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GRADE 12 EXAMINATION
PRELIMINARY EXAMINATION 2024

PHYSICAL SCIENCES: PAPER I

Time: 3 hours

200 marks

Examiner: K Mari

Moderator: J Morrison-Young

NAME																	
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PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 24 pages and a Data Sheet of 2 pages. Please check that your question paper is complete.
 2. Read the questions carefully.
 3. Answer ALL the questions.
 6. Use the data and formula sheet whenever necessary.
 7. Show your working in all calculations.
 8. Units need not be included in the working calculations, but appropriate units should be shown in the answer.
 9. Answers must be expressed in decimal format, not left as proper fractions.
 10. Where appropriate, express answers to TWO decimal places.
 11. It is in your own interest to write legibly and to present your work neatly.
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Question 1

Answer these questions on the multiple-choice answer sheet below. Make a cross (X) in the box corresponding to the letter that you consider to be correct.

A	B	~~C~~	D
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Here the option C has been marked as an example.

1.1	A	B	C	D
1.2	A	B	C	D
1.3	A	B	C	D
1.4	A	B	C	D
1.5	A	B	C	D
1.6	A	B	C	D
1.7	A	B	C	D
1.8	A	B	C	D
1.9	A	B	C	D
1.10	A	B	C	D

1.1 Which of the following pairs of physical quantities contains ONLY scalar quantities?

- A) velocity, energy B) acceleration, distance
C) work, speed D) displacement, velocity

1.2 An athlete runs 300 m due north at $1,5 \text{ m.s}^{-1}$ and then 400 m due east at $2,0 \text{ m.s}^{-1}$. What is the average speed for her run?

- A) $1,25 \text{ m.s}^{-1}$ B) $1,5 \text{ m.s}^{-1}$
C) $1,75 \text{ m.s}^{-1}$ D) $2,0 \text{ m.s}^{-1}$

1.3 A bus is travelling at a CONSTANT velocity.

Which ONE of the following statements about the forces acting on the bus is always CORRECT?

- A) There are no forces acting on the bus.
- B) There is a non-zero net force acting on the bus.
- C) The net force acting on the bus is zero
- D) The normal force acting on the bus is equal to the weight of the bus.

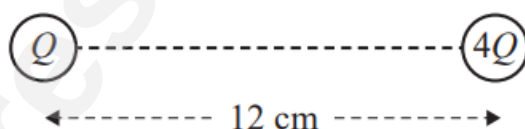
1.4 Which one of the following is the unit for impulse?

- A) $kg \cdot m \cdot s^{-2}$
- B) $kg \cdot m^{-1} \cdot s^{-1}$
- C) $N \cdot s$
- D) $N \cdot m$

1.5 A ball with mass m is dropped from a height h and hits the ground with a velocity v . What will be the velocity of the ball with mass $2m$ dropped from a height of $\frac{1}{2}h$.

- A) $\sqrt{2}v$
- B) $2v$
- C) $\frac{1}{2}v$
- D) $\frac{1}{\sqrt{2}}v$

1.6 Two point charges, with magnitudes Q and $4Q$ are placed 12 cm apart, as shown in the diagram below:



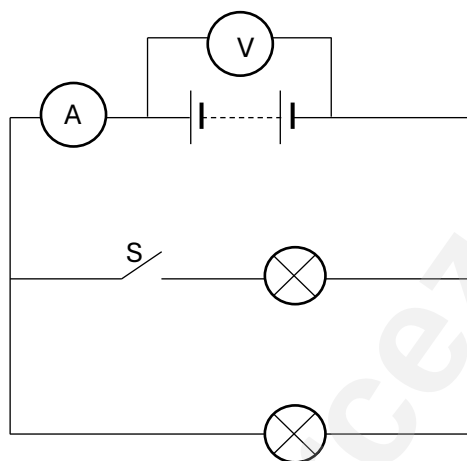
On the straight line between the charges Q and $4Q$, the electric field is

- A) non-zero everywhere
- B) zero at a point 2,4 cm from Q
- C) zero at a point 3 cm from Q
- D) zero at a point 4 cm from Q

- 1.7 The kettle in the Science Lab is rated 2 500 W. During winter it is used for a total of 130 minutes per day. The cost of electricity is R1,09 per kWh. Which of the expressions can be used to calculate the cost in Rands, per day, of using the kettle?

A) $\frac{2,5 \times 130 \times 1,09}{1000}$ B) $\frac{2,5 \times 130 \times 190}{1000}$
 C) $\frac{2500 \times 130 \times 1,09}{1000 \times 60}$ D) $\frac{2500 \times 130 \times 1,09}{60}$

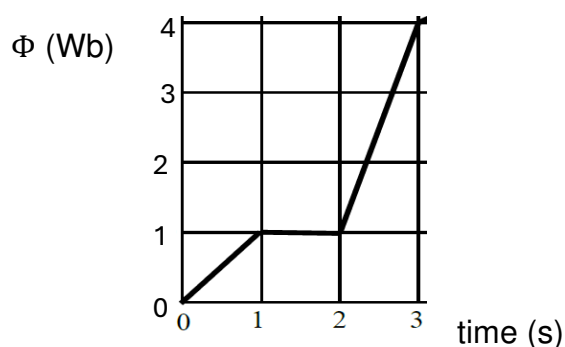
- 1.8 In the circuit below the resistance of the ammeter, switch and wires are negligible. The voltmeter has a very high resistance. The battery has significant internal resistance.



How are the readings on the ammeter and voltmeter affected if switch S is closed?

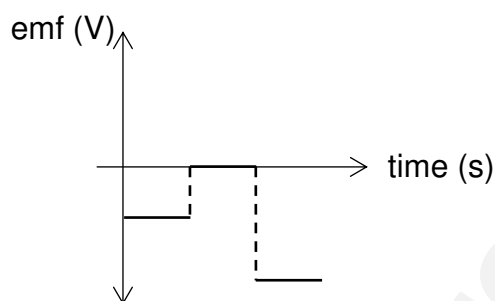
	Ammeter	Voltmeter
A	Decrease	Increase
B	Decrease	No change
C	Increase	No change
D	Increase	Decrease

- 1.9 The magnetic flux passing through a coil of wire varies as shown in the graph of magnetic flux vs time.

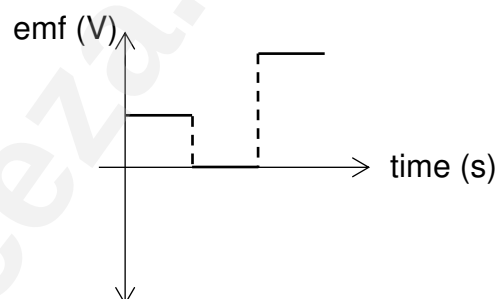


Which of the emf versus time graphs corresponds to the above flux vs time graph?

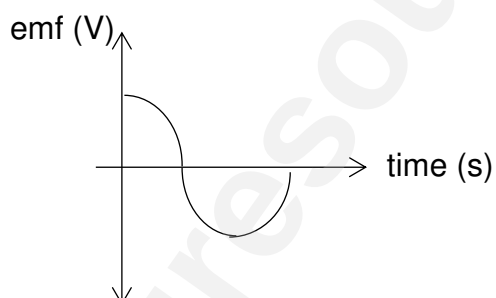
A)



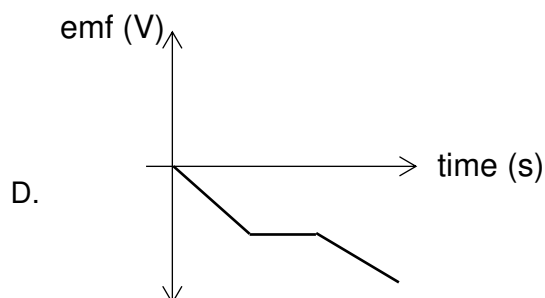
B)



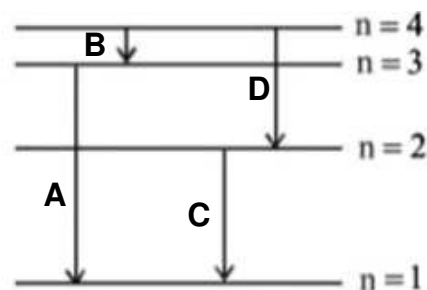
C)



D)



- 1.10 The diagram shows the energy levels for an electron in a certain atom. Which transition shown represents the emission of light with the greatest wavelength?



A) A

B) B

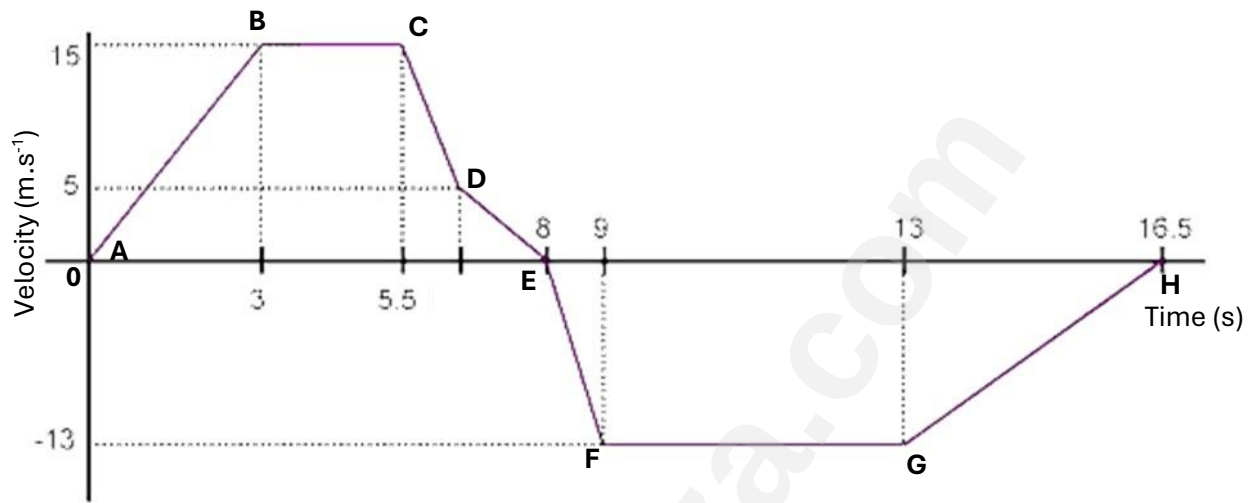
C) C

D) D

[20]

Question 2

Consider the velocity vs. time graph of a motorbike starting from rest, then initially travelling North along a straight road. The diagram is **not** drawn to scale.



- 2.1 Using the letters **A, B, C, D, E, F, G** and **H** from the graph, write down the **interval (or intervals)** that best describes the following motion:
- 2.1.1 The motorbike is travelling North at constant velocity. (1)
- 2.1.2 The motorbike is speeding up. (2)
- 2.1.3 The motorbike is moving North while accelerating South. (2)
- 2.1.4 The motorbike is moving South while accelerating North. (1)
- 2.2 Define the term *acceleration*. (2)

2.3 Using the graph, calculate the acceleration of the motorbike for the first 3s. (3)

2.4 It is found that the rate at which the motorbike decelerates between points C and D is 10 m.s^{-2} . Calculate the time value of D. (3)

2.5 Calculate:

2.5.1 the total displacement for the entire journey. ($t=0$ until $t=16,5\text{s}$) (5)

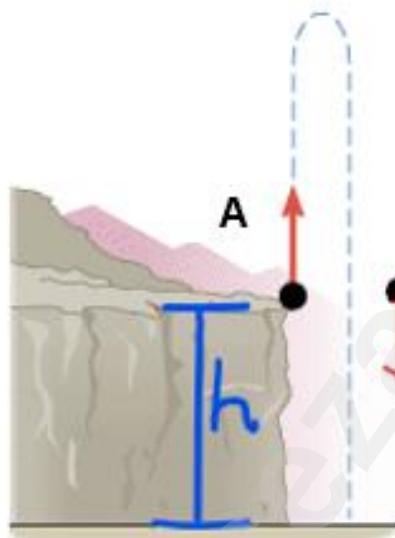
2.5.2 the average velocity for the 16,5 seconds of travel. (3)

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Question 3

A ball, **A**, is thrown vertically upward from a height, h , with a speed (v) of 54 km.h^{-1} . AT THE SAME INSTANT, a second identical ball, **B**, is dropped from the same height as ball **A**, as shown in the diagram below.

Both balls undergo free fall and eventually hit the ground.



- 3.1 Convert 54 km.h^{-1} to m.s^{-1} . (1)
- 3.2 Explain what is meant by the term 'free-fall'. (2)
- 3.3 Calculate the time taken for Ball A to return to its starting point. (4)
- 3.4 What would be the distance between the two balls once Ball A has reached its highest point of projection? (7)

- 3.5 If ball **B** takes 3,2 seconds to hit the ground calculate the height h (above the ground) from which both balls were projected. (3)

- 3.6 Sketch a velocity-time graph on the graph paper provided for the motion of ball **A** from the time it is projected until it hits the ground and the motion of ball **B**. **Draw the graphs on the same system of axes.**

For ball A: Clearly show the following on your graph:

- The initial velocity
- The time it takes to reach its maximum height
- The time it takes to return to its starting point

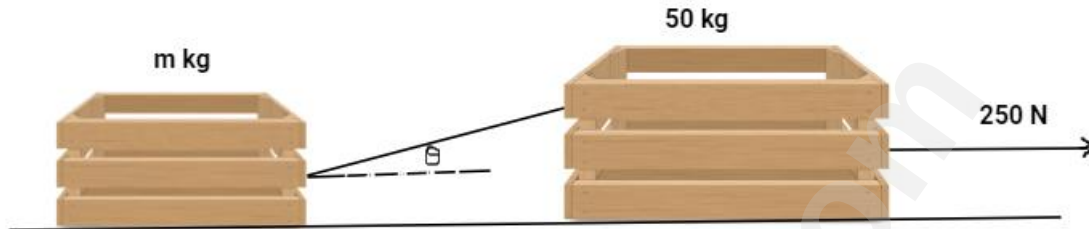
(6)



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Question 4

- 4.1 Two crates of masses **m kg** and **50 kg** resting on a rough horizontal surface are connected by a light, inextensible string as shown in the diagram below.



A force of 250 N is applied on the 50 kg crate resulting in both crates accelerating to the right at $3,6 \text{ m.s}^{-2}$. Both crates experience frictional forces. Crate of mass m kg has a frictional force of 8 N and the 50 kg crate has a frictional force of 27 N.

- 4.1.1 State *Newton's Second Law of Motion*. (2)

- 4.1.2 Draw a labelled free-body diagram indicating all the forces acting on the 50 kg crate as it moves across the surface. (5)

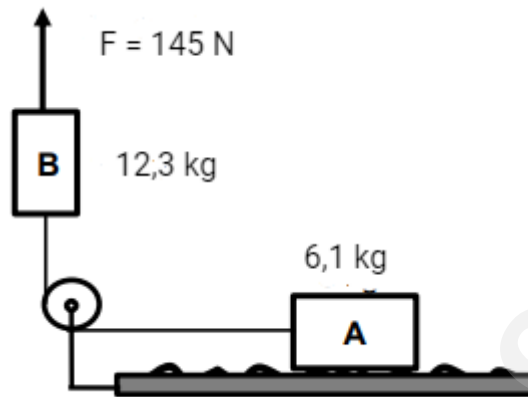
4.1.3 Calculate the magnitude of mass m .

(6)

The coefficient of kinetic friction between the crate with mass m kg and the surface is 0,25.

4.1.4 Calculate the magnitude of the angle (θ) shown in the diagram above. (6)

- 4.2 Block A of mass 6,1 kg is on a rough horizontal board. A light inextensible string is passed over a pulley connecting block A and block B of mass 12,3 kg. A force of 145 N is applied vertically upwards on block B as shown in the diagram below. Ignore the effects of friction due to the pulley.



The coefficient of kinetic friction between the surface and block A is 0,2.

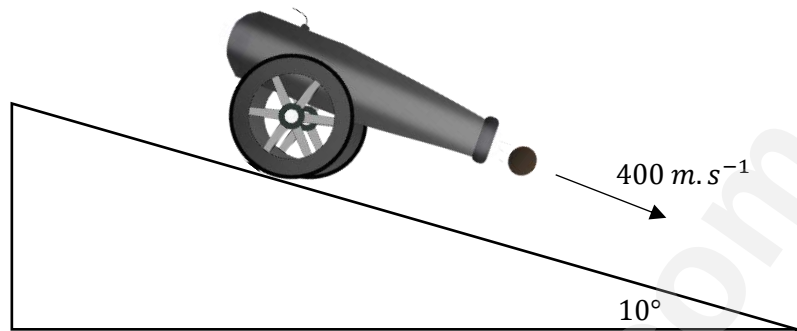
- 4.2.1 Draw a labelled free-body diagram of all the forces acting on block B. (3)

- 4.2.2 Calculate the magnitude of the frictional force acting on block A. (3)

- 4.2.3 Calculate the magnitude of the tension force acting on block B. (6)

Question 5

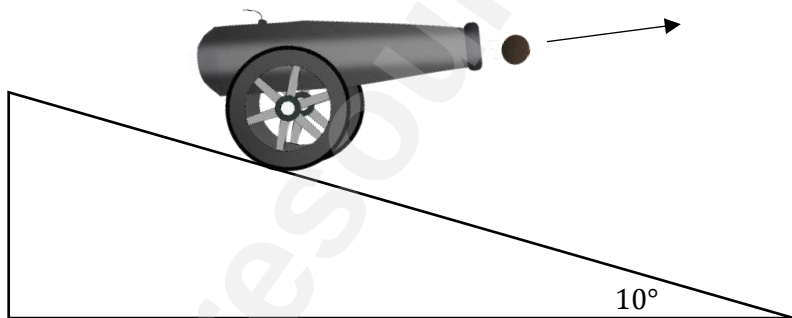
A gun of mass 2 000 kg is in equilibrium on a rough inclined plane at 10° to the horizontal. The gun fires a shell of mass 3 kg down a line parallel to the slope at a velocity of 400 m.s^{-1} .



- 5.1 Calculate the component of the weight parallel to the inclined plane. (2)
- 5.2 Write down the frictional force the gun experiences. (2)
- 5.3 State the *law of conservation of linear momentum*. (2)
- 5.4 Determine the velocity of the gun immediately after the gun is fired. (5)
- 5.5 State the *law of conservation of energy*. (2)

- 5.6 Calculate how far the gun moves up the slope before coming to rest. The kinetic friction on the slope is 2 800 N. (5)

The gun now fires a shell at an angle above the inclined plane.



- 5.7 How will the recoil distance of the gun compare to the answer calculated in question 5.6. Write only increase, decrease or remain the same. (2)

Question 6

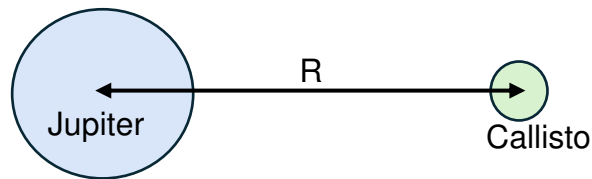
Jupiter is a very large planet with many moons. Refer to the data given below on Jupiter.

Mass of Jupiter: $1,90 \times 10^{27}$ kg

Radius of Jupiter: 69 911 km

- 6.1 Calculate the magnitude of the gravitational field strength, g , at the surface of Jupiter. (4)
- 6.2 Define the term *weight*. (2)
- 6.3 Calculate the magnitude of the weight of a car of mass 1300 kg on the surface of Jupiter. (3)

- 6.4 Jupiter has many moons. One of the moons is Callisto, with a mass of $1,08 \times 10^{23}$ kg. The radius of Callisto is $2,41 \times 10^6$ m. The distance between the centres of Jupiter and Callisto is **R**. The following sketch is NOT to scale.



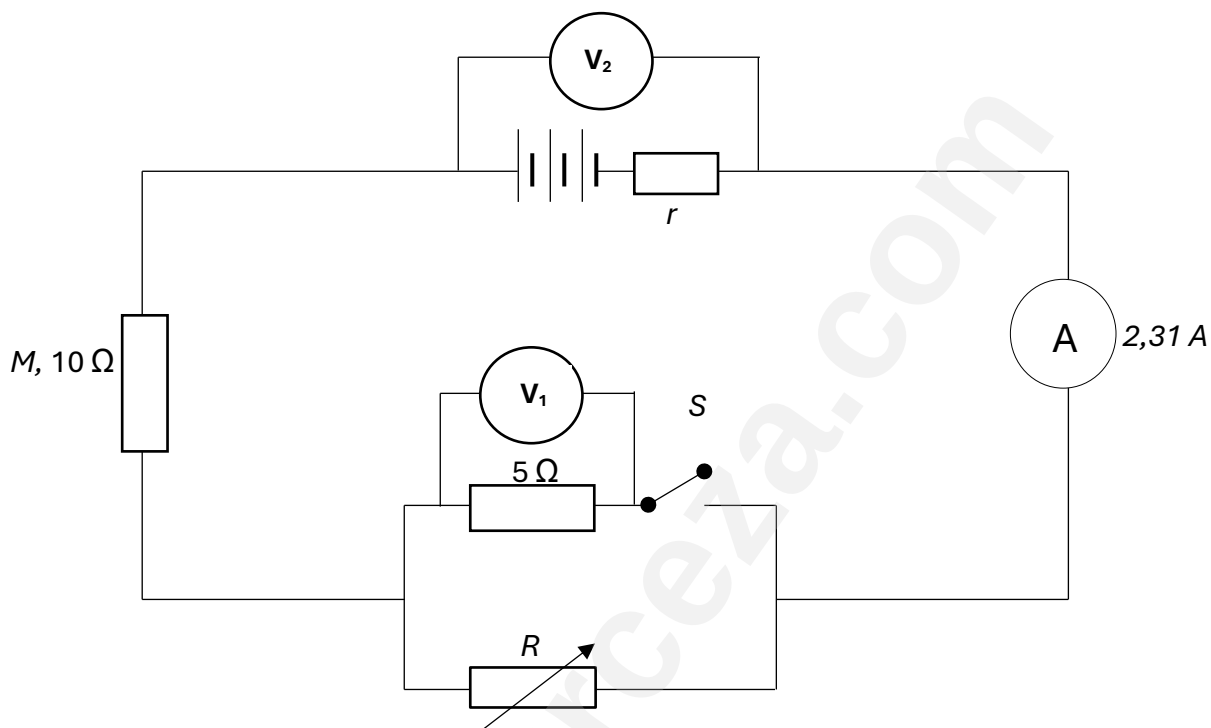
- 6.4.1 State *Newton's Law of Universal Gravitation*. (2)

- 6.4.2 The gravitational force between Jupiter and Callisto is $3,86 \times 10^{21}$ N. Calculate the distance between the **surface** of Callisto and the **surface** of Jupiter. (6)

[17]

Question 7

A circuit consists of a battery with an emf of 30 V and an internal resistance of $1\ \Omega$. A motor, M , a variable resistor (rheostat) R , a $5\ \Omega$ resistor and a switch S are connected as shown below.



The reading on the ammeter is 2,31 A with the **switch open**.

7.1 Define the term *current*. (2)

7.2 Calculate the power dissipated in the motor, M . (3)

7.3 Calculate the resistance at which the rheostat, R is set. (4)

- 7.4 What is the reading on the voltmeter V_1 ? (1)
- 7.5 What is the reading on the voltmeter V_2 ? (2)
- 7.6 Define the term *resistance*. (2)
- 7.7 Suppose the rheostat, R , is now adjusted so that it has a higher resistance. How will the power dissipated in the motor be affected? Explain your answer making reference to a relevant formula. (4)

7.8 The switch is now closed. The rheostat, R , is adjusted so that its resistance is $10\ \Omega$.

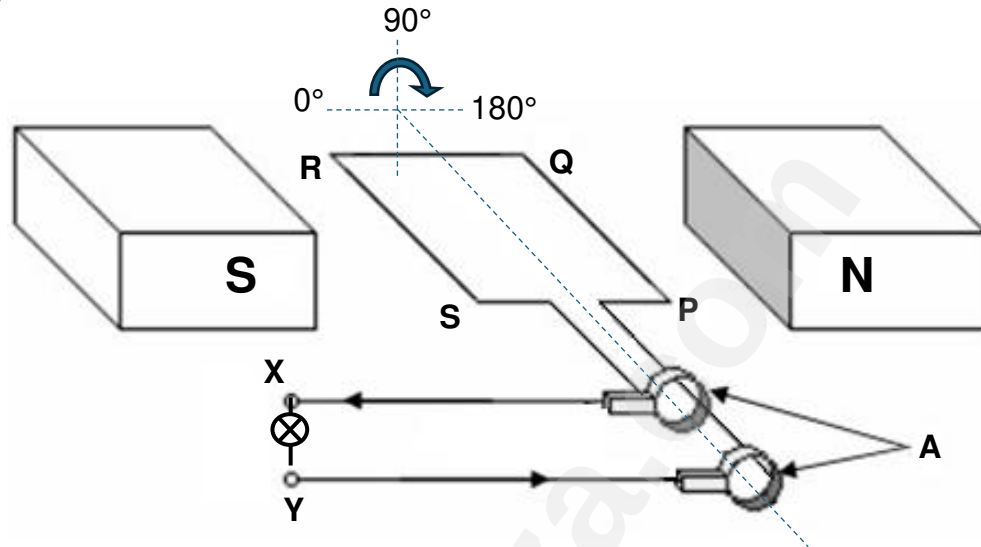
7.8.1 Calculate the reading on the ammeter. (5)

7.8.2 Calculate the reading on the voltmeter, V_1 . (3)

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Question 8

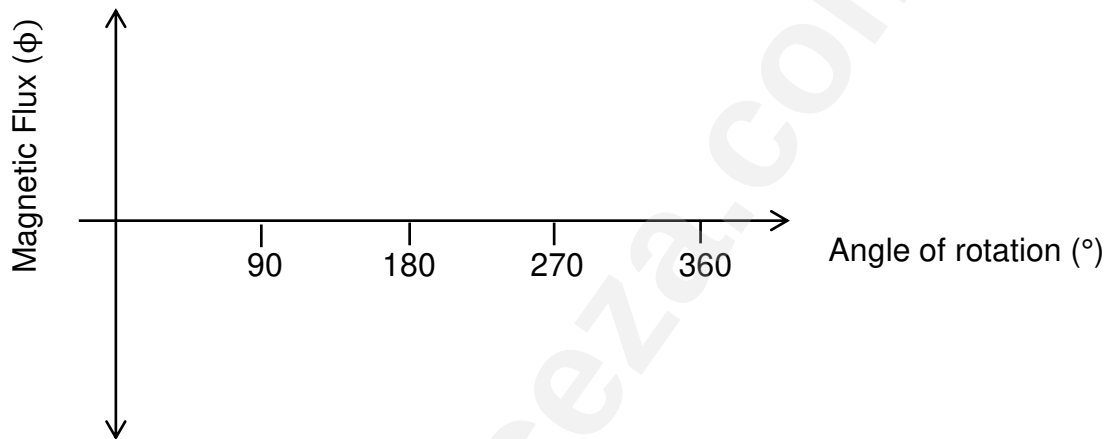
The following diagram represents a simple AC generator. The position of the coil is shown as 0° in the diagram below.



- 8.1 State the energy conversion that takes place in a generator. (1)
- 8.2 The coil is rotated clockwise (RS moves upwards from the position shown). State the direction in which conventional current is induced to flow in the coil. State only PQRS or SRQP. (2)
- 8.3 State the name of the law used to predict the direction of induced current. (1)
- 8.4 Name the part labelled A. (1)
- 8.5 State the function of part A. (2)

8.6 Define magnetic *flux linkage*. (2)

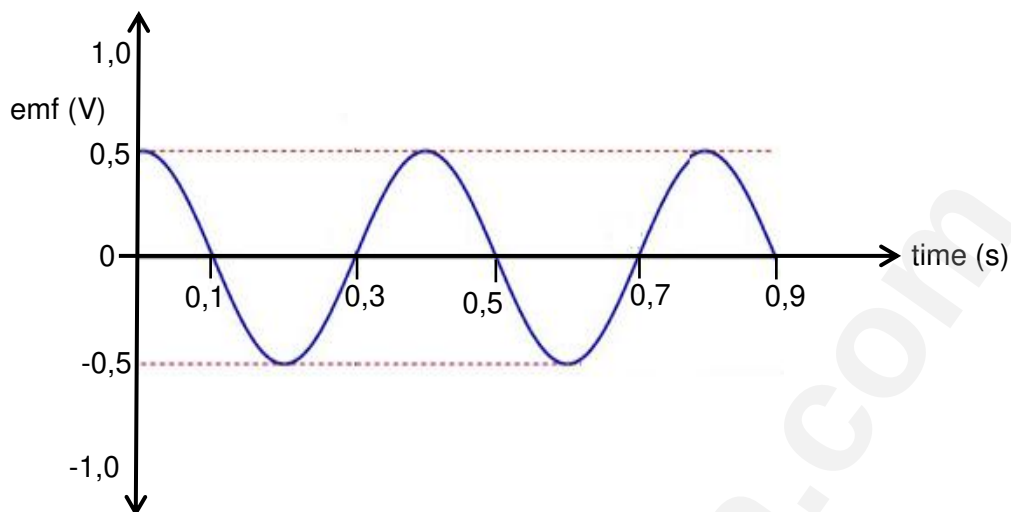
8.7 On the axes provided below, sketch how the magnetic flux (ϕ) through the coil changes as the coil rotates through 360° . The coil begins rotating at 0° , the position shown in the picture above. (2)



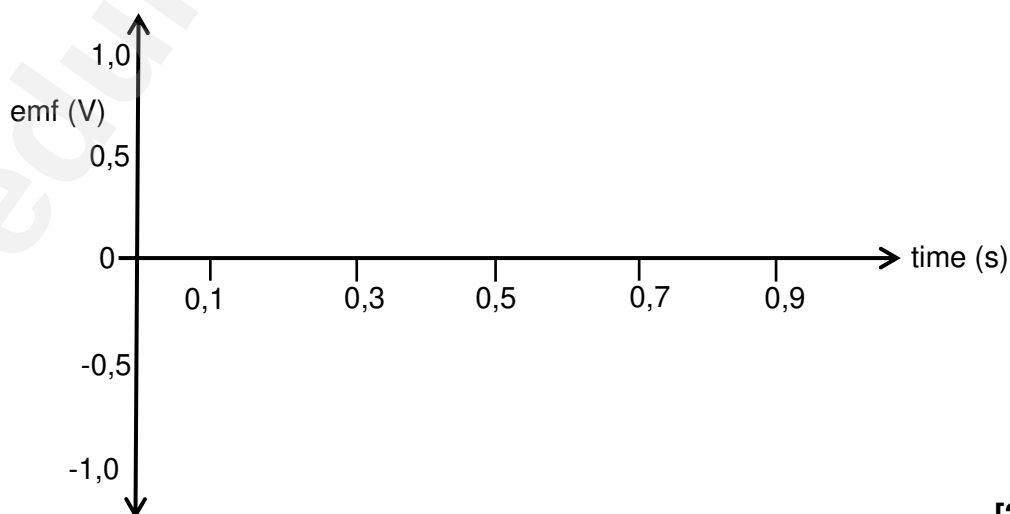
8.8 State *Faraday's Law of electromagnetic induction*. (2)

8.9 Using the concept of magnetic flux, fully explain how rotating the coil induces a current to flow in the coil. (3)

- 8.10 A voltmeter is connected at XY and the following graph shows how the induced emf varies with time when the coil is rotated in a clockwise direction.



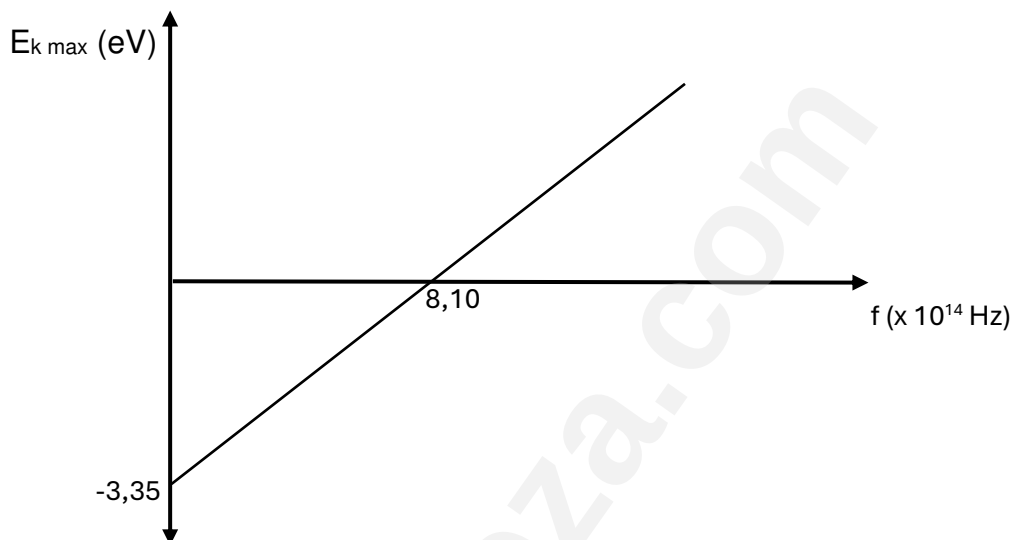
- 8.10.1 How many rotations did the coil make? (1)
- 8.10.2 In what initial position was the coil for the above graph to have been drawn? State only 0° , 90° , 180° , or 270° . (2)
- 8.10.3 Describe what would happen to the graph if the coil was instead rotated in an anticlockwise direction. (2)
- 8.10.4 The same coil is rotated at half the speed in an anticlockwise direction. The coil does one full rotation starting from the same position. On the axes below, draw the graph of the emf versus time. (4)



[25]

Question 9

An experiment investigating the maximum kinetic energy of emitted electrons in the photoelectric effect, as a function of the frequency of incident radiation yields the results shown in the graph below.



- 9.1 Describe the photoelectric effect. (2)
- 9.2 State the threshold frequency of the metal being used in this experiment. (2)
- 9.3 Define the term *work function*. (2)
- 9.4 Determine the work function of the metal in joules. (3)

9.5 Use the graph to show that Planck's constant is $6,6 \times 10^{-34} \text{ J}\cdot\text{s}$. (3)

9.6 Determine, by calculation, whether a photon with wavelength 320 nm would be able to eject an electron from the surface of this metal or not. (4)

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TOTAL MARKS: 200