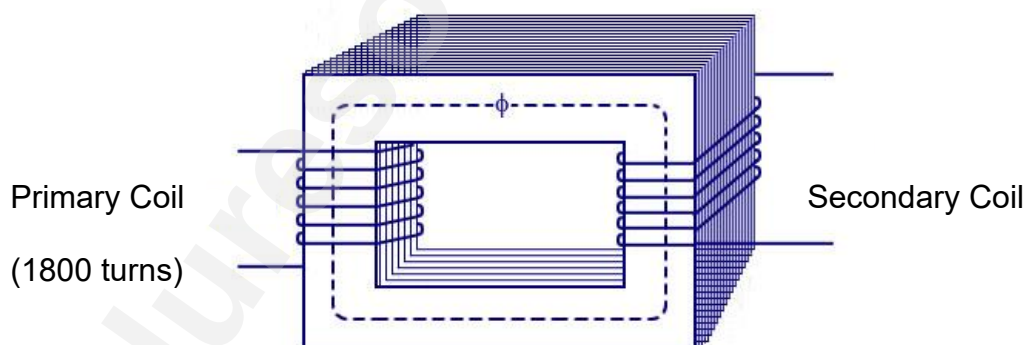
[31]

Question 7: Electrodynamics

- 7.1 Jane moves the north pole of a magnet towards and through a coil of wire. This action induces an emf across the ends of the coil.

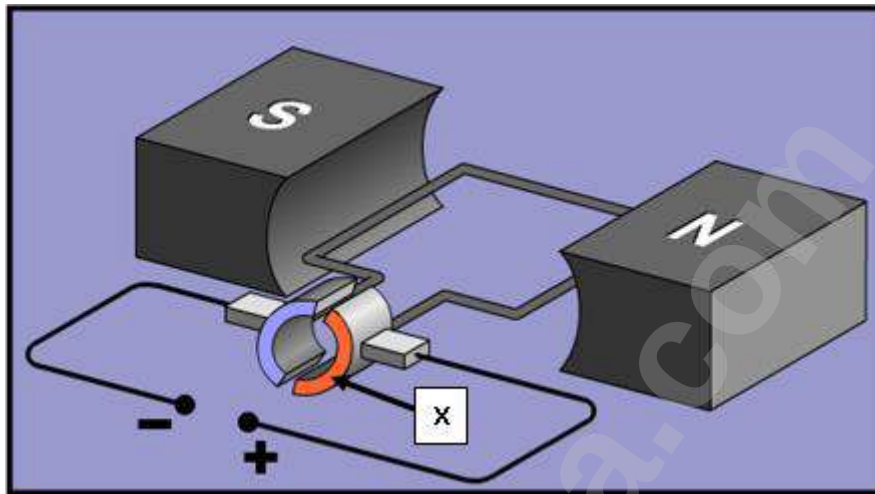


- 7.1.1 Does Jane's action also induce a current **in the coil**? Explain your answer. (2)
- 7.1.2 How will the magnitude and direction of the induced emf change if Jane uses the magnet's south pole instead of the north? (2)
- 7.1.3 State three ways in which Jane can induce a bigger emf in the coil. (3)
- 7.2 A transformer, to be used in a low voltage power supply is connected to the **240 V, 50Hz a.c.** mains supply and gives an output voltage of **12V**. There are **1800 turns** on the primary coil.



- 7.2.1 Using Faraday's Law, explain how a transformer works. (5)
- 7.2.2 The output from the transformer is rectified by the use of a single diode in series with the load. Sketch the output waveform, showing clearly how the value of the voltage across the load changes with time. Your sketch should include suitable time scales. (3)

- 7.3 Consider the diagram below which shows a simple DC motor and answer the questions that follow.



- 7.3.1 State the energy conversion that takes place inside an electric motor. (2)
- 7.3.2 Does the coil turn clockwise or anti-clockwise? (1)
- 7.3.3 Explain why the coil experiences the most force when in this (horizontal) position. (2)
- 7.3.4 Name component X and state its function. (3)

[23]

END