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**ST. MARY'S DSG KLOOF
PHYSICAL SCIENCES
TRIALS PAPER 1: PHYSICS**

GRADE 12

TIME: 3 hours + 10 minutes reading

August 2017

MARKS: 200

Examiner: Mrs G. Main

Moderators: Mrs K. Bolton and Mrs T. Kirsten

Read the Following Instructions Carefully:

1. This paper consists of:
 - A question paper of 15 pages
 - An answer sheet
 - Data sheet
2. Read the questions carefully.
3. Answer **ALL** questions.
4. Number your answers exactly as the questions are numbered.
5. Write legibly and present your work neatly.
6. All working should be shown and units **MUST** be given with answers. Work to two significant figures. **Make sure your calculator is in the correct mode.**
7. Consult the data sheet where necessary.
8. Answers are to be collated in three separate parts:
 1. Question 1 and 2 (including answer sheet)
 2. Question 3 and 4
 3. Question 5, 6 and 7

QUESTION 1 MULTIPLE CHOICE

Answer these questions on the multiple-choice **Answer Sheet** provided. Make a cross (X) in the box corresponding to the letter which you consider to be the most correct.

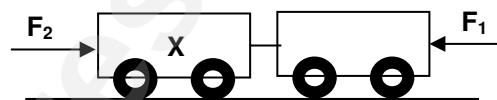
1.1 When an object falls freely in a vacuum near the surface of the Earth...

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

1.2 If the momentum of an object, of constant mass, is doubled, then its kinetic energy will be:

- A Halved
- B Doubled
- C Three times greater
- D Four times greater

1.3 Two forces are exerted on two trolleys, as shown in the sketch. $F_1 > F_2$. If the mass of each trolley is m , what is the magnitude of the acceleration experienced by trolley X?



- A $\frac{F_1 - F_2}{m}$
- B $\frac{F_1 + F_2}{m}$
- C $\frac{F_1 - F_2}{2m}$
- D $\frac{F_1 + F_2}{2m}$

1.4 Which one of the following physical quantities is equivalent to the rate of change of momentum?

- A Net force
- B Impulse
- C Energy
- D Power

1.5 The acceleration due to gravity on the Earth is g . What is the acceleration due to gravity on a planet which has triple the mass of the Earth and a quarter of the radius of the Earth?

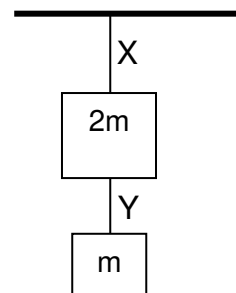
- A $12g$
- B $48g$
- C $\frac{3}{4}g$
- D $24g$

1.6 Power is a useful quantity to know in both electrical and mechanical systems. Which quantity is equivalent to 1 W?

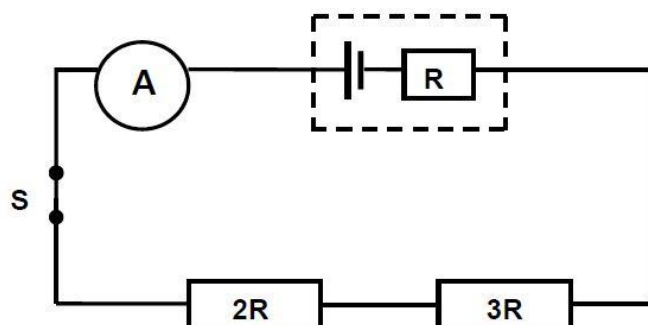
- A 1 V.C
- B 1 J.m
- C 1 J.s
- D 1 V.A

1.7 The diagram shows two blocks of mass m and $2m$ suspended by light strings. Select the correct statement concerning the tension at X (T_X) or the tension at Y (T_Y).

- A $T_Y = 3mg$
- B $T_Y = 2mg$
- C $T_X = mg$
- D $T_X = 3mg$



- 1.8 In the circuit below, two resistors of resistance $2R$ and $3R$ are connected in series with a battery, which has an emf of E and an internal resistance R .



What is the potential difference across the resistor of resistance $2R$?

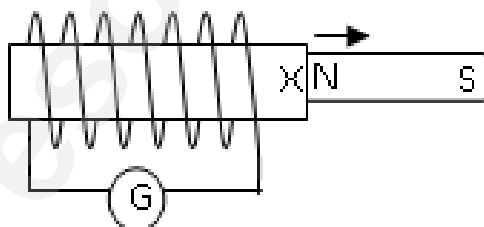
A $\frac{2E}{5}$

B $\frac{E}{3}$

C $\frac{E}{2}$

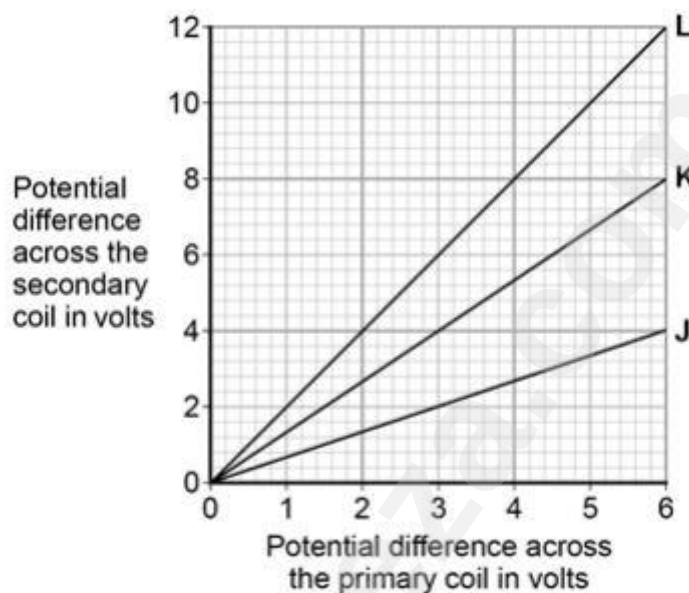
D $\frac{E}{6}$

- 1.9 The magnet is removed from the coil. Give the polarity of the solenoid at X and the direction of the induced current through the galvanometer.



	Direction of induced current through G	Polarity at X
A	Left to right	North
B	Left to right	South
C	Right to left	North
D	Right to left	South

- 1.10 A student makes three simple transformers, **J**, **K** and **L**. The graph below shows how the potential difference across the secondary coil of each transformer varies as the potential difference across the primary coil of each transformer is changed.



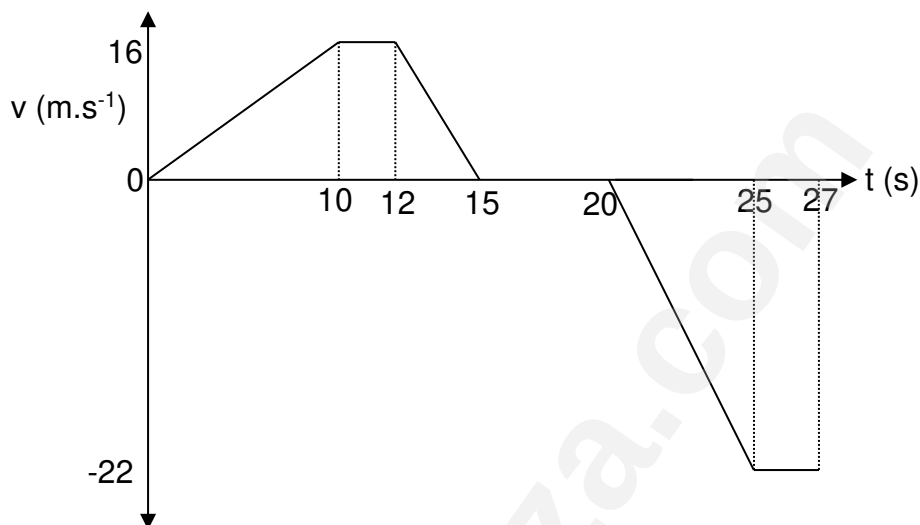
Which line represents a step-down transformer?

- A **J**
- B **K**
- C **L**
- D None of them.

(10 x 2) = **[20]**

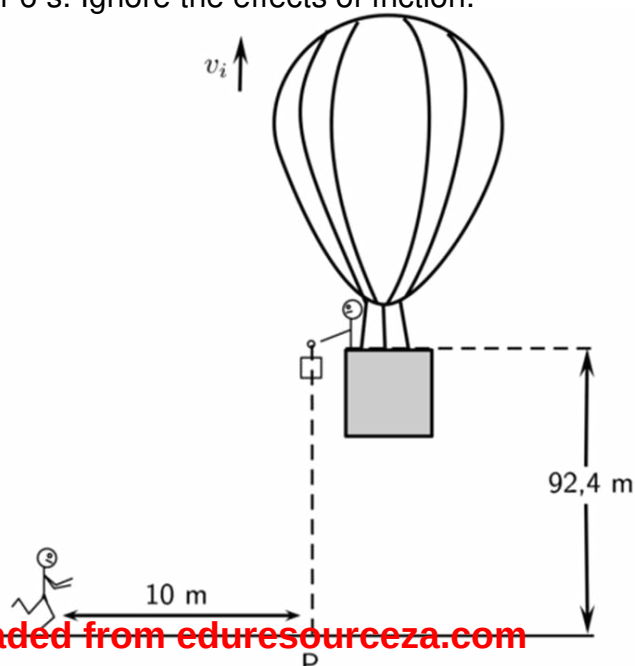
QUESTION 2 KINEMATICS

- 2.1 The velocity-time graph below represents the motion of a car which is initially travelling West.



- 2.1.1 Describe the motion of the car for the following time intervals:
- 0 – 10 s (3)
 - 25 – 27 s (2)
- 2.1.2 Define *acceleration*. (2)
- 2.1.3 Calculate the acceleration of the car between 20 s and 25 s. (4)
- 2.1.4 Calculate the displacement of the car in the 27 s time interval. (4)

- 2.2 A tourist takes a trip in a hot air balloon. The hot-air balloon is moving vertically upwards at a constant speed. A camera is accidentally dropped from the balloon at a height of 92,4 m as shown in the diagram below. The camera strikes the ground after 6 s. Ignore the effects of friction.



2.2.1 Calculate the speed at which the balloon is rising when the camera is dropped. (4)

2.2.2 Draw a sketch graph of velocity versus time for the entire motion of the camera. Use **down as positive**.

Indicate the following on the graph:

- Initial velocity
- Time at which it reaches the ground (4)

2.2.3 A jogger, 10 m away from point **P**, as shown in the above diagram, is running at a constant speed of $2 \text{ m} \cdot \text{s}^{-1}$. He sees the camera at the same instant it leaves the balloon. Calculate the time it takes the jogger to cover the 10 m and hence determine whether he will catch the camera before it hits the ground. (4)

2.3 An investigation was carried out to determine how the mass of a toy car affects the top speed it can reach. Five different cars were constructed having the same shape, size and wheels but each one had a different mass. Each car was tested three times to measure the speed after the same time period.

The average of their results were recorded in the table below.

Car	Mass (m) (g)	Maximum speed (v) ($\text{m} \cdot \text{s}^{-1}$)
A	80	1,25
B	150	0,7
C	260	0,4
D	335	0,3
E	400	0,25

2.3.1 What was the dependent variable in this investigation? (1)

2.3.2 On the graph paper provided, plot a graph to represent the relationship between the mass of the toy car and the maximum speed reached in a set time period. (7)

2.3.3 Why did they keep the shape, size and wheels of each car the same? (2)

2.3.4 Give a scientific conclusion for this investigation by stating the relationship between the variables as shown by the graph and the data in the table. (2)

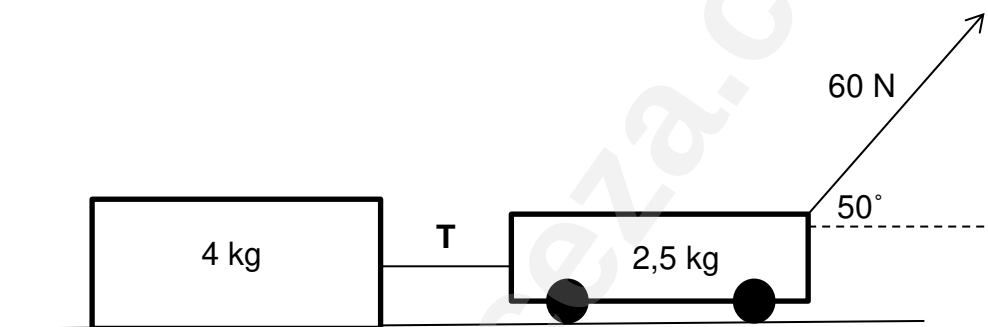
- 2.3.5 Prove the mathematical relationship between the mass (m) of the car and speed (v) (as concluded in Q 2.3.4), reached in a set time period by using data for the cars, A, D and E. (4)

[43]

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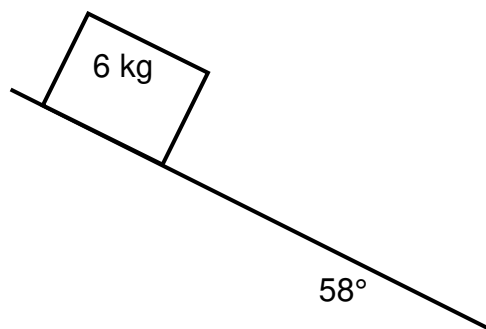
QUESTION 3 NEWTON'S LAWS

- 3.1 A 2,5 kg trolley is pulled along a smooth horizontal surface by a 60 N force as shown in the diagram. The force makes an angle of 50° with the horizontal. A 4 kg box is tied to the back of the trolley by a piece of string. There is a frictional force of 3 N between the surface and the box.



- 3.1.1 Draw a free body diagram of all the forces acting on the **4 kg box**. (4)
- 3.1.2 Calculate the acceleration of the system. (5)
- 3.1.3 Calculate the magnitude of the tension, **T**, in the string joining the trolley and the box. (3)
- 3.1.4 Would the trolley be lifted off the surface by the 60 N force? Use a calculation to explain your answer. (4)

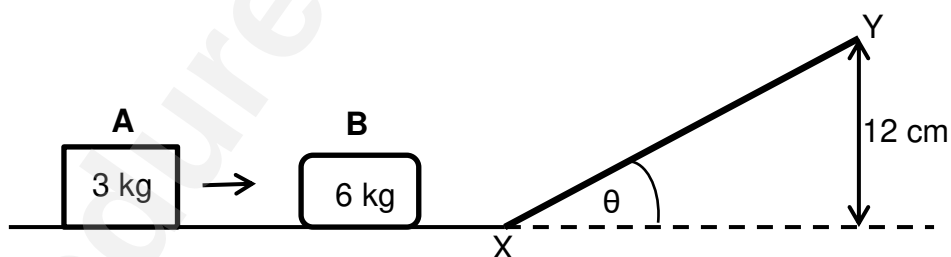
- 3.2 A 6 kg block is at rest on an inclined plane. The plane is tilted until the block just starts to slide down the slope. The angle of the slope when the block just starts to slide is 58° .



- 3.2.1 Draw a labelled free body diagram to represent the forces acting on the block. (4)
- 3.2.2 Calculate the maximum static frictional force (F_f) acting up the slope. (2)
- 3.2.3 Calculate the co-efficient of static friction between the block and the slope. (4)
- [26]

QUESTION 4 MOMENTUM, IMPULSE, WORK, ENERGY AND POWER

- 4.1 Block **A** with a mass of 3 kg moves right at a constant velocity on a horizontal frictionless surface. It collides with a stationary block **B** of mass 6 kg. Immediately after the collision block **A** moves at $0,5 \text{ m}\cdot\text{s}^{-1}$ to the left and block **B** at $2,25 \text{ m}\cdot\text{s}^{-1}$ to the right.



- 4.1.1 State the *Law of conservation of linear momentum*. (2)
- 4.1.2 Calculate the speed of block **A** before the collision. (4)
- 4.1.3 If the blocks remain in contact with each other for $0,01 \text{ s}$, calculate the magnitude of the force exerted by the 3 kg block on the 6 kg block during the collision. (3)

After the collision, block **B** moves up a rough incline XY. A constant frictional force of 10 N acts on the block and causes it to come to rest at point Y.

- 4.1.4 In which direction is the net force on block **B** on the incline?
Choose either FROM X TO Y or FROM Y TO X. (1)

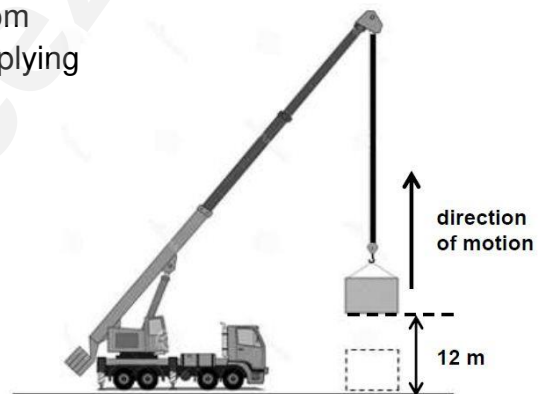
- 4.1.5.1 Define the *work-energy theorem*. (2)

- 4.1.5.2 Use trigonometry ratios to find an expression for the distance XY. (2)

- 4.1.5.3 Give an expression for the net force acting on block **B**. (2)

- 4.1.5.4 Use the work-energy theorem to calculate the angle of the incline. (3)

- 4.2 A crane lifts a crate of mass 500 kg from rest through a height of 12 m when applying a force of 6000 N to the crate.



- 4.2.1 Calculate the total work done by the crane on the crate. (3)

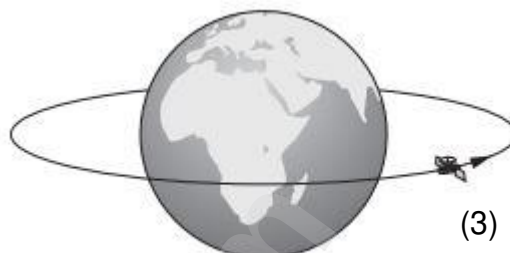
- 4.2.2 Calculate the work done by the net force on the crate. (3)

- 4.2.3 Use the work-energy theorem to calculate the final speed of the crate. (3)
[28]

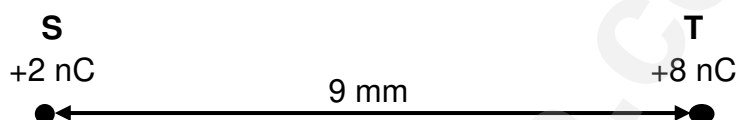
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QUESTION 5 GRAVITATIONAL AND ELECTRIC FIELDS

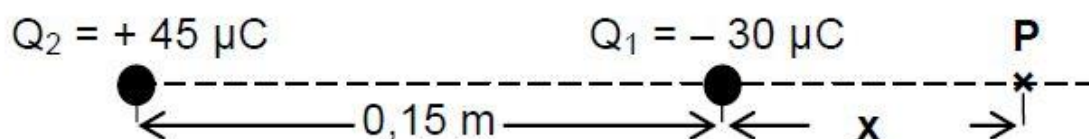
- 5.1 Calculate the distance between the centres of the Earth, of mass 6×10^{24} kg, and a satellite, of mass 500 kg, that is orbiting Earth, if the force they exert on each other is $4,15 \times 10^6$ N.



- 5.2 Two positive point charges, **S** and **T**, are separated by a distance of 9 mm. The charge on **S** is 2 nC and the charge on **T** is 8 nC.



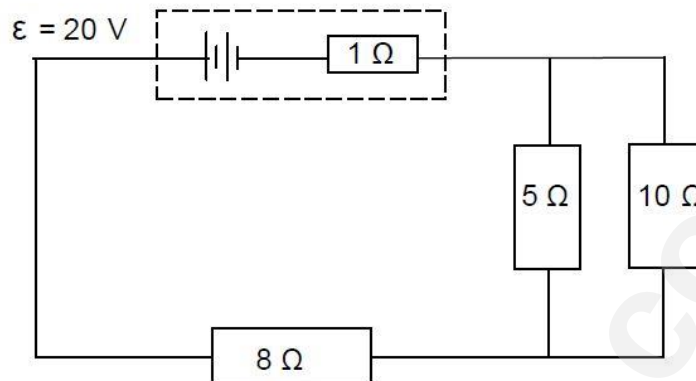
- 5.2.1 Draw an electric field line diagram to represent the field set up by charges **S** and **T**. (3)
- 5.2.2 State *Coulomb's Law*. (2)
- 5.2.3 Calculate the force exerted by charge **S** on charge **T**. (5)
- 5.2.4 Calculate the number of electrons that charge **S** lost when it obtained its charge of 2 nC. (2)
- 5.2.5 Charges **S** and **T** touch and then separate. What is the charge on **S** and **T** after they have touched and separated? (2)
- 5.3.1 Define the magnitude of the *electric field at a point*. (2)
- 5.3.2 A $-30 \mu\text{C}$ point charge, Q_1 , is placed at a distance of 0,15 m from a $+45 \mu\text{C}$ point charge, Q_2 , in space, as shown in the diagram below. The net electric field at point P, which is on the same straight line as the two charges, is zero.



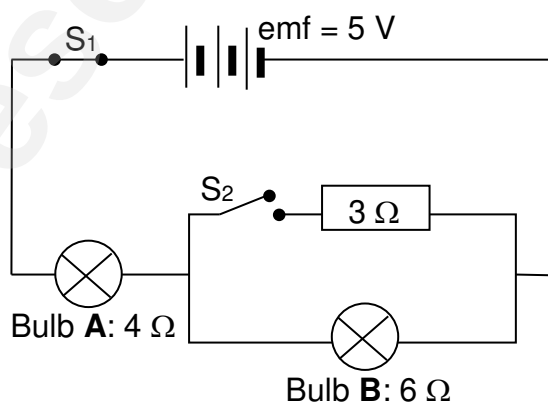
- Calculate **X**, the distance of point P from charge Q_1 . (5)
- [24]

QUESTION 6 ELECTRIC CIRCUITS

- 6.1 A battery with an emf of 20 V and an internal resistance of $1\ \Omega$ is connected to three resistors, as shown in the circuit below.



- 6.1.1 Define the term *emf* of a cell. (2)
- 6.1.2 Calculate the effective resistance of the parallel combination in the circuit. (3)
- 6.1.3 Calculate the total resistance of the external circuit. (1)
- 6.1.4 Calculate the current in the $8\ \Omega$ resistor. (3)
- 6.1.5 Calculate the potential difference across the $5\ \Omega$ resistor. (3)
- 6.1.6 Calculate the total power supplied to the external circuit, by the battery. (3)
- 6.2 In the circuit shown below the battery has no internal resistance.



When the S_1 is closed and the S_2 is open, the current through the battery is **0,5 A**.

- 6.2.1 Calculate the rate of energy transfer in bulb A. (3)
- 6.2.2 Which bulb, if any, is brighter, A or B? Explain your answer with reference to suitable calculations. (4)

6.2.3 **BOTH switches are closed.**

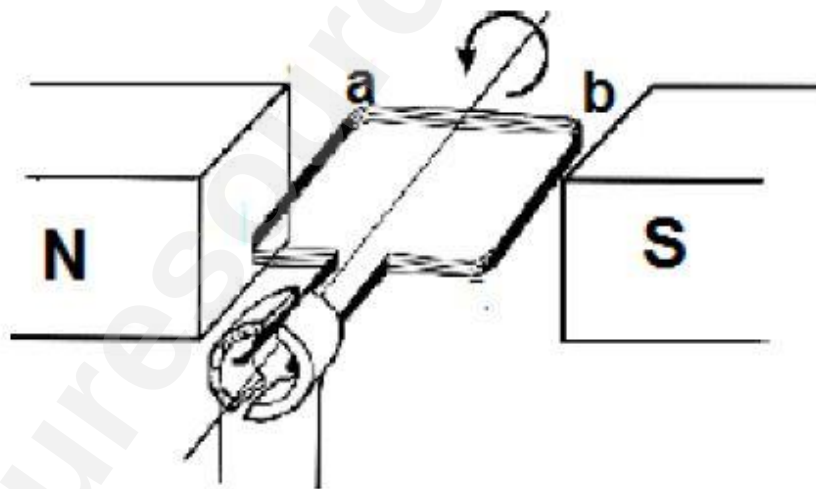
6.2.3.1 What happens to the brightness of bulb **A** (*brighter, dimmer or not affected*)? Explain your answer with reference to a suitable **formula**. (3)

6.2.3.2 What happens to the brightness of bulb **B** (*brighter, dimmer or not affected*)? Explain your answer with reference to one or more suitable **calculations**. (4)

6.3 Calculate the cost of using a 100 W bulb for 3,5 hours at a cost of R1,45 per unit (kWh) (3)
[32]

QUESTION 7 ELECTRODYNAMICS

7.1 A part of a simplified DC motor is shown in the sketch below.

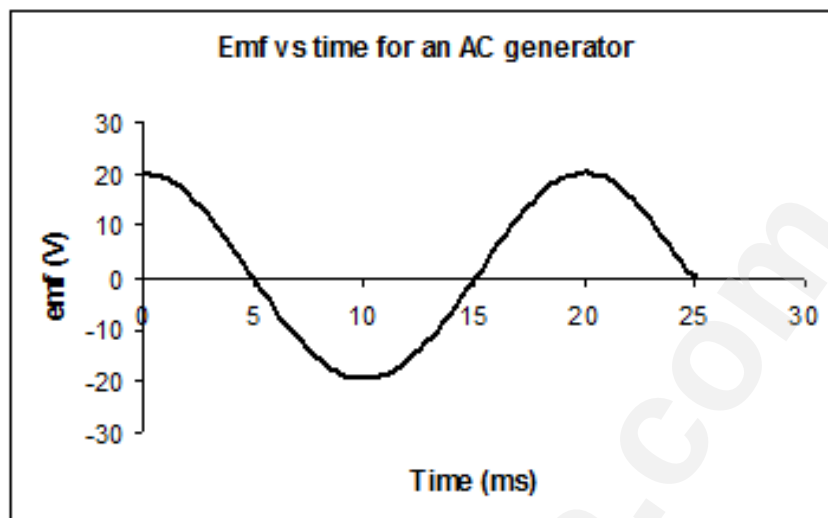


7.1.1 In which direction (**a to b** OR **b to a**) is the current flowing through the coil if the coil rotates anticlockwise as indicated in the sketch? (2)

7.1.2 Name the rule you used to answer question 7.1.1. (2)

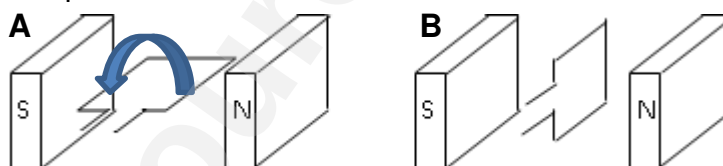
7.1.3 Which component in the sketch must be replaced in order for the device to operate as an AC generator, and what must its replacement be? (2)

- 7.2 The graph below shows the induced emf produced by a generator over a certain time.



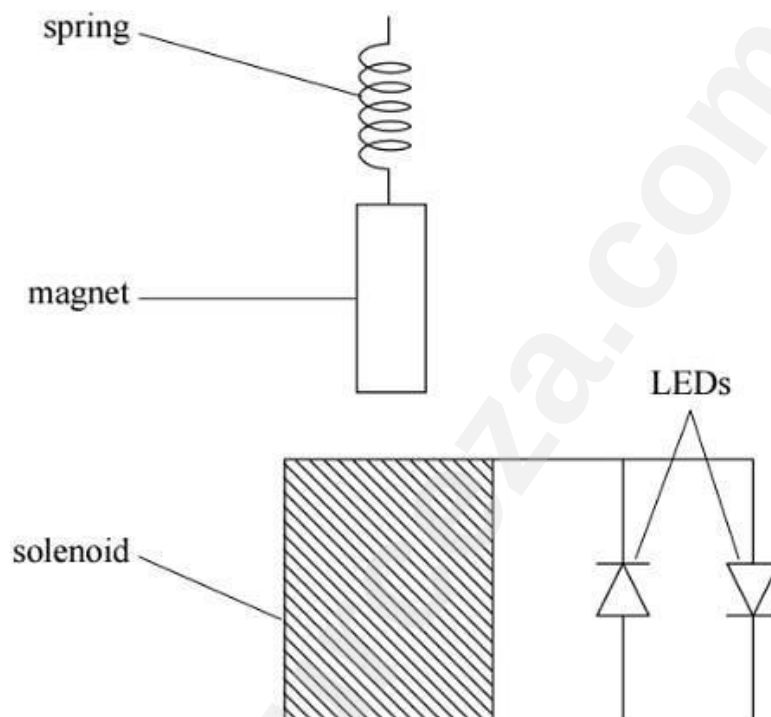
- 7.2.1 How can you tell from the graph that this is an AC generator? (2)

The following diagrams show the orientation of the coil within the magnetic field of the magnets at different points in its rotation.



- 7.2.2 From the graph choose a time that corresponds to position **A** and a time that corresponds to position **B**. (2)
- 7.2.3 For diagram **A**, use Faraday's Law to explain why it has the time period that you have chosen. (3)
- 7.2.4 What energy conversion takes place in the generator? (2)

- 7.3 A teacher demonstrates electromagnetic induction to her class using the apparatus shown below. A magnet suspended from a spring moves up and down along the axis of a solenoid. The solenoid is connected to two light-emitting diodes (LEDs). The magnet does not exit the solenoid at the bottom.



- 7.3.1 Explain why there is current in the solenoid when the magnet is moving. (2)
- 7.3.2 Explain why only one of the LEDs lights up when the magnet moves down. (2)
- 7.3.3 What is the purpose of the other LED in this demonstration? (1)
- 7.3.4 State *Lenz's Law*. (2)
- 7.3.5 Give two factors that could increase the induced current in the coil. (2)
- 7.3.6 Explain why the average brightness of both LEDs decreases with time. (3)

[27]