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**PHYSICAL SCIENCE
PRELIM – PAPER 1 – PHYSICS
JULY 2017**

**MARKS: 200
EXAMINER: C. ORCHISON**

**TIME: 3 HOURS
MODERATOR: C.VISSER**

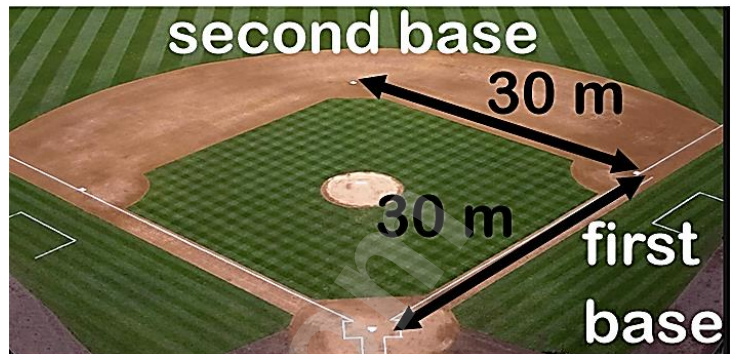
INSTRUCTIONS AND INFORMATION

1. This question paper consists of 12 pages with 9 questions
2. A data sheet is provided
3. Answer the multiple choice and the indicated questions on the answer sheet.
4. Write your name and teacher's name in the appropriate spaces on the ANSWER BOOK.
5. You may use a non-programmable calculator and appropriate mathematical instruments.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Use mark allocation as guide to the maximum time you should spend on a question.
8. May the m x a be with you ☺

QUESTION 1

- 1.1 On a baseball field, first base is 30m away from home plate and second base is 30m away from first base. If the Flash makes it to second base in a time of 11ns, what is the magnitude of his velocity?

A $5,45 \times 10^6 \text{ m.s}^{-1}$
B $3,86 \times 10^6 \text{ m.s}^{-1}$
C $2,73 \times 10^6 \text{ m.s}^{-1}$
D $7,04 \times 10^5 \text{ m.s}^{-1}$



- 1.2 Hawkeye shoots two arrows into a pile of hay. If one has twice the speed of the other, how much farther does the faster arrow penetrate, if we assume that the force of the haystack on the arrow is constant?

A half the distance B the same distance
C double the distance D four times the distance

- 1.3 Ant Man exerts a force of 4000N on a huge crate in order to pull it along the floor at a constant velocity. Which of the following statements is correct?

I – the crate exerts a reaction force of 4000N on Ant Man

II – the frictional force must be zero since the crate exerts 4000N on Ant Man to balance the forces

III – the frictional force must be equal to 4000N

A I and II B II and III C I and III D I only

- 1.4 The force which produces an acceleration in a body is equal to rate of change of...

A velocity B momentum C impulse D mass

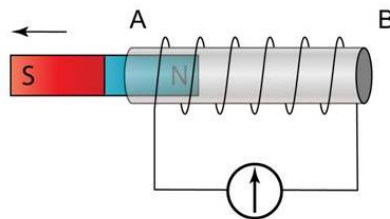
- 1.5 Two point charges, Q and $2Q$, are a distance d apart. Which of the statements is correct about the force they experience as a result of each other?

A Q experiences double the force that $2Q$ does
B Q experiences half the force that $2Q$ does
C Q experiences a quarter of the force that $2Q$ does
D Q experiences the same force that $2Q$ does

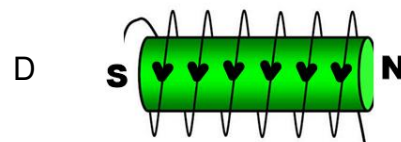
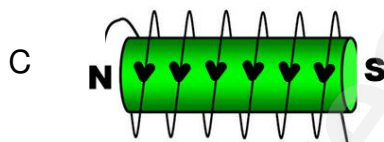
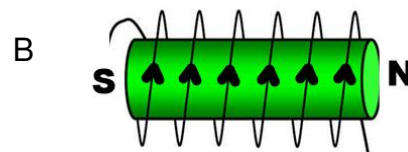
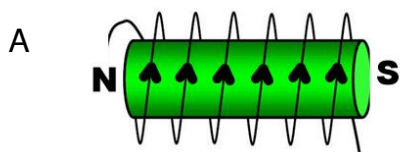
- 1.6 The direction of an electric field is...

A always in the direction an electron would move
B always in the direction a positive charge would move
C always from positive to negative
D along the field lines that surround the magnet

- 1.7 When a current of 0,5A flows through a 2Ω resistor for 2 minutes, the electrical energy spent is given by ..
 A 1J B 2J C 60J D 120J
- 1.8 The efficiency of a generator is calculated to be 75%. If the work done by the generator is measured as 800J in a time of 1 minute, what is the input power?
 A 13,33W B 17,78W C 600 J D 9,99W
- 1.9 In the diagram below, Vision is pulling the magnet to the left as shown.



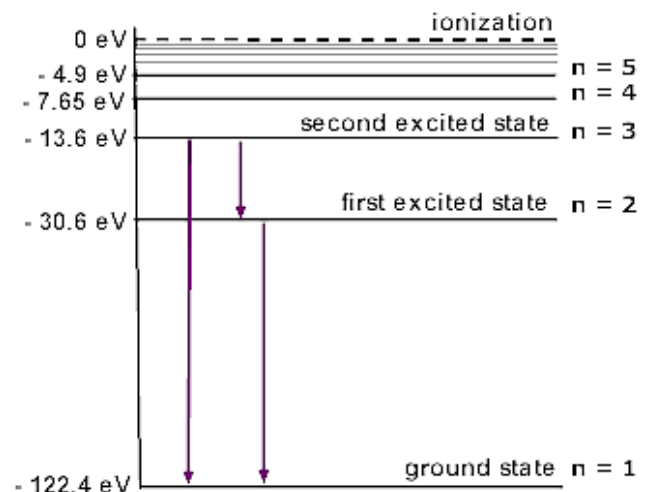
Which of the following correctly shows both the resulting polarity of the solenoid and the current in the coil?



- 1.10 The graph given shows the energies associated with the emission spectrum of hydrogen.

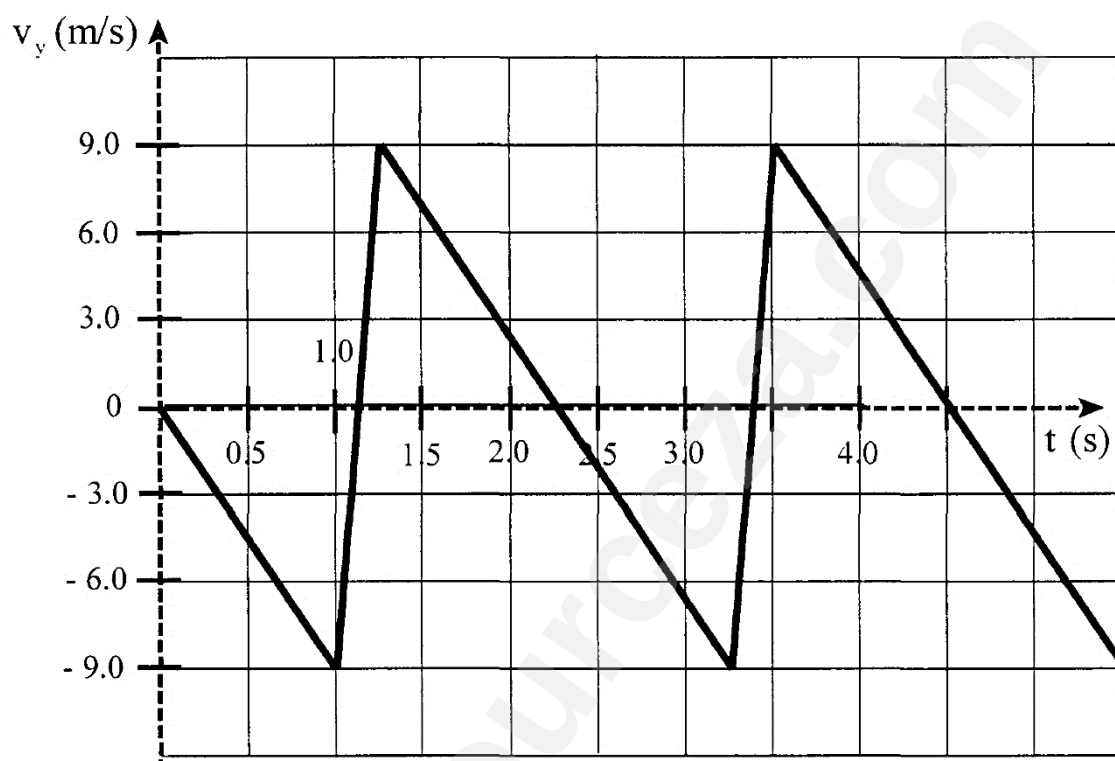
Between which two levels was an electron likely to have moved if the resulting emitted photon had a wavelength of 142nm?

- A 4 and 3
 B 2 and 1
 C 5 and 3
 D 3 and 1



QUESTION 2

While racing across the planet Hoth on his hovercraft in pursuit of Princess Leia, a Snowtrooper (yes.. that's really what cold assault Stormtroopers are called) drops his favourite bouncy ball which has a mass of 400g. The graph below depicts the motion of the ball:



- 2.1 How many times does the graph indicate that the ball bounced? (1)
- 2.2 Calculate the height from which the bouncy ball was dropped. (3)
- 2.3 Define acceleration. (2)
- 2.4 By calculating the acceleration of the bouncy ball, calculate the ratio of Hoth's gravitational acceleration to that of Earth's. (4)
- 2.5 Calculate the force exerted by the surface of the ice when the ball is in contact with it. (5)



- 2.6 Trying to redeem himself after dropping the ball, the Snowtrooper says that the bouncy ball experiences an elastic collision with the ground and that can be seen from the constant gradient of the graph after each bounce. Is he correct in both his statement and his reasoning? Explain fully. (3)

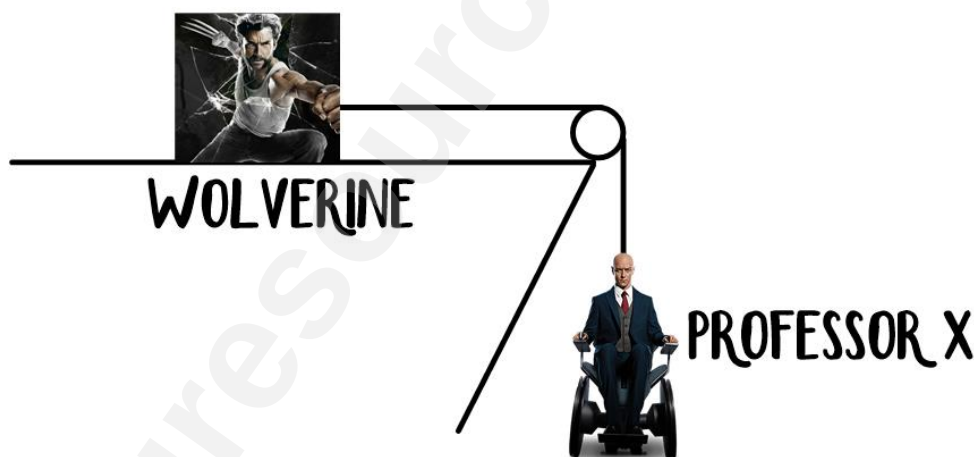
Back at base camp the Snowtrooper finds another ball and stands on top of the bunker and throws the ball vertically downwards with a velocity of 3 ms^{-1} .

- 2.7 If the ball takes 2s to reach the ground, calculate the height of the bunker. (3)
- 2.8 With what speed will the ball reach the ground? (3)
- 2.9 Sketch a displacement-time graph for the motion of the ball, including all calculated values, taking the ground as the reference point. (4)

28 MARKS

QUESTION 3

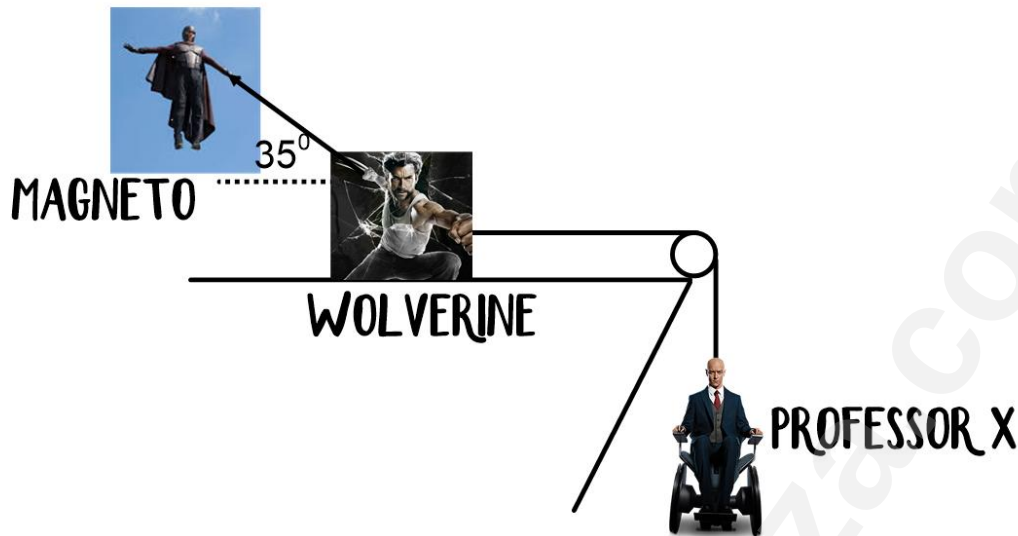
Professor X (mass 86 kg and wheelchair mass 18 kg) is dangling off the edge of a cliff and Wolverine (mass 82kg) is trying desperately to keep him from falling. The surface Wolverine is sliding across has a kinetic frictional coefficient of 0,9.



- 3.1 Calculate the frictional force that Wolverine experiences. (4)
- 3.2 State Newton's second law. (3)
- 3.3 Calculate the acceleration of the system. (6)



Magneto (who is for the moment one of the good guys again) comes to assist and attaches a cable to Wolverine and pulls at an angle of 35° to the horizontal. Thanks to his efforts Professor X accelerates upwards at $0,4 \text{ m.s}^{-1}$.



- 3.4 Draw a free body diagram of all the forces acting on Wolverine. (3)
- 3.5 Calculate the magnitude of the force that Magneto must have applied to Wolverine if we assume that the frictional force he now experiences is 600 N . (6)

22 MARKS

QUESTION 4

Bumblebee, the Autobot who transforms into a Chevrolet Camaro (mass 1763 kg) and Barricade, the evil Decepticon who transforms into a Ford Mustang police car (mass 1682 kg) are racing towards each other.

Transformers



EXPECTATIONS



REALITY

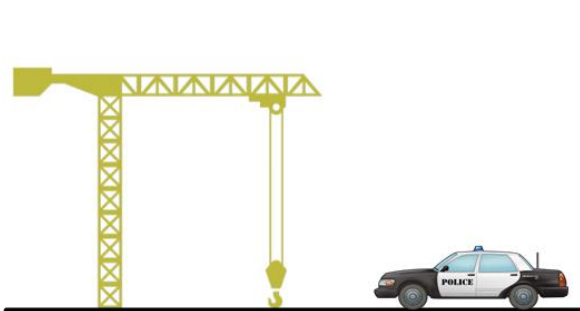
**BUMBLEBEE**mass: 1763 kg **BARRICADE**mass: 1682 kg 

Bumblebee accelerates from rest at 5 m.s^{-2} for 3 seconds and Barricade, initially travelling at 6 m.s^{-1} , accelerates at 4 m.s^{-2} for 2s.

4.1 Calculate their respective final velocities after their accelerations. (4)

4.2 State the law of conservation of linear momentum. (2)

4.3 If the transformers were to collide and move off together, calculate their final velocity. (5)



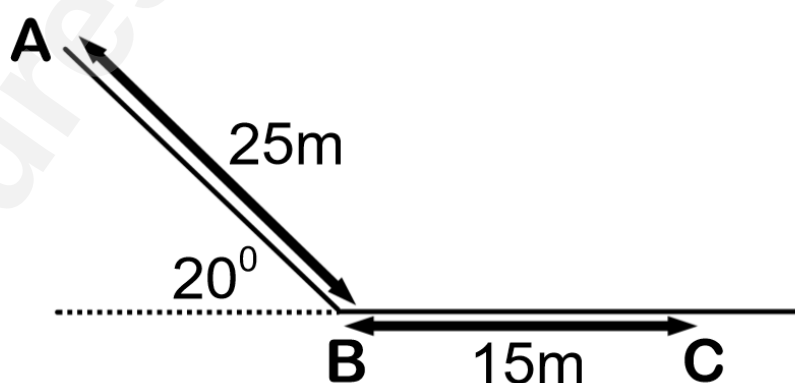
4.4 At the last second however, Bumblebee swerves and Barricade crashes into a hook suspended from a crane at the end of an inextensible cable instead.
If Barricade continues to move at 13 ms^{-1} , calculate the height to which the hook, with a mass of 100 kg , will rise if the mass of the cable is ignored. (8)

19 MARKS

QUESTION 5

In the East Rand remake of a particular movie, titled “Slow 5: Rocksburg Drifting”, the hero Van Petrol is escaping by sliding down an inclined surface as shown in the diagram below.

He starts at point A from rest and has a mass of 95 kg .



5.1 Calculate Van's potential energy at point A. (4)

5.2 If a frictional force of 50 N acts on Van as he slides down the incline, calculate the velocity with which he will reach point B. (8)

5.3 State the work-energy theorem. (2)

- 5.4 When Van reaches point B he travels a distance of 15m before coming to rest. Determine the net work done on Van and hence calculate the net force acting on him during this motion. (3)

17 MARKS

QUESTION 6

While on their quest through Middle Earth to destroy the ring (with a mass of 8 g), Frodo drops it and out of nowhere Gollum appears hissing 'my preciousssss'. Imagine the scene slows down like in any good anime, so they're both staring at the ring and not moving yet except for their bulging eyes.

- 6.1 State Newton's law of gravitation. (2)
- 6.2 Taking **ALL gravitational forces** into account, use the diagram below to determine what the magnitude of resultant force on the ring would be at the exact moment shown. (9)



As the ring slipped through Frodo's pocket it acquired $-2nC$ of charge.

- 6.3 What is the definition of the magnitude of an electric field? (1)
- 6.4 Calculate the electric field experienced at a distance of 9cm from the ring. (4)
- 6.5 By what factor would this change if the distance was halved and the charge on the ring doubled? (2)
- 6.6 What would the charge on another object a distance of 5 mm away need to be in order for the force between them to be 10N? (4)
- 6.7 Name the law used in 6.6 above. (1)

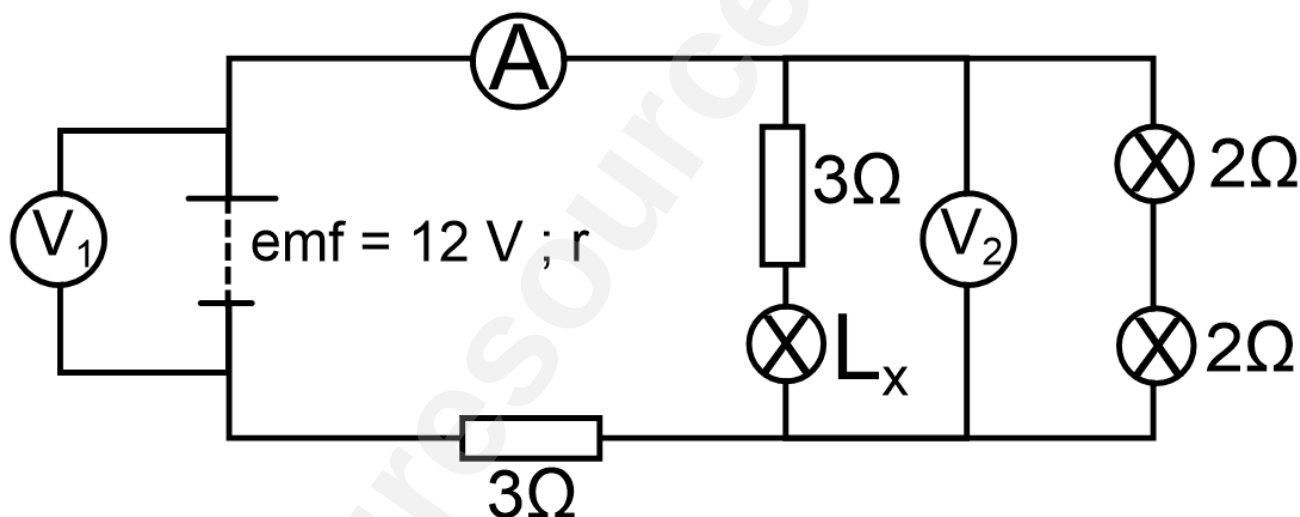
QUESTION 7

Captain America (Steve) and the Winter Soldier (Bucky) are trapped in a panic room designed to withstand a nuclear blast, leaving Cap's majestic shield and Bucky's cybertronically enhanced arm useless.

Their only hope is to solve the circuit questions below. The problem is that Steve's knowledge of electricity is shaky at best, so it's up to you and Bucky to save the day.



In the circuit below, the battery has an emf of 12V and an internal resistance of $0,33\Omega$. The ammeter reads 2A. Each of the resistors and lightbulbs have their resistance indicated on the diagram and the resistance of lightbulb L_x is unknown.



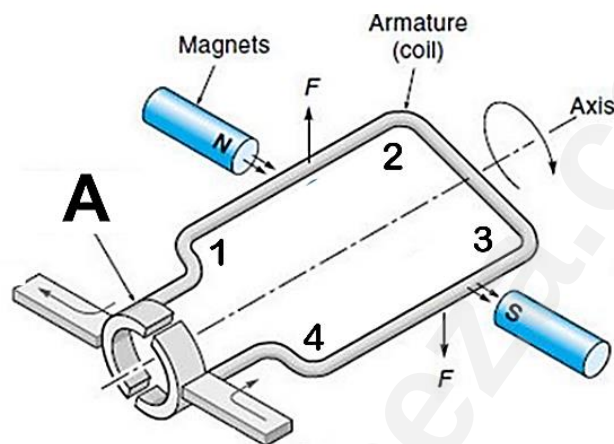
- 7.1 Explain in terms of the definition of current what it means that the ammeter reads 2A. (2)
- 7.2 Calculate the total external resistance of the circuit. (3)
- 7.3 Calculate the reading on voltmeter V_1 . (3)
- 7.4 Calculate the reading on voltmeter V_2 . (4)
- 7.5 Prove that the resistance of lightbulb L_x is 5Ω . (4)
- 7.6 Calculate the charge that passes through the 2Ω bulbs in a time of 10s. (5)
- 7.7 Explain what would happen to the reading on V_1 if the filament in lightbulb L_x blew. (4)

QUESTION 8

We all know that Peter Parker, a.k.a. Spider-Man, is a science genius. He and Tony Stark are chatting about motors and generators in order to develop new technology for the Avengers.

8.1 What is the energy conversion that takes place in a DC motor? (1)

8.2 In the diagram shown below, what is the component labelled A? (1)



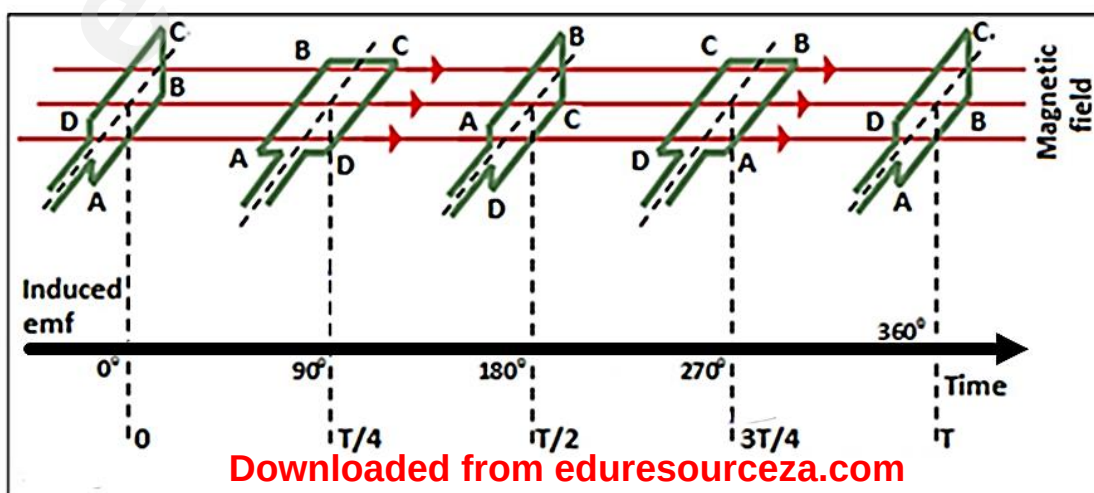
8.3 If the coil is rotating as shown, does conventional current flow in the direction 1-2-3-4 or 4-3-2-1? (2)

8.4 If Peter wanted to convert this motor into an AC generator, give two changes he would have to make. (2)

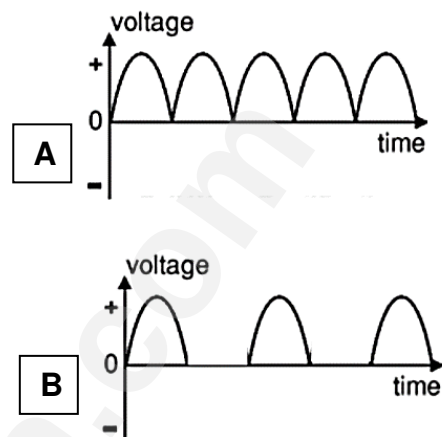
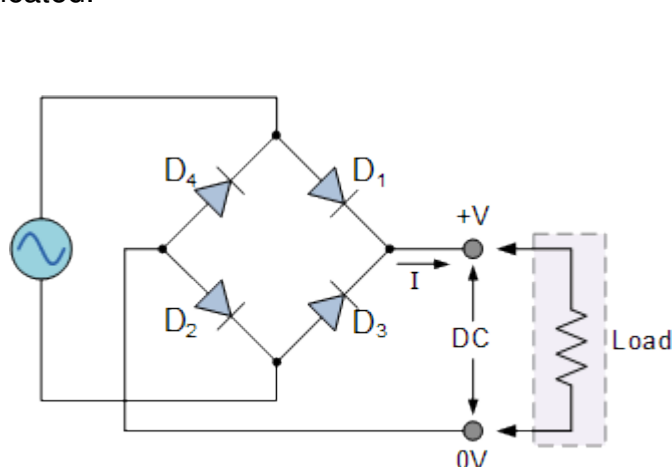
8.5 State Faraday's law of electromagnetic induction. (2)

8.6 Tony wants the generator to produce an increased current. How could this be achieved? Give three ways. (3)

8.7 Peter knows that the position of the coil in relation to the magnetic field makes a difference to the induced emf in a generator. Complete the graph below on your answer sheet to show that you also understand how the induced emf varies according to the rotations of the coil as given. (2)



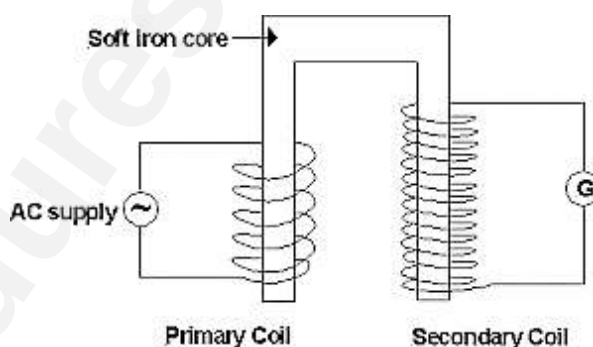
While Peter is working on the generator, Tony is focussing on converting the AC from the generator into DC so that he can make toast for Hulk... because you don't want to be around a hungry Hulk. He sets up the following circuit and connects the toaster where the resistor is indicated.



8.8 What is the function of a diode in a circuit? (1)

8.9 Which of the voltage graphs, above right, correctly shows the output voltage of this circuit? Explain your answer fully by making reference to the diodes labelled D₁, D₂, D₃ and D₄. (4)

In order to run the Avengers Headquarters, Tony needs to install suitable transformers to cope with the amount of voltage that is required.



8.10 What type of transformer is indicated in the diagram? (1)

8.11 If the primary coil has 20 turns and a current of 5A, calculate the current in the secondary coil which has 80 turns. (3)

8.12 Thor is clearly not a scientist, and decided to 'help' by connecting the primary coil to a DC supply. Explain fully what the effect on the voltage across the secondary coil would be if a DC supply was used instead of an AC supply. (2)

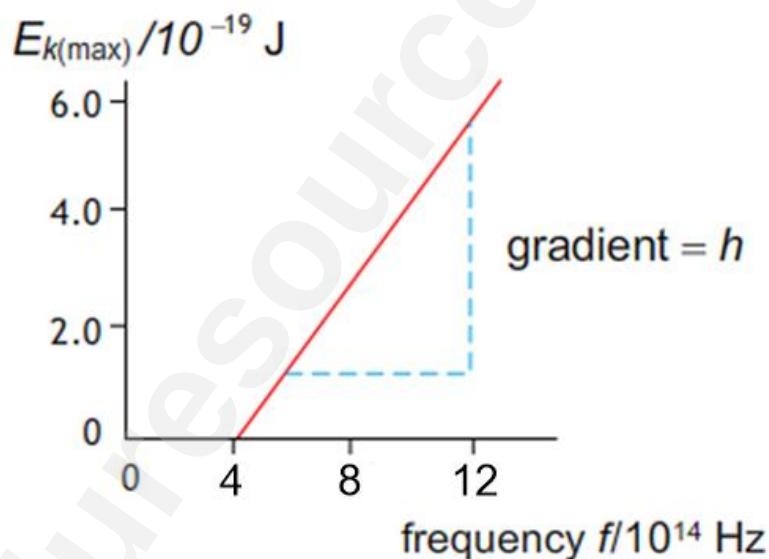
8.13 What is the magnitude of the power in the secondary coil if the primary coil has a voltage of 12V? (3)

QUESTION 9

Baby Groot is using his solar-powered calculator (which mercifully is not a Casio) to work out how fast they need to be travelling to get away from the Sovereign alien race who Rocket casually stole batteries from. In order for the solar panel to work, Rocket yells that the threshold frequency needs to be met.

- 9.1 What is meant by 'threshold frequency'? (2)
- 9.2 Explain how the solar panel provides current for his calculator to operate by making reference to the principles of the photoelectric effect. (2)

Use the graph below to answer the questions that follow:



- 9.3 Calculate the work function of this particular metal. (3)
- 9.4 If incident radiation with a wavelength of 800nm was shone onto the surface of this same metal, calculate the velocity of the ejected electrons. (7)
- 9.5 What difference would it make to the number and speed of photoelectrons if Baby Groot used brighter light while keeping the wavelength constant, assuming that the work function has been met? Explain fully. (4)

19 MARKS**TOTAL FOR PAPER 200 MARKS**