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ST BENEDICT'S

SUBJECT	Preliminary Examination Paper 1	DATE	4 September 2020
GRADE	12	MARKS	
EXAMINER	Mr du Toit	MODERATOR	Mr McCoy
NAME		DURATION	3 hours
CLASS			

LOW ORDER

HIGH ORDER

INSTRUCTIONS

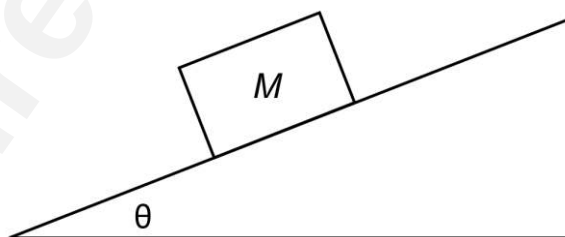
1. This question paper consists of 14 pages, an Answer Sheet of 3 pages and a Data Sheet of 2 pages. Please make sure that your question paper is complete.
2. Answer ALL the questions.
3. Read the questions carefully.
4. Use the data and formulae whenever necessary.
5. **Start each question on a new page.**
6. Show your working in all calculations.
7. Units need not be included in the working of calculations, but appropriate units should be shown in all answers.
8. Express all answers to TWO decimal places unless told otherwise.
9. It is in your own interest to write legibly and to present your work neatly.

Question	1	2	3	4	5	6	7	8	9	10	TOTAL
Total	20	26	19	24	22	19	15	15	24	16	200

QUESTION 1**20 MARKS**

Answer the following multiple-choice questions on your separate ANSWER SHEET. Make a cross (X) in the box corresponding to the letter which you consider to be the most correct.

- 1.1 Which of the following pairs of quantities are BOTH vector quantities?
- A direction and displacement
 - B acceleration and position
 - C charge and electric field intensity
 - D voltage and acceleration
- (2)
- 1.2 Which one of the following statements is TRUE of a body that accelerates uniformly?
- A Its rate of change of position with time remains constant.
 - B Its position changes by the same amount in equal time intervals.
 - C Its velocity increases by the same amount in equal time intervals.
 - D Its velocity increases by increasing amounts in equal time intervals.
- (2)
- 1.3 A hot-air balloon was rising vertically upward at a constant speed of $4 \text{ m}\cdot\text{s}^{-1}$ when a passenger's binoculars fell overboard. The binoculars, when viewed from the ground, will ...
- A initially remain suspended and eventually fall to the ground.
 - B initially rise, then fall downwards.
 - C immediately begin to fall downwards with a constant acceleration of $9,8 \text{ m}\cdot\text{s}^{-2}$.
 - D fall to the ground with a constant speed of $4 \text{ m}\cdot\text{s}^{-1}$.
- (2)
- 1.4 An object with mass M is at rest on a rough incline as shown below. The angle of the slope is set to θ which is the angle just before the block is about to slide down. The coefficient of static friction is μ .



Which of the following pair of expressions can be used to calculate the maximum static frictional force experienced by the object?

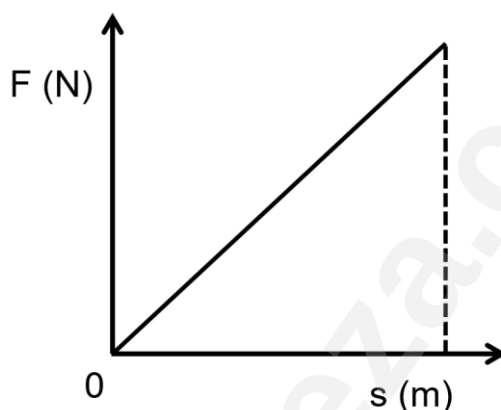
A	$Mg \cos\theta$	or	$Mg \sin\theta$
B	$Mg \cos\theta \times \mu$	or	$Mg \sin\theta \times \mu$
C	$Mg \cos\theta \times \mu$	or	$Mg \sin\theta$
D	$Mg \cos\theta$	or	$Mg \sin\theta \times \mu$

(2)

- 1.5 A force of 58 N is applied to a 4 kg box to slide it 10 m along a horizontal, rough surface with a friction force of 2 N. How much work is done to overcome gravity?
- A 39,2 N.m
 B 392 N.m
 C 0 N.m
 D 560 N.m

(2)

- 1.6 Consider the following graph below.



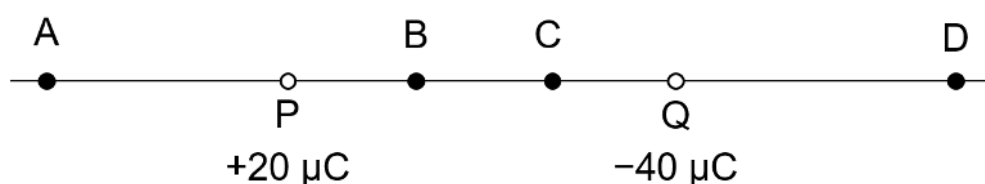
What physical quantity does the area under the graph represent?

- A work
 B impulse
 C momentum
 D velocity
- 1.7 The mass of a planet is twice that of Earth. Its radius is half that of the radius of Earth. The gravitational field strength at the surface of Earth is g . What is the gravitational field strength at the surface of the planet?
- A $\frac{1}{2}g$
 B g
 C $2g$
 D $8g$

(2)

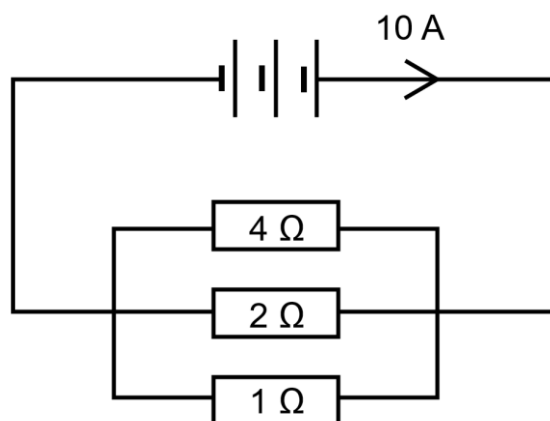
(2)

- 1.8 The following diagram, not drawn to scale, shows two point charges, P and Q. At which position could the electric field equal to zero?



(2)

1.9 The current in a cell is 10 A has shown.

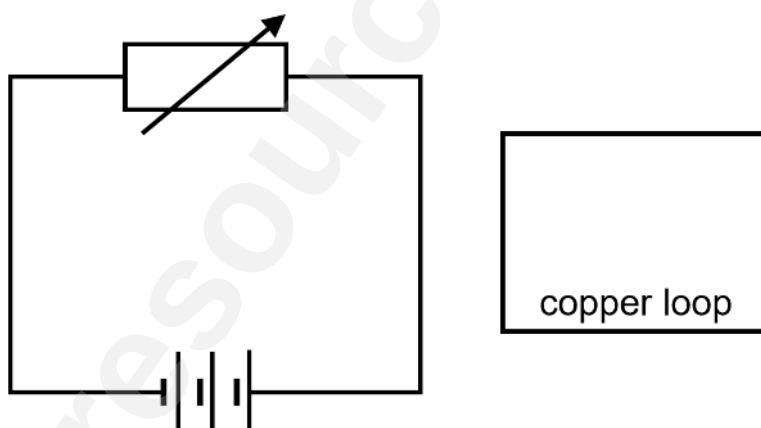


What is the current in the 2 Ω resistor?

- A 0,35 A
- B 2,86 A
- C 3,50 A
- D 7,14 A

(2)

1.10 A circuit shown below is position next to a loop of copper loop.



Which of the following correctly describes the flux and the direction of the induced current in the copper loop when the resistance of the variable resistor decreases?

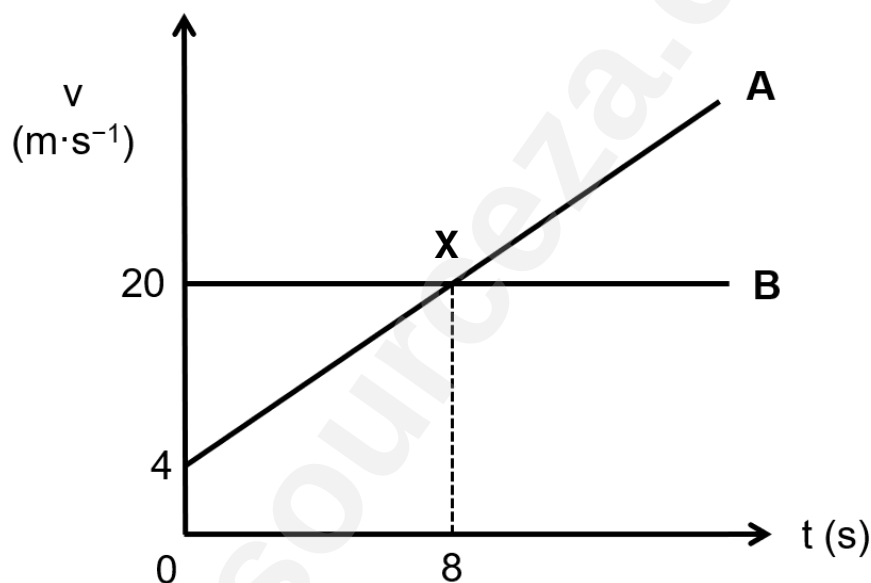
	Flux in copper loop	Direction of induced current in copper loop
A	Into the page	Clockwise
B	Into the page	Anticlockwise
C	Out of the page	Clockwise
D	Out of the page	Anticlockwise

(2)

QUESTION 2**26 MARKS**

- 2.1 Jared runs 4 km from point A on a bearing of 0° to point B and then 2 km on a bearing of 90° to point C.
- 2.1.1 Define *resultant vector*. (2)
- 2.1.2 Draw a fully labelled vector addition diagram to show Jared's journey from A to B to C and his resultant displacement. Your diagram must show the resultant vector and all relevant angles. (4)
- 2.1.3 Determine Jared's resultant displacement in kilometres. (4)
- 2.1.4 If the journey from A to C took 30 minutes, calculate:
- a) the magnitude of Jared's average velocity in $\text{m}\cdot\text{s}^{-1}$. (3)
- b) Jared's average speed in $\text{km}\cdot\text{h}^{-1}$. (3)

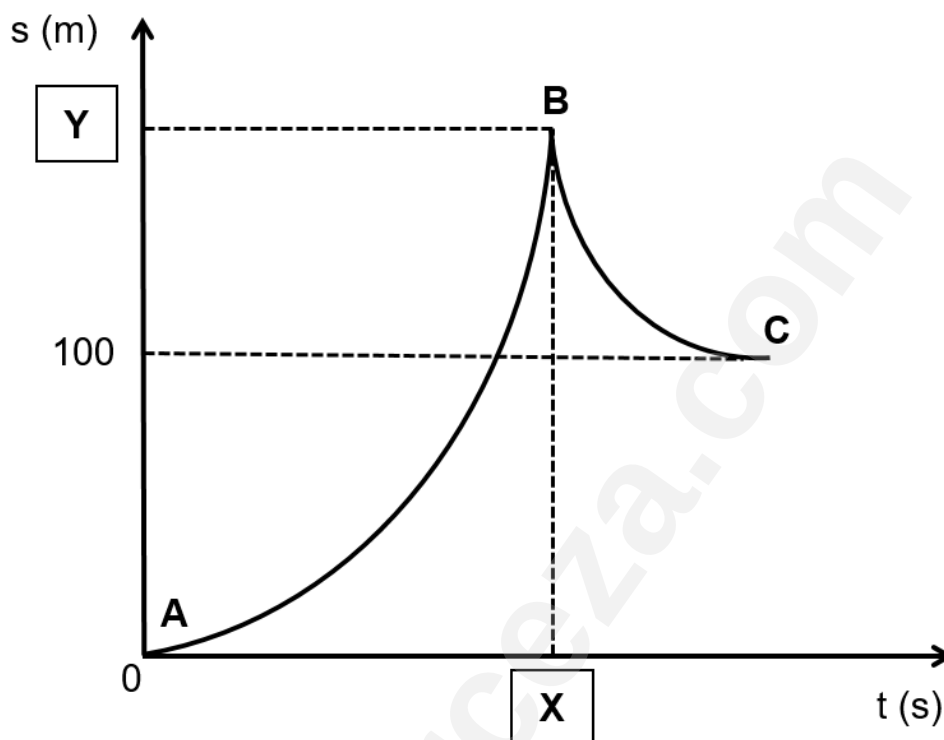
- 2.2 The following velocity-time graph shows the motion of two cars, A and B.



- 2.2.1 Define *velocity*. (2)
- 2.2.2 The two graphs intersect at point X. What can you conclude about the cars at this point? (1)
- 2.2.3 At what distance after time zero will car A catch up to car B? (7)

QUESTION 3**19 MARKS**

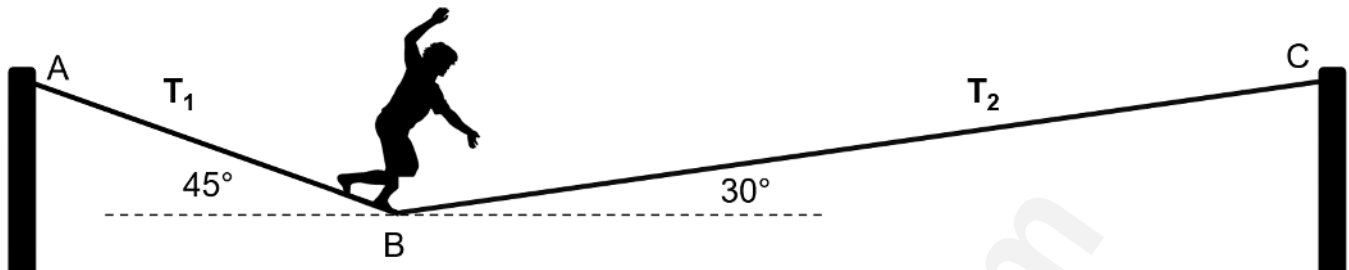
A child throws a ball vertically downwards from a window of a high building with an initial velocity of $15 \text{ m}\cdot\text{s}^{-1}$ at point A. It strikes the ground travelling at $55 \text{ m}\cdot\text{s}^{-1}$ at point B and bounces up off the ground to an unknown maximum height at point C as shown on the following position time graph below. Ignore the effects of air resistance.



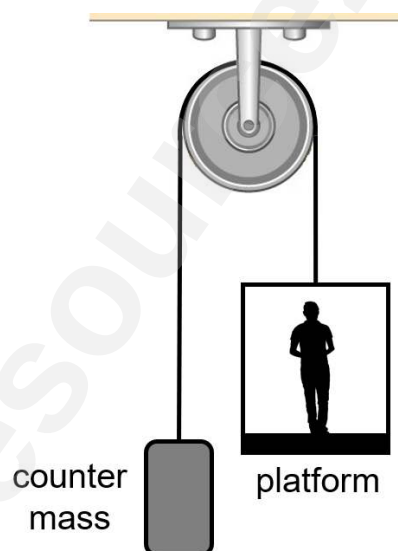
- 3.1 Describe the motion of the ball from A to B. (2)
- 3.2 Calculate the value of X on the graph. (3)
- 3.3 Calculate the value of Y on the graph. (3)
- 3.4 Hence, determine the maximum height that the ball reaches above the ground after the bounce. (2)
- 3.5 Describe the feature of the graph that indicates that, at point C, the ball is at maximum high above the ground after the bounce. (2)
- 3.6 Is the collision of the ball with the floor ELASTIC or INELASTIC?
Give a reason for your answer by referring the graph above. (2)
- 3.7 Draw a velocity versus time sketch graph for the motion of the ball from A to C taking down as positive. You must include only known values on this graph and the relative sizes of the velocity values on your graph must be correct. (5)

QUESTION 4**24 MARKS**

- 4.1 A 70 kg circus performer rests at point B on a rope ABC as shown below. BA and BC slope up from the horizontal at 45° and 30° respectively. BA experiences tension T_1 and BC experiences a tension of T_2 . The system is in equilibrium.



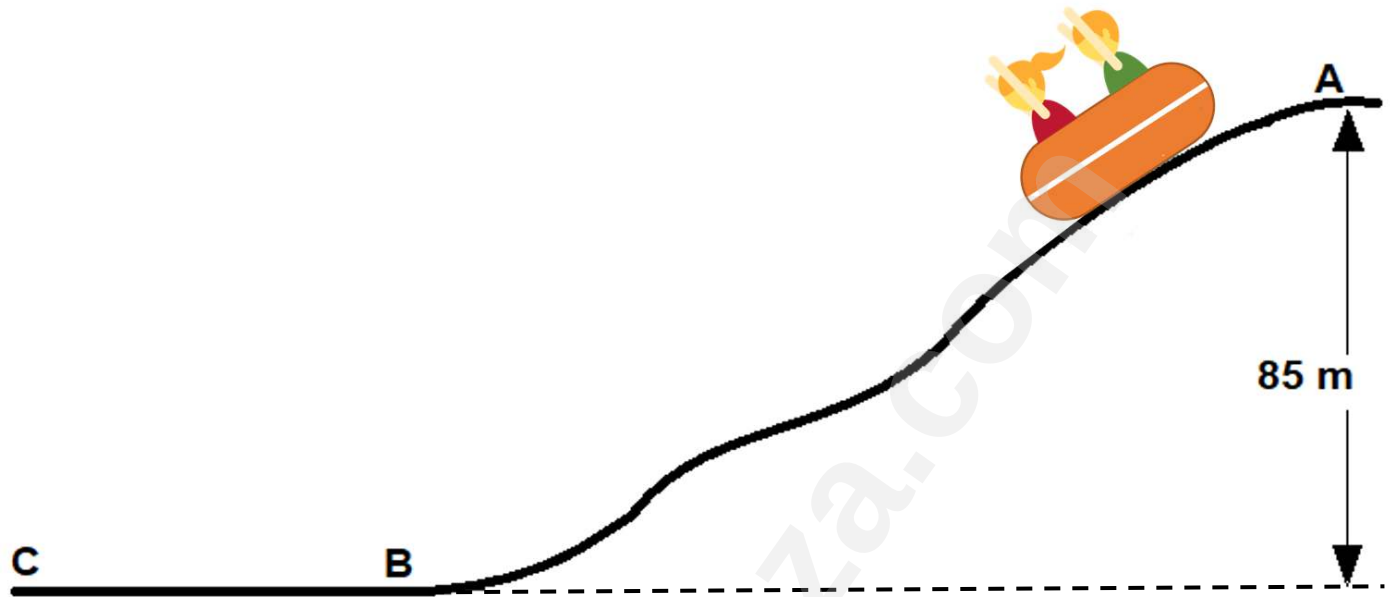
- 4.1.1 Define *weight*. (2)
- 4.1.2 Calculate the weight of the performer. (3)
- 4.1.3 Draw a free body diagram showing all the forces acting on the rope at point B. (3)
- 4.1.4 Calculate the magnitude of the tension in T_2 . (6)
- 4.2 The 70 kg performer is eager to get back on the ground after his performance. He stands on a lift platform connected to counter mass of 60 kg by a massless and inextensible rope that is passed over a pulley as shown. The lift platform and the man have combined mass of 100 kg and accelerates downwards.



- 4.2.1 State *Newton's second law*. (2)
- 4.2.2 Prove that the magnitude of the acceleration of the system is $2,45 \text{ m}\cdot\text{s}^{-2}$. (4)
- 4.2.3 Calculate the normal force of the platform on the man as the system accelerates downwards. (4)

QUESTION 5**22 MARKS**

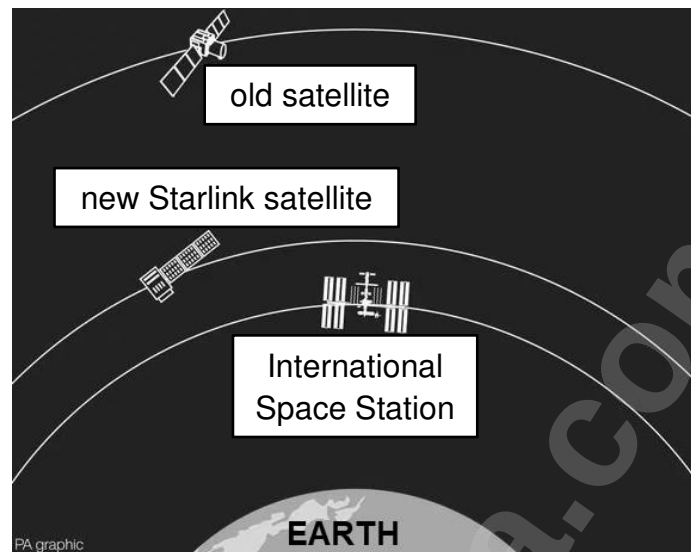
James (mass 70 kg) and Sofie (mass 55 kg) are at a water theme park. Their favourite slide is an 85 m high tube slide. The last part of the slide is a flat, horizontal section between points B and C that is designed to bring them to a standstill. The coefficient of kinetic friction between the tube and the slide from point A to C is 0,13.



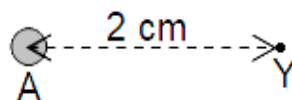
- 5.1 Define *gravitational potential energy*. (2)
- 5.2 If the mass of the tube is 5 kg, calculate the total gravitational potential energy of James, Sofie and the tube at point A. (3)
- 5.3 If James and Sofie start at rest at point A and reach point B with a velocity of $16,67 \text{ m}\cdot\text{s}^{-1}$, determine the work done by friction along the slide from A to B. (4)
- 5.4 State the *work-energy theorem*. (2)
- 5.5 Use the work-energy theorem to determine the minimum distance of slide needed between points B and C to bring James, Sofie and the tube to a standstill. Give your answer to the nearest metre. (5)
- 5.6 James and Sofie go down the slide again and collide at point B with Joe who went down the slide just before them. At the time of the collision Joe was moving with a velocity of $10 \text{ m}\cdot\text{s}^{-1}$. They all attach and move together after the collision with a velocity of $14,03 \text{ m}\cdot\text{s}^{-1}$. Determine Joe's mass if he also has a 5 kg tube. (6)

QUESTION 6**19 MARKS**

- 6.1 SpaceX launched its seventh batch of Starlink satellites on a Falcon 9 rocket in April, growing its internet constellation to 422 satellites in low Earth orbit. The diagram shows one new Starlink satellite in orbit relative to other objects in Earth's orbit.



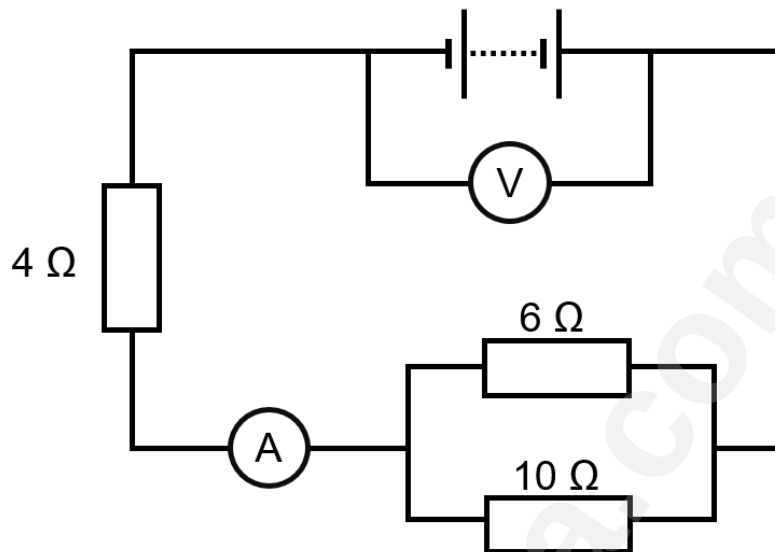
- 6.1.1 State *Newton's law of Universal Gravitation*. (2)
- 6.1.2 The distance between a Starlink Satellite and the International Space Station is 140 km. Calculate the force that they exert on each other when the mass of the International Space Station is 420 000 kg and the mass of a Starlink Satellite is 240 kg. (4)
- 6.1.3 A student makes the following incorrect statement:
"The gravitational field experienced by the old satellite is the same as the gravitational field experienced by a new Starlink Satellite because even though it is further away from the surface of the Earth its mass is greater."
Correct the statement made by the student. (3)
- 6.1.4 Stainless steel bolts are used as fasteners on satellites. One such bolt has a mass of 30 grams. Compare the mass and weight of this bolt when the Starlink satellite is in space and on Earth. (2)
- 6.2 A charged sphere A holding a charge of $-10\ \mu\text{C}$, is held in a fixed position on a horizontal, insulated surface, 2 cm away from point charge Y.



- 6.2.1 Define *electric field*. (2)
- 6.2.2 Draw the electric field line pattern around charge A. (2)
- 6.2.3 Calculate the magnitude of the electric field experienced by point charge Y. (4)

QUESTION 7**15 MARKS**

A circuit that consists of a battery with an emf of 26 V and an unknown internal resistance, three resistors, an ammeter and a voltmeter is set up as shown in the diagram below.



7.1 Define *resistance*. (2)

7.2 Calculate the effective resistance of the circuit. (3)

The ammeter measures a current of 3 A with the circuit connected as shown.

7.3 Determine the internal resistance of the battery. (3)

Sometimes resistors burn out while in operation

7.4 Describe what would happen to the reading on the voltmeter if the 6 Ω resistor burnt out. Use a suitable equation in your answer. (4)

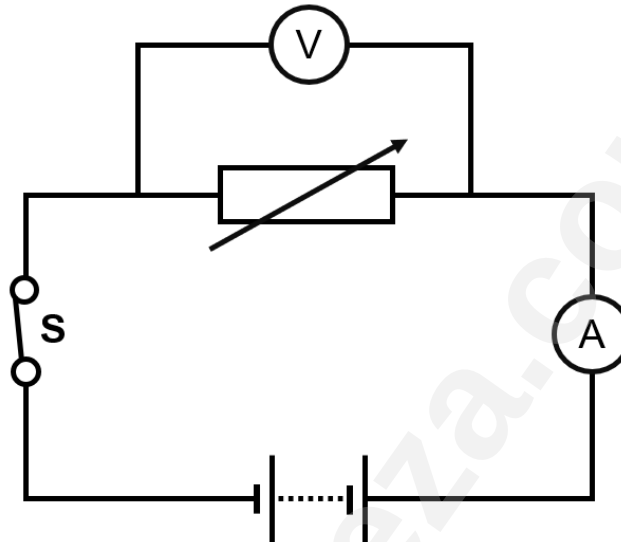
7.5 Predict what the reading on the voltmeter would be if the 4 Ω resistor burnt out. Briefly explain your answer. (3)

QUESTION 8

15 MARKS

COMPLETE ALL OF QUESTION 8 ON THE ANSWER SHEET

A group of learners conduct an investigation to determine the emf ($\mathcal{E}$) and internal resistance (r) of a battery. They connect a battery to a rheostat (a variable resistor), an ammeter and a voltmeter as shown below. Assume that the resistance of the ammeter and connecting wires is negligible.



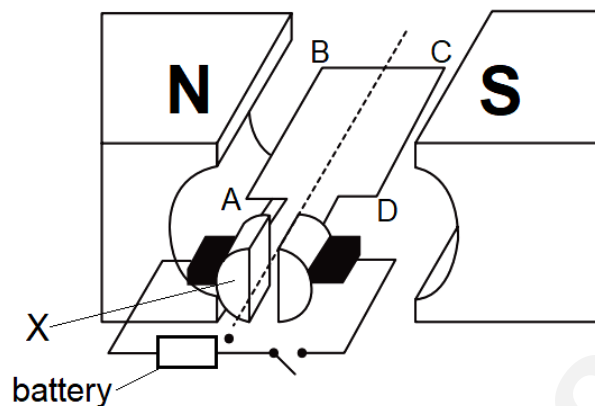
In this investigation the resistance of the rheostat is changed and the readings on the voltmeter and the ammeter are recorded in the table below:

Reading on ammeter (A)	Reading on voltmeter (V)
0,58	2
0,46	3
0,36	4
0,24	5
0,14	6

- 8.1 Define *emf*. (2)
- 8.2 Using the information in the table above, plot the points and draw the line of best fit on graph paper. The x-axis has been scaled and labelled for you. (5)
- 8.3 Rearrange the formula $\mathbf{emf = V_{load} + Ir}$ into the straight line formula to match the quantities plotted on each axis of your graph in QUESTION 8.2. (2)
- 8.4 Hence, use the graph drawn in QUESTION 8.2 to determine the following:
 - 8.4.1 the emf ($\mathcal{E}$) of the battery. (2)
 - 8.4.2 internal resistance (r) of the battery. (4)

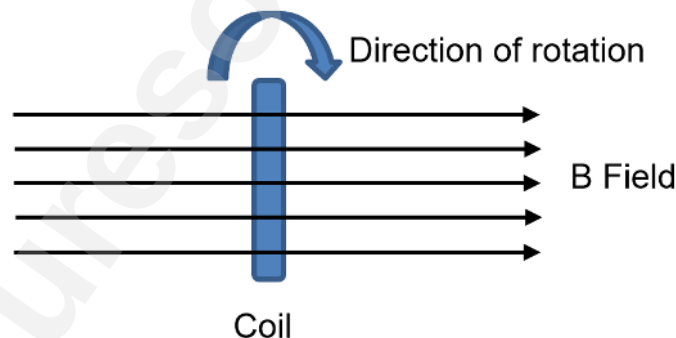
QUESTION 9**24 MARKS**

9.1 The simplified diagram below represents an electric motor.



- 9.1.1 State the energy conversion that takes place in the above motor. (2)
- 9.1.2 Give the name of the component labelled X and give its function. (2)
- 9.1.3 The switch is closed. If the loop turns in a clockwise direction, in which direction is the current in section AB of the loop flowing in the above diagram? Write down A to B, or from B to A only. (2)
- 9.1.4 The force experienced by a current-carrying loop can be influenced by different factors. State how the angle between the current and the magnetic field will influence the force experienced by section AB as the loop is rotated. Refer to the appropriate equation in your answer. (4)

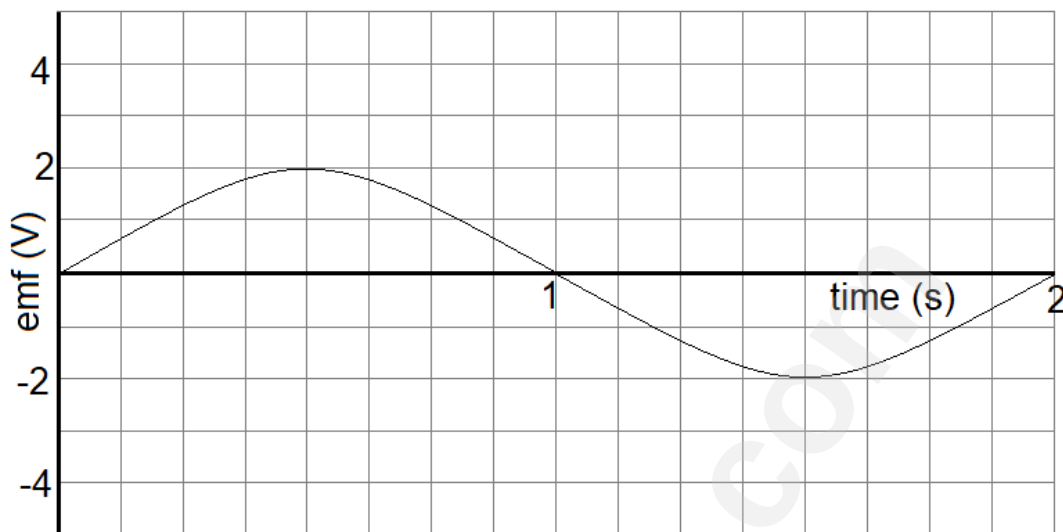
9.2 The diagram below shows a single loop of copper wire being rotated in a region of uniform magnetic field about a horizontal axis, this forms part of a small AC generator.



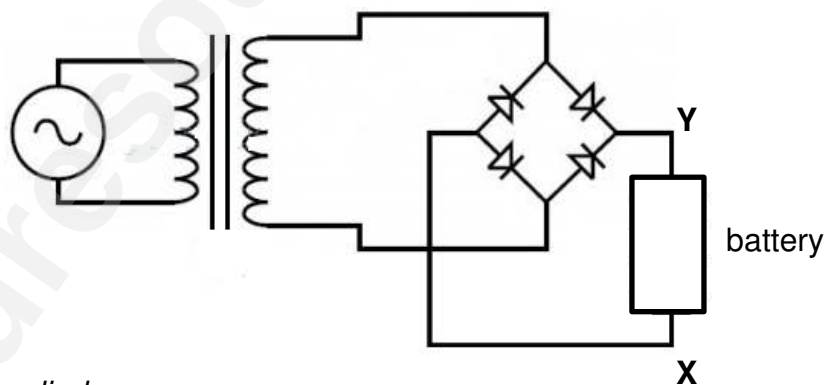
The magnitude of the magnetic field strength is B and the area of the loop is A .

- 9.2.1 Define *magnetic flux linkage*. (2)
- 9.2.2 State the maximum value (in terms of B and A) of magnetic flux in the loop when it is in the position shown above. (2)
- 9.2.3 Name the electrical component that should be used to connect the loop to the external circuit. (1)

- 9.2.4 The following graph shows the change in the induced emf against time when the loop of copper wire is rotated through the uniform magnetic field when the generator is operating.



- a) Use the given induced emf vs. time graph and sketch the corresponding magnetic flux vs. time graph on the set of axes provided on your answer sheet. (2)
- b) The induced emf is increased when the loop of copper wire is rotated faster. Explain why the maximum induced emf changes by naming and referring to the appropriate law. (3)
- 9.2.5 The generator is used to charge a battery. To successfully charge the battery a step-up transformer and a rectifier should be used as shown in the diagram.



- a) Define *diode*. (2)
- b) In which direction will the current follow in the battery. State either from X to Y or Y to X (2)

QUESTION 10**16 MARKS**

10.1 In a demonstration experiment of the photoelectric effect, incident light of a frequency of $6,81 \times 10^{14}$ Hz shone on a clean metal surface causes electrons to be emitted. The threshold frequency of the metal is $5,45 \times 10^{14}$ Hz.

10.1.1 Define *threshold frequency*. (2)

10.1.2 Calculate the maximum speed of the emitted electrons in the experiment. (5)

10.1.3 The intensity of the 440 nm light is increased. State what happens to each of the following: (State only INCREASES, DECREASES or REMAINS THE SAME)

a) the number of photoelectrons emitted. (2)

b) the maximum kinetic energy of the photoelectrons. (2)

10.2 The following image shows the three lowest energy levels of an atom labelled $n = 1$, 2 and 3



Electron transitions between these energy levels can produce three different wavelengths of radiation.

Transition	Wavelength (nm)
$n = 2$ to $n = 1$	440
$n = 3$ to $n = 2$	590
$n = 3$ to $n = 1$	?

Calculate the wavelength in nanometres of the photons emitted by the transition from $n = 3$ to $n = 1$. (5)

END OF EXAMINATION