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DEPARTMENT OF PHYSICAL SCIENCE

PRELIMINARY EXAMINATIONS 2017 GRADE 12 PHYSICAL SCIENCE PAPER I: PHYSICS

Date: Saturday 8 July 2017
Examiner: Mr FC Gray
Moderator: Ms L Swanepoel
Maximum time: 3 hours (+10 minutes reading time) **Marks:** 200

Name: _____

Instructions:

1. Read the questions carefully.
2. This question paper consists of **15 pages**.
3. Answer ALL the questions in the **Answer Booklet** provided.
4. **START EACH QUESTION ON A NEW PAGE.**
5. It is in your own interest to write legibly and to present your work neatly.
6. Ensure that the numbering of your answers is correct.
7. Show all your working, where necessary.
8. A data sheet is provided which may be used to assist you in answering the questions.
9. All answers should be given to 2 decimal places.

QUESTION 1**MULTIPLE CHOICE**

Use the multiple choice answer sheet on **page 4** of your answer booklet to answer this question. Place a cross over the letter which corresponds to the most correct answer.

1.1 Which of the following are vector quantities?

- (i) Electric field intensity
- (ii) Acceleration
- (iii) Kinetic energy
- (iv) Change in momentum

- A (ii) only
- B (i) and (ii) only
- C (ii) and (iv) only
- D (i), (ii) and (iv) only

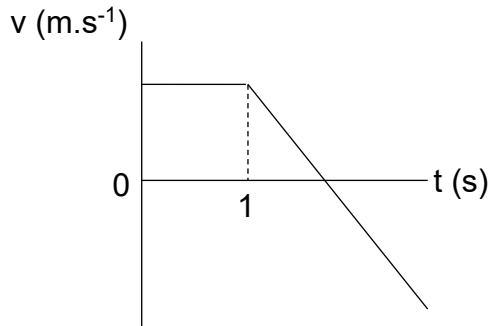
1.2 Which of the following units is NOT equivalent to the Joule (J)?

- A N.m
- B N.s
- C W.s
- D V.C

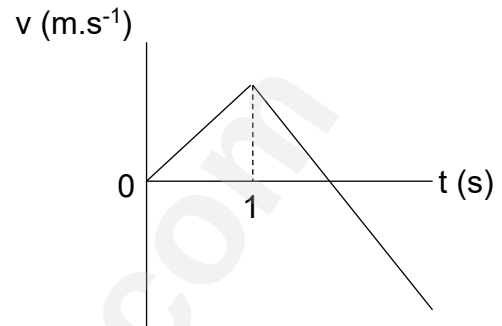
1.3 The resultant force acting on an object is equal to the ...

- A rate of change of momentum of the object
- B change in momentum of the object
- C acceleration of the object
- D mass of the object

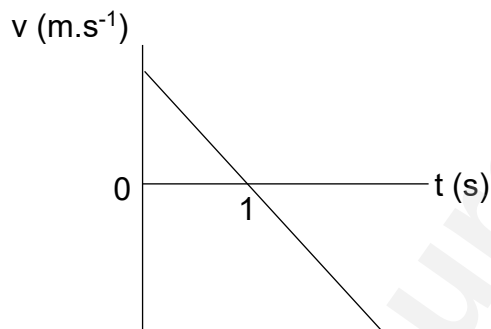
- 1.4 A student throws a ball vertically upwards. The ball is in contact with her hand for 1 s while she throws it. Ignore air resistance. Which of the following is the most likely velocity versus time graph for the motion of the ball during the throw and after it has left her hand.



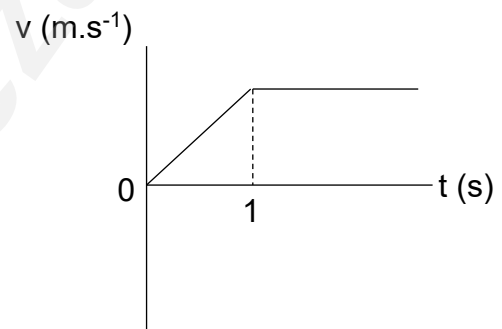
A



B



C

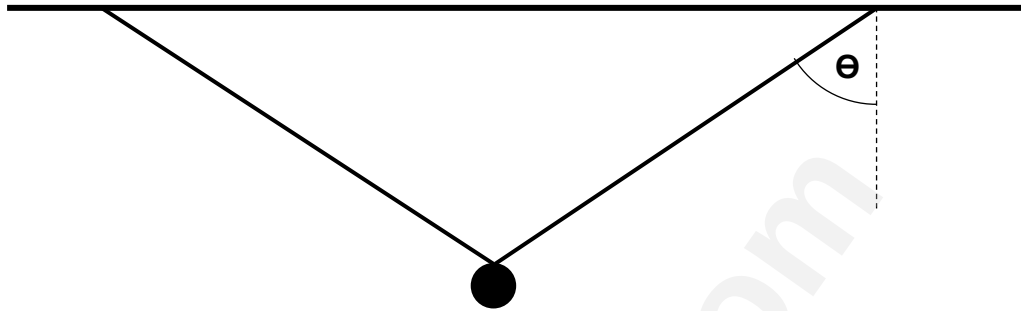


D

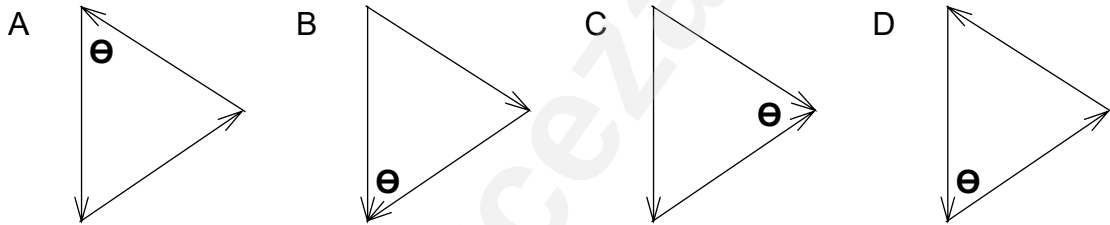
- 1.5 A horizontal force $\mathbf{F}$ is applied to an object of mass $\mathbf{m}$ along a frictionless horizontal surface, which produces an acceleration $\mathbf{a}$. What is the acceleration of an object of half the mass, which experiences a force of $2\mathbf{F}$?

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

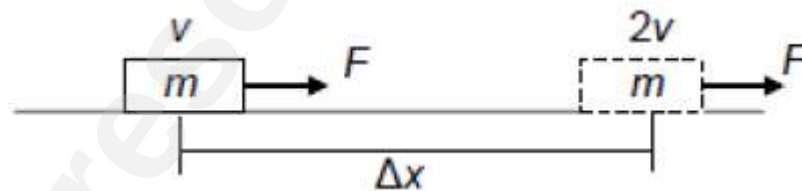
- 1.6 An object hangs from two strings attached to the ceiling. One of the strings makes an angle θ to the vertical as shown in the diagram below.



Which of the following vector diagrams correctly represents the forces acting on the hanging object?

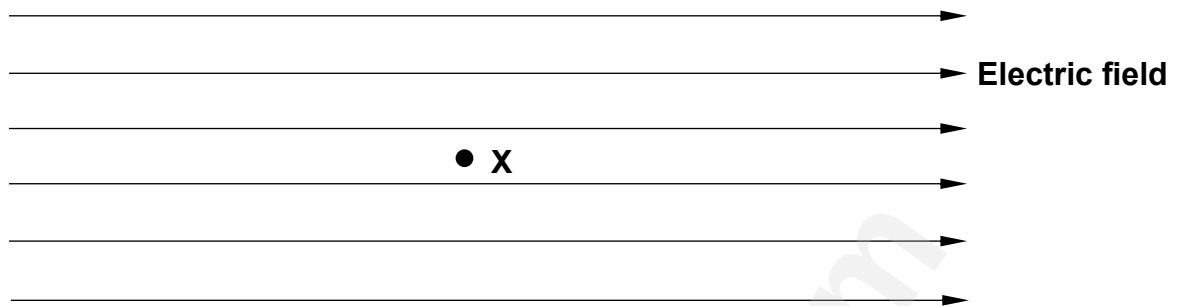


- 1.7 An applied force F accelerates an object of mass m on a horizontal frictionless surface from a velocity v to a velocity $2v$. What is the work done on the object by this force?



- A $\frac{1}{2}mv^2$ B mv^2 C $\frac{3}{2}mv^2$ D $2mv^2$

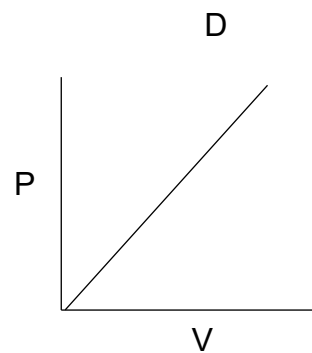
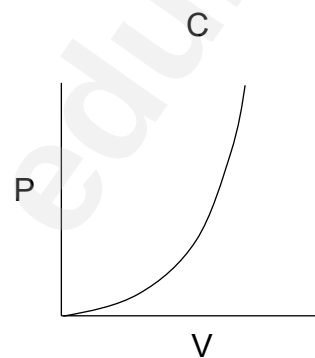
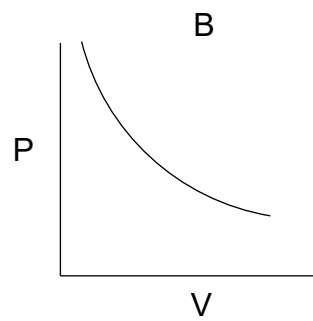
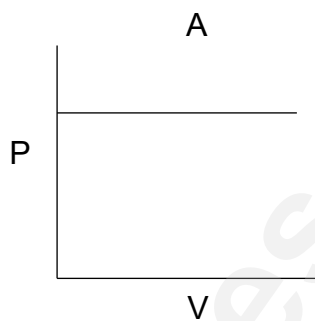
1.8 The diagram below shows a uniform electric field.



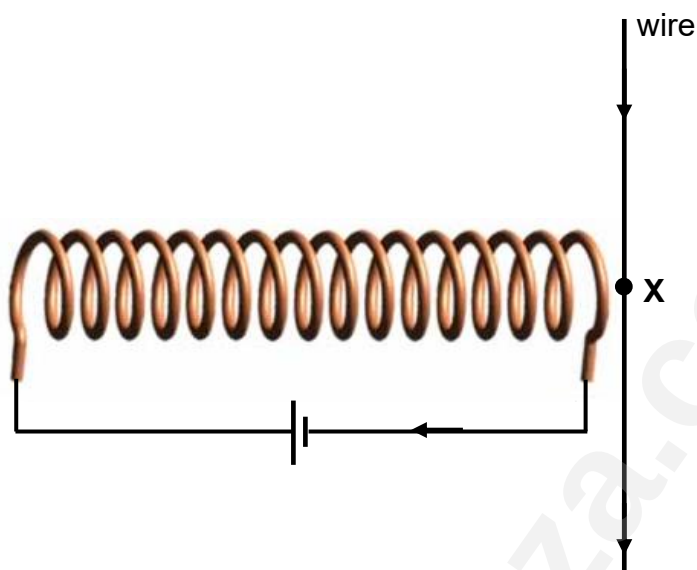
An electron is placed at point **X**. In which direction will the electron move?

- A To the right
- B To the left
- C Out of the page
- D Into the page

1.9 Which ONE of the following graphs best represents the relationship between the electrical power and the potential difference across a given ohmic conductor?



- 1.10 A solenoid is placed next to a straight wire. When both the solenoid and the wire carry an electric current, a force is exerted on the wire. The directions of the currents are shown by arrows on the diagram. The point **X** lies on the axis of the solenoid.



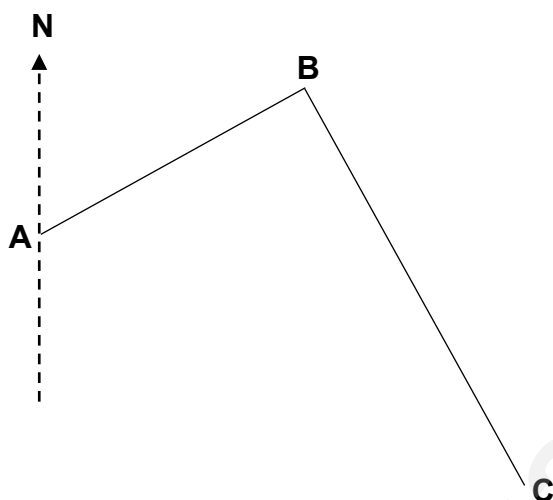
Which one of the following best describes the direction of the magnetic field due to the solenoid and the force on the wire at point **X**?

	Magnetic field direction due to solenoid at X	Direction of force on wire at X
A	Left	Into page
B	Right	Out of page
C	Right	Into page
D	Left	Out of page

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QUESTION 2 KINEMATICS

A stationary police car sets off from **A** in pursuit of a criminal on a motor bike.



The police car travels 2 km **north-east** (bearing 45°) for 80 s along a straight road before turning sharply at **B** and travelling 3 km **south-east** (bearing 135°) for 90 s along another straight road before coming to a stop at **C**.

- 2.1 Define a *resultant vector*. (2)
- 2.2 How far **east** is the police car from **A**, after 80 s? (2)
- 2.3 Using a neat, fully labelled vector diagram, determine the resultant displacement of the police car for the entire trip. (5)
- 2.4 Define *speed*. (2)
- 2.5 Calculate the average speed of the police car for the entire trip (in $\text{m}\cdot\text{s}^{-1}$). (3)
- 2.6 Calculate the magnitude of the average velocity of the police car for the entire trip (in $\text{m}\cdot\text{s}^{-1}$). (3)
- 2.7 Distinguish between average velocity and instantaneous velocity. (2)
- 2.8 Consider the motion of the police car **after** it has turned the corner at **B**. Draw the most likely position versus time graph for its motion from the corner until it stops. Take the corner as the reference point. Time and position values are not required. (4)
- 2.9 Describe the motion of the police car as shown by your graph in question 2.8. (2)

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QUESTION 3 KINEMATICS

Students set out to verify the value for the acceleration due to gravity on Earth.

They used a drone to drop a ball (**from rest**) from various heights above the ground.

Video analysis of each drop was used to measure the velocity with which the ball hit the ground.

The following data was collected:



Height Δx (m)	Final velocity v_f (m.s ⁻¹)	Final velocity squared v_f^2 (m ² .s ⁻²)
5	9,90	
10	14,0	
15	16,8	
20	19,4	
25	21,7	
30	23,7	
35	25,4	

- 3.1 Define *acceleration*. (2)
- 3.2 Complete the table on **page 4** of your answer booklet by filling in the last column (to the nearest whole number). (3)
- 3.3 Explain what is meant by a *dependent* variable. (2)
- 3.4 Plot a graph of final velocity squared (v_f^2) versus height (Δx) on the graph paper provided on **page 5** of your answer booklet. (6)
- 3.5 Use your graph to state the relationship between the plotted variables. (2)
- 3.6 Calculate the gradient of your graph on **page 5** of your answer booklet (underneath your graph). **Clearly** mark the two points that you used on your graph. Provide a **unit** for your answer. (4)
- 3.7 Use your answer to question **3.6**, the equation for a straight line ($y = mx + c$) and the equation of motion ($v_f^2 = v_i^2 + 2a\Delta x$) to determine the acceleration due to gravity. (4)
- 3.8 Explain why the value for g calculated from this investigation is less than the accepted value of g (9,8 m.s⁻²). (2)

QUESTION 4 NEWTON'S LAWS

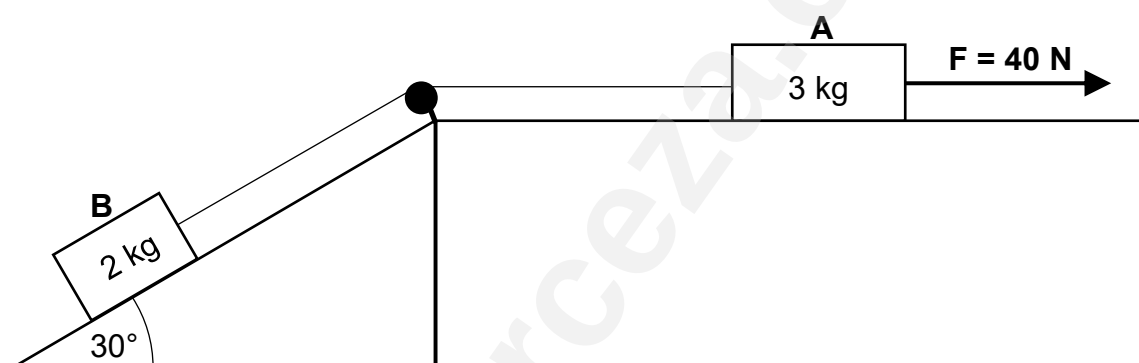
4.1 State *Newton's first law of motion*. (2)

4.2 A teacher is walking along the corridor carrying a full cup of coffee, when a student runs in front of her. She stops suddenly and spills her coffee.

Use Newton's first law to explain why the coffee spills forwards when the teacher suddenly stops.



4.3 Consider the diagram shown below.



Block **A** (3 kg) and block **B** (2 kg) are attached by means of a thin chord that doesn't stretch. The chord is passed over a frictionless pulley.

A horizontal force **F** of 40 N is applied to block **A**.

Block **A** slides along a rough horizontal surface and block **B** slides up a rough plane inclined at 30° to the horizontal. Block **A** experiences a frictional force of 14,7 N.

4.3.1 Draw fully labelled free-body diagram for block **B**. (4)

4.3.2 Calculate the magnitude of the frictional force acting on block **B** if the coefficient of kinetic friction is 0,5. (3)

4.3.3 State *Newton's second law of motion*. (3)

4.3.4 If the system accelerates at $1,4 \text{ m}\cdot\text{s}^{-2}$ (from left to right), calculate the magnitude and direction of the tension **T** in the chord. (4)

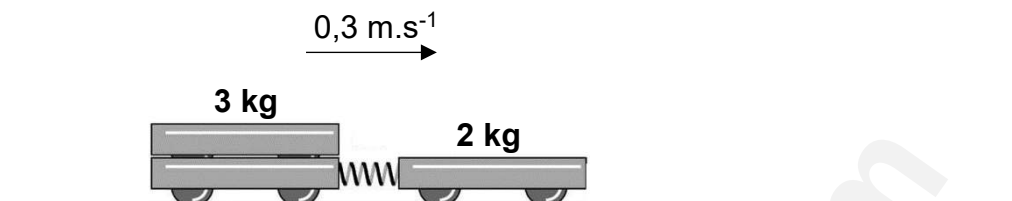
4.3.5 Block **B** accelerates uniformly up the slope from rest for 2 s and then the chord snaps. Draw a velocity versus time graph for the motion of block **B** while it is sliding up the slope. (3)

4.3.6 How does the acceleration of block **A** change after the chord snaps? Write INCREASE, DECREASE or REMAIN THE SAME. (2)

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QUESTION 5 MOMENTUM, WORK, ENERGY and POWER

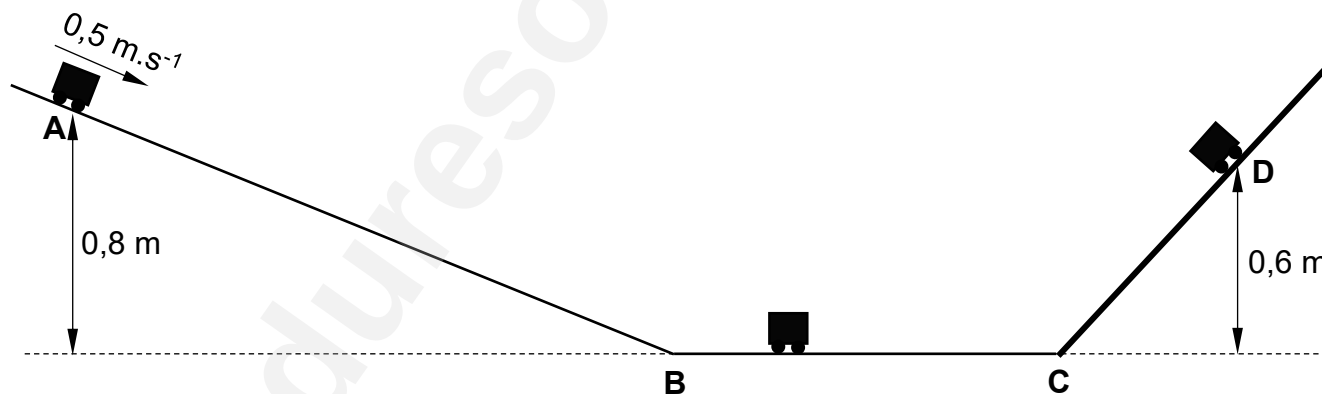
- 5.1 A 3 kg cart and a 2 kg cart are joined together by a compressed spring as shown in the diagram below.



The joined carts are moving to the right at $0,3 \text{ m.s}^{-1}$ when the spring releases and pushes the carts apart. The spring takes $0,1 \text{ s}$ to release. After the spring has released, the 3 kg cart is seen to be moving to the left at $0,2 \text{ m.s}^{-1}$.

- 5.1.1 State the *law of conservation of momentum*. (2)
- 5.1.2 Calculate the velocity of the 2 kg cart after the spring is released. (4)
- 5.1.3 Calculate the impulse provided to the 3 kg cart. (3)
- 5.1.4 Determine the magnitude and direction of the rate of change of momentum of the 2 kg cart. (3)

- 5.2 A toy car of mass 435 g is freewheeling down a frictionless inclined plane **AB**. It passes point **A** with speed of $0,5 \text{ m.s}^{-1}$ as shown in the diagram below.



- 5.2.1 Define *mechanical energy*. (2)
- 5.2.2 If point **A** is 0,8 m above the ground, calculate the speed of the toy car at point **B**. (4)
- The toy car now moves along the frictionless horizontal plane **BC**.
- 5.2.3 Describe the motion of the toy car as it travels from **B** to **C**. (2)
- 5.2.4 Define the *work done on an object by a force*. (2)

- 5.2.5 A student makes the following statement: “*Work is being done on the toy car to keep it moving from B to C.*”
Do you agree or disagree with this statement? Justify your answer. (3)

The toy car now moves up the rough inclined plane **CD**, eventually coming to rest at **D**, which is 0,6 m above the ground.

- 5.2.6 While the toy car is moving up **CD**, it experiences a frictional force of 1,2 N. Use the **law of conservation of energy** to calculate the length of the inclined plane **CD**. (5)

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QUESTION 6 FIELDS

- 6.1 The two Moons of **Mars** are Phobos and Deimos. Photos of Phobos and Deimos are shown below.



Phobos



Deimos

Mass of Phobos = $1,1 \times 10^{16}$ kg

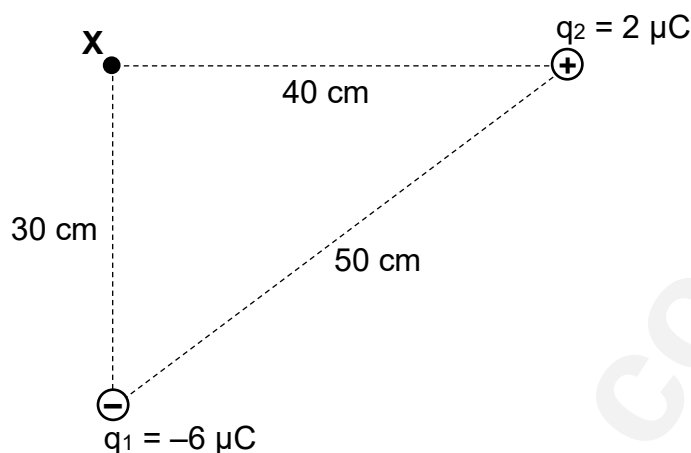
Radius of Phobos = 11,1 km.

The distance between the centers of Mars and Phobos is 9 377 km.

Mass of Mars = $6,4 \times 10^{23}$ kg.

- 6.1.1 Calculate the gravitational force of Mars on Phobos. (4)
- 6.1.2 Calculate the magnitude of the gravitational acceleration on the surface of Phobos. Write your answer in scientific notation correct to two decimal places. (3)
- 6.1.3 By what factor would the acceleration due to gravity differ on the surface of **Deimos**, which has half the radius of Phobos and one tenth of its mass? (3)

- 6.2 Two point charges are placed at two of the corners of a right angled triangle as shown in the diagram below. The distance between the point charges is shown. **X** is a point at the third corner of the right angled triangle.



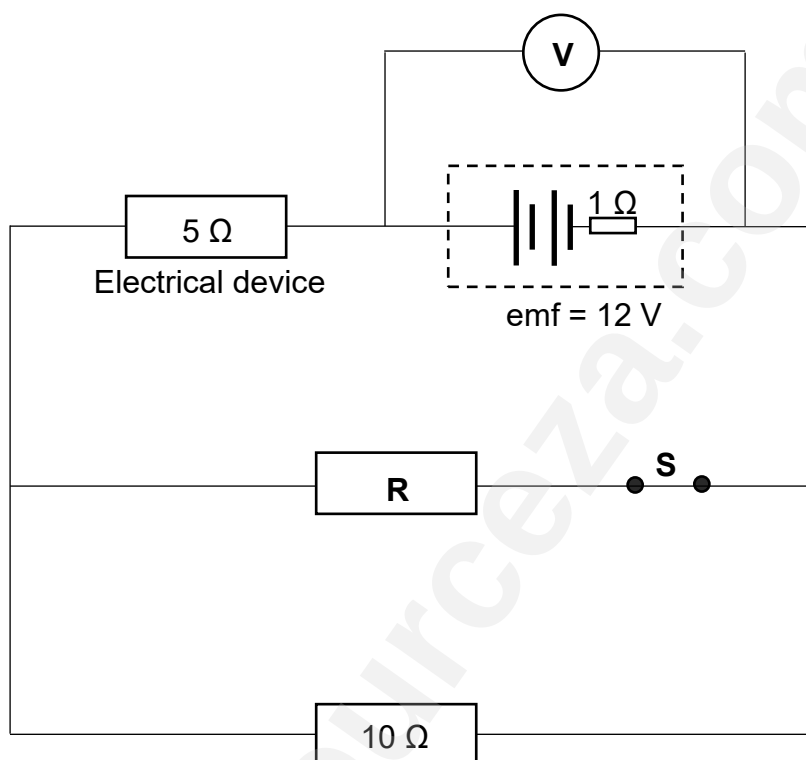
- 6.2.1 State Coulomb's law. (2)
- 6.2.2 Calculate the electrostatic force that q_1 exerts on q_2 . (4)
- 6.2.3 Draw a neat diagram of the electric field between q_1 and q_2 on **page 6** of your answer booklet. (3)
- 6.2.4 Calculate the electric field strength at point **X** due to q_2 only. (4)
- 6.2.5 On **page 6** of your answer booklet, draw a neat, labelled electric field vector diagram to show the resultant electric field at point **X**, due to both q_1 and q_2 . No calculations are required. (3)

[26]

QUESTION 7 ELECTRIC CIRCUITS

A student wants to use a battery with an emf of 12 V and 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.



- 7.1 Explain, in words, the meaning of *an emf of 12 V*. (2)
- 7.2 Explain, in words, the meaning of *a power of 5 W*. (2)
- 7.3 Show that the current in the electrical device is 1 A. (3)
- 7.4 Calculate the energy dissipated in the electrical device in 2 minutes. (3)
- 7.5 Calculate the reading on the voltmeter. (3)
- 7.6 Calculate the resistance of resistor **R**. (6)

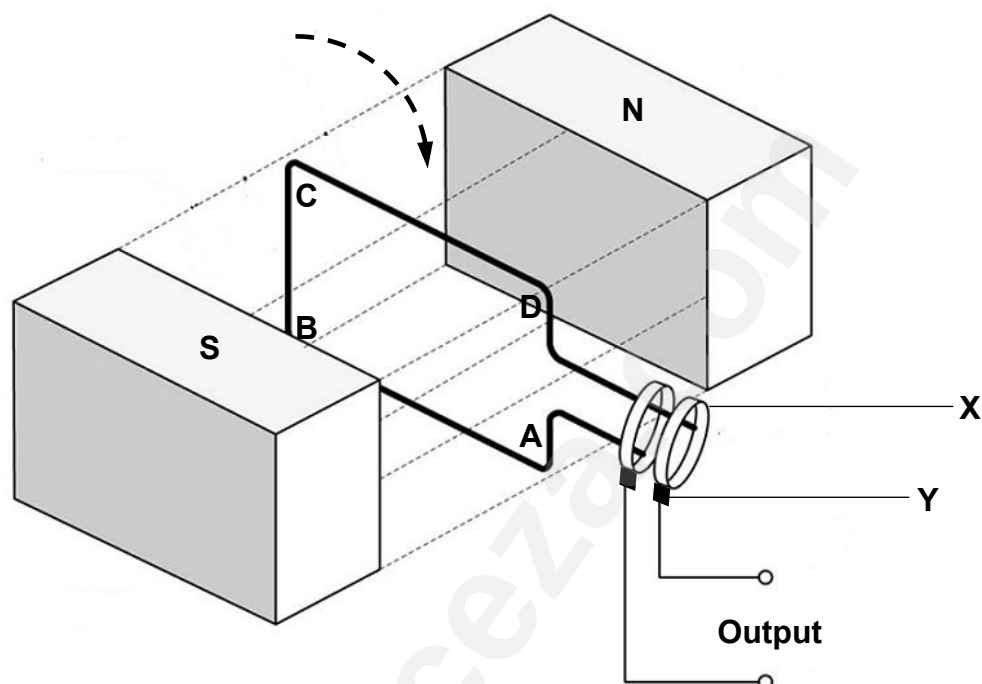
Switch **S** is now **opened**.

- 7.7 How will the current in the electrical device change? Write INCREASE, DECREASE or REMAIN THE SAME. Explain your answer. (3)
- 7.8 How will the voltmeter reading change? Write INCREASE, DECREASE or REMAIN THE SAME. Explain your answer. (3)

[25]

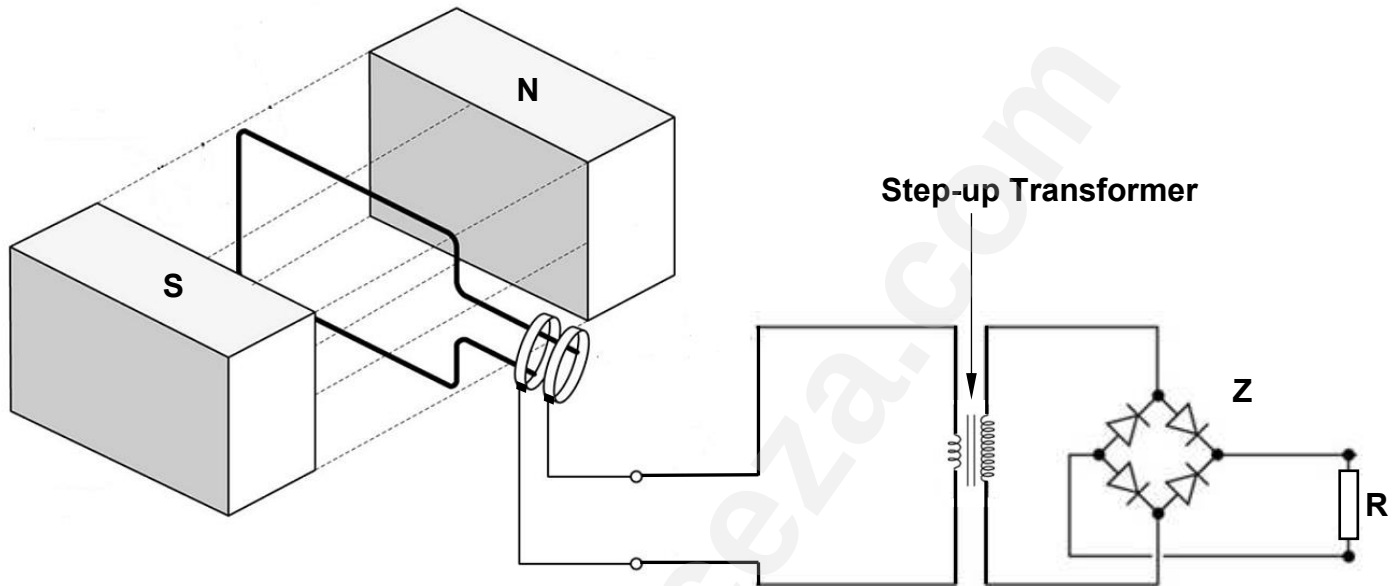
QUESTION 8 ELECTRODYNAMICS

The diagram below represents an AC generator. Two components are labelled **X** and **Y**.



- 8.1 Write down the name of the component:
- 8.1.1 **X** (1)
- 8.1.2 **Y** (1)
- 8.2 State the energy conversion which takes place in an AC generator. (2)
- 8.3 The coil is rotated **from** the vertical position **towards** the horizontal position as shown in the diagram. Use the letters given on the coil to indicate the direction of the current flow in the coil while it is rotated as shown. (2)
- 8.4 Write down TWO changes that can be brought about to increase the output of the generator. (2)
- 8.5 State Faraday's law of electromagnetic induction. (2)
- 8.6 Consider the coil as it moves through the horizontal position. State whether the following quantities are a MAXIMUM or a MINIMUM.
- 8.6.1 Magnetic flux Φ passing through the coil. (1)
- 8.6.2 The rate of change of magnetic flux $\frac{\Delta\Phi}{\Delta t}$. (1)
- 8.6.3 Induced current in the coil. (1)
- 8.7 Explain using Faraday's law why the maximum emf induced in the coil increases if the coil is rotated faster. Use bullet points in your explanation. (3)

- 8.8 Draw a neat sketch graph of **induced current** in the coil versus **position of coil** for ONE complete revolution of the coil. Start with the coil in the vertical position as shown in the diagram. (3)
- 8.9 A step-up transformer is now connected to the output of the AC generator as shown in the diagram below.



- 8.9.1 Use your understanding of electromagnetic induction and Faraday's law to explain how a step-up transformer works. Use bullet points in your explanation. (4)
- 8.9.2 Draw a neat sketch graph of **current** in resistor **R** versus **position of coil** for ONE complete revolution of the coil. Start with the coil in the vertical position as shown in the diagram. (2)

[25]