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GRADE 12
Physical Science Prelim: Paper 1 - Physics
July 2018

Time: 3 hours
Examiner: K van Schoor

Marks: 201
Moderator: M Naidoo

READ THESE INSTRUCTIONS:

1. This paper consists of 15 pages (including the front page). Ensure that your paper is complete.
2. Take note of mark allocation and read the question thoroughly.
3. Start each question on a new page.
4. You must show all working for calculations and give appropriate units for numerical answers
5. An information sheet, grid for question 1 and graph paper is provided in the cover of your answer booklet
6. Where appropriate write all final numerical answers to of 2 decimal places

Exam number:	Class:
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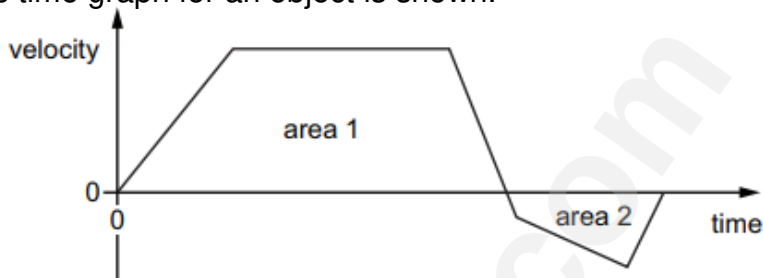
Some questions adapted from the following sources: CIE 2018, 2013, Cluster 2017, Reddam 2018, IEB 2015, St Johns College 2016, <https://phet.colorado.edu/en/simulations>

Question 1: Multiple choice

[20]

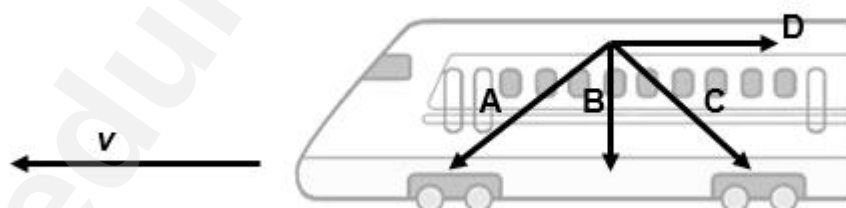
Make a clear cross over the letter of the correct answer in the cover of your answer booklet

- 1.1. The velocity vs time graph for an object is shown.



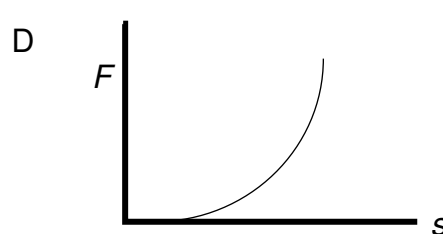
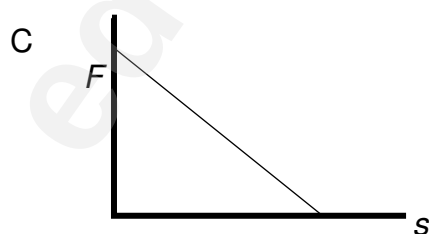
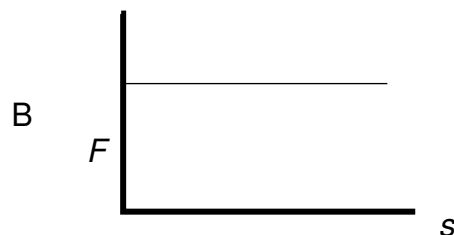
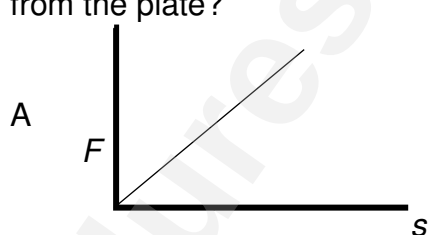
How can the total displacement of the object be determined? (2)

- A area 1 – area 2
 B $\frac{(\text{area 1} + \text{area 2})}{2}$
 C area 1 + area 2
 D area 2 – area 1
- 1.2. A girl is being pushed by her dad on a swing. What would the reaction force be of the weight of the girl? (2)
- A The force of the Earth on the girl
 B The force of the swing seat on the girl
 C The force of the tension in the cable holding the swing
 D The force of the girl on the Earth
- 1.3. A ball is dropped from point P near the roof of a Gautrain coach traveling at a constant speed v . From the diagram below choose the direction of motion of the ball after being dropped. (2)

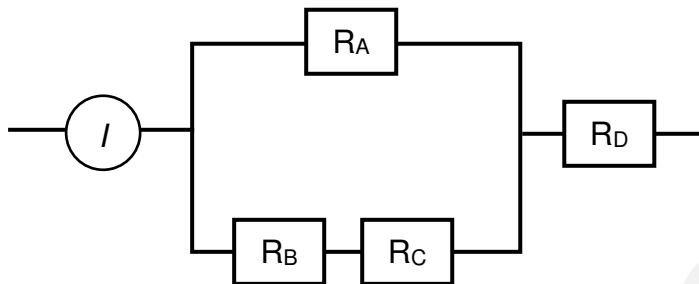


- 1.4. A stone is thrown vertically upwards. Which one of the following quantities in respect to the stone will be zero when it reaches the maximum height? (2)
- A acceleration
 B gravitational potential energy
 C kinetic energy
 D weight

- 1.5. A boy of mass m jumping on a trampoline hits the mat at a velocity of v and rebounds in a straight line at the same velocity. What is the boy's change in momentum? (2)
- A $0\ mv$
 B $2\ mv$ downwards
 C mv upwards
 D $2\ mv$ upwards
- 1.6. The kinetic energy of object A is E . An object B has double the mass and moves with twice the velocity of A. What would the kinetic energy be of object B? (2)
- A $2E$
 B $4E$
 C $6E$
 D $8E$
- 1.7. The mass of an object on Earth is 380 kg. What would the **mass** be in kg of the same object on a planet with double the mass and half the radius of the Earth? (2)
- A 3040
 B 380
 C 190
 D 760
- 1.8. A negative point charge is allowed to accelerate towards a positively charged plate through a uniform field. Which of the following graphs shows the magnitude of the electrostatic force (F) on the charge against the distance (s) from the plate? (2)



- 1.9. A current I flows into the network shown below where all the resistors have the same resistance R . Across which resistor or combination of resistors will the smallest potential difference be measured? (2)



- A R_A
 - B R_B
 - C R_B and R_C in series
 - D R_D
- 1.10. Two identical conducting wires are moved through a magnetic field. Wire A takes 10 seconds to be moved through the field and wire B takes 6 seconds. Which of the following options will be true for the **induced** voltages in the wires? (2)
- A The induced voltage is not dependent on the time it takes to move through the field.
 - B The induced voltage in wire A will be larger than that in wire B.
 - C The induced voltage in wire B will be larger than that in wire A.
 - D There will be no induced voltage in the wires.

Question 2: Free falling?**[32]**

A light aircraft needs to take off to drop a skydiver.

The engines exert a constant net force of 2 000 N on the aircraft of total mass 1 250 kg. The aircraft needs to reach a speed of 36 m.s^{-1} before it will take off.

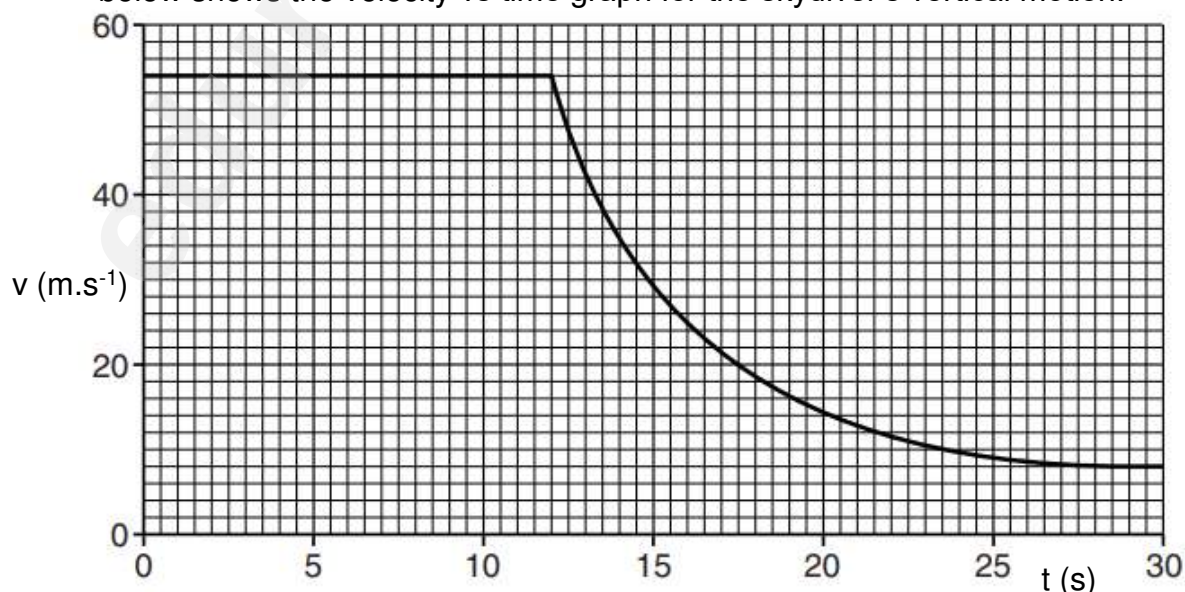
- 2.1. Determine the acceleration of the aircraft. (3)
- 2.2. Calculate the time taken for the aircraft to reach the lift-off speed. (3)
- 2.3. The length of the runway is 525 m. Determine whether the aircraft will safely take off before it reaches the end of the runway. (4)

The skydiver of mass 70 kg is falling towards the Earth at a **constant velocity** after jumping from the aeroplane.



- 2.4. Explain the difference between speed and velocity. (3)
- 2.5. Draw a labelled free body diagram showing all the forces acting on the skydiver. Show relative sizes of the forces. (3)

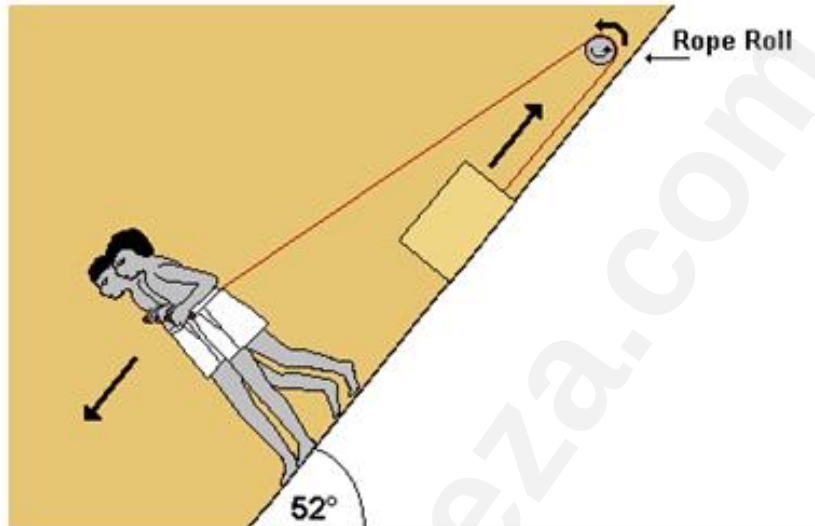
At time $t = 0$, he receives a radio signal and opens his parachute. The figure below shows the velocity vs time graph for the skydiver's vertical motion.



- 2.6. How long did it take for the skydiver to open his parachute? (1)
- 2.7. Use the graph above to determine the distance that he fell before he opened the parachute. (3)
- 2.8. Describe the motion of the skydiver for the last 18 seconds as shown on the graph. (3)
- 2.9. After the 30 seconds the skydiver is 32 m above the ground. At this point his phone falls out of his pocket.
- 2.9.1. What is the initial velocity of the phone? (2)
- 2.9.2. How long does it take for the phone to fall to the ground?
(Air resistance on the phone is negligible) (3)
- 2.9.3. The skydiver's friend is watching from the ground and sees the phone fall. After a reaction time of 0,8 seconds he starts to run to the dropping point 4 m away from him. He accelerates at $2,4 \text{ m.s}^{-2}$. Determine if the friend manages to catch the phone before it hits the ground. (4)

Question 3: Some strong men**[21]**

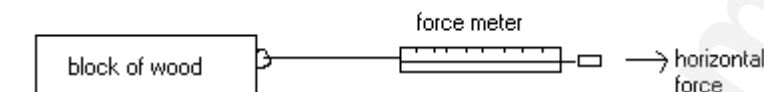
It is believed that the Egyptians used a rope roll system to move the granite blocks up the pyramids. Such a system is illustrated in the diagram below. Teams of haulers are used to move the blocks which have a mass of around 45 tons (45 000 kg) each. The blocks are placed on lubricated tracks with a kinetic friction coefficient of 0,35.



- 3.1. Draw a labelled free body diagram of all the forces acting on the **block** while the block is accelerating up the slope. (4)
- 3.2. State *Newton's second law*. (2)
- 3.3. If the block accelerates at $0,25 \text{ m}\cdot\text{s}^{-2}$, calculate the magnitude of the resultant force on the 45 000 kg block. (3)
- 3.4. Calculate the maximum force of kinetic friction on the block. (4)
- 3.5. If each hauler can apply a force of 9075,8 N, determine how many haulers need to be in a team to cause the acceleration of $0,25 \text{ m}\cdot\text{s}^{-2}$. (5)
- 3.6. Just before the block reaches the top of the slope the haulers let go of the rope. Use one of Newton's laws to explain why the block still makes it to the top of the slope. (3)

Question 4**[19]**

To investigate the frictional forces between different surfaces some students set up a block of wood on a mat and determine the force that they need to apply to move the block (just overcome frictional force). They increased the mass of the block by each time adding mass pieces on top of the block and determined the force needed to just get the block to move.



The table below shows their results.

Mass of the block and mass piece (kg)	Force on the meter (N)
1,0	3,9
1,5	6,0
2,0	7,8
3,0	11,8
4,5	17,7
6,0	23,5

- 4.1. Define *frictional force*. (2)
- 4.2. On the graph paper provided, plot a graph of the force on the meter vs the total mass of the block and the mass pieces. (6)
- 4.3. Determine the gradient of the graph.
(Show clearly on the graph the values used) (4)
- 4.4. What relationship is shown by this graph? (2)
- 4.5. Use the equation for static friction ($F_{\text{fric}} = \mu F_N$) to write down an equation that links the mass of the object with the frictional force. (2)
- 4.6. Use your answers for **4.3**, **4.5**. and your knowledge of the straight line equation $y = mx + c$ to determine the coefficient of static friction for the block on the mat. (3)

Question 5: Blocks and bullets**[22]**

During a forensic investigation bullets are fired into a 6 kg wooden block to determine information about the speed of the bullet and distances travelled by the object that was shot. In one of the tests a bullet of mass 40 g is fired horizontally into a block. The block is initially at rest, but the bullet is embedded in the block and they move off at a velocity of $7,8 \text{ m.s}^{-1}$.



5.1. State the principle of conservation of linear momentum. (2)

5.2. Calculate the magnitude of the velocity with which the bullet strikes the block (4)

The bullet and block moves further on the **rough** surface from A to B at the bottom of a slight incline of 15° to the horizontal. The speed of the block and bullet decreases from $7,8 \text{ m.s}^{-1}$ to $4,1 \text{ m.s}^{-1}$ between A and B.

5.3. Determine the kinetic energy of the bullet and block at A. (3)

5.4. State the work-energy theorem. (2)

5.5. Use the work-energy theorem to determine the distance travelled between A and B if the force of friction acting on the block is 195 N. (4)

The block and bullet moves up the inclined surface to point C at a height h above B.

5.6. Use the principle of conservation of energy to determine the small height reached by the block and bullet if the work done against friction is 40 J. (4)

Police officers use padded bullet proof vests to protect them from the bullet as well as the impact.

5.7. Use an appropriate equation to explain why the padding on the vests will make protect the police officers from getting hurt. (3)

Question 6: Fields**[19]**

- 6.1. On 6 February 2018 SpaceX placed 'starman' and his sport roadster of in orbit using the Falcon Heavy rocket.

Table of masses:

Object	Mass (kg)
Roadster with Starman	1 300
Earth	6×10^{24}
Mars	$6,39 \times 10^{23}$



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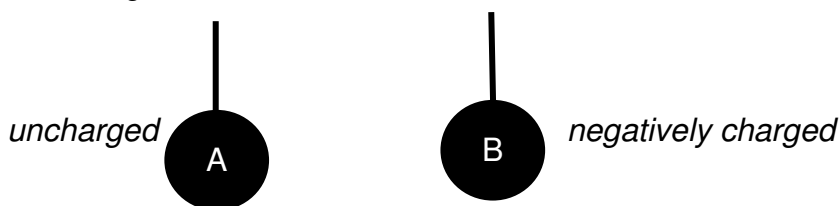
On the 21 February the car was $4,5 \times 10^6$ km away from Earth.

- 6.1.1 State Newton's Law of universal gravitation. (2)
- 6.1.2 Determine the gravitational force between Earth and the car at this point. (4)

At this point the roadster is $216,1 \times 10^9$ m away from Mars.

- 6.1.3 Determine the magnitude and the direction of the **resultant** gravitational field strength in N.kg^{-1} acting on the roadster at this point between Mars and Earth. (Assume the 3 objects are situated in a straight line) (5)

- 6.2 An uncharged spherical conductor A and an identical negatively charged conductor B hang close to each other from silk threads as shown.

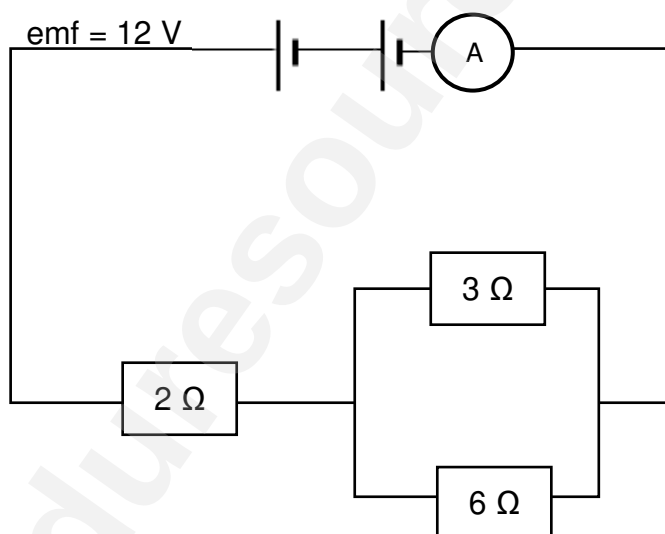


- 6.2.1 Explain why the spheres experience a force of attraction. (3)
- 6.2.2 When the two spheres are allowed to touch each other they immediately repel each other. Give a reason for this movement making reference to movement of charges. (3)
- 6.2.3 The repulsion force between the spheres is 56 N. What would the magnitude of the repulsion force be when the distance between the spheres is halved? (2)

Question 7: Electric Circuits

[18]

The diagram below represents an electric circuit consisting of a battery with an emf of 12 V, an ammeter and three resistors connected as shown.

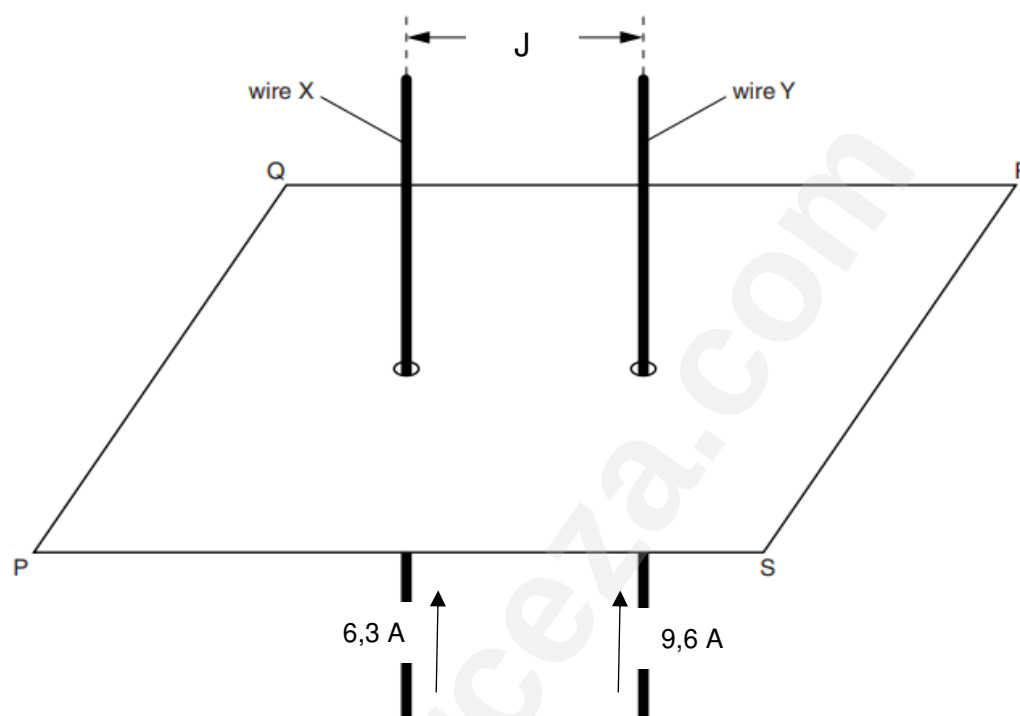


- 7.1. Define emf. (2)
- 7.2. Determine the total effective resistance of the circuit. (4)
- 7.3. The reading on the ammeter is 2,2 A. Determine the internal resistance of the battery. (4)
- 7.4. Calculate the energy converted in the 6 Ω resistor in 5 minutes. (4)
- 7.5. By referring to an appropriate equation, explain whether the rate of energy conversion is greater in the 3 Ω resistor or in the 6 Ω resistor. (4)

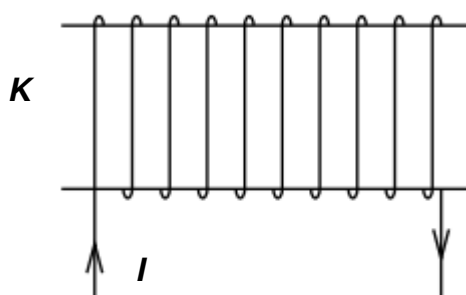
Question 8: Electrodynamics

[29]

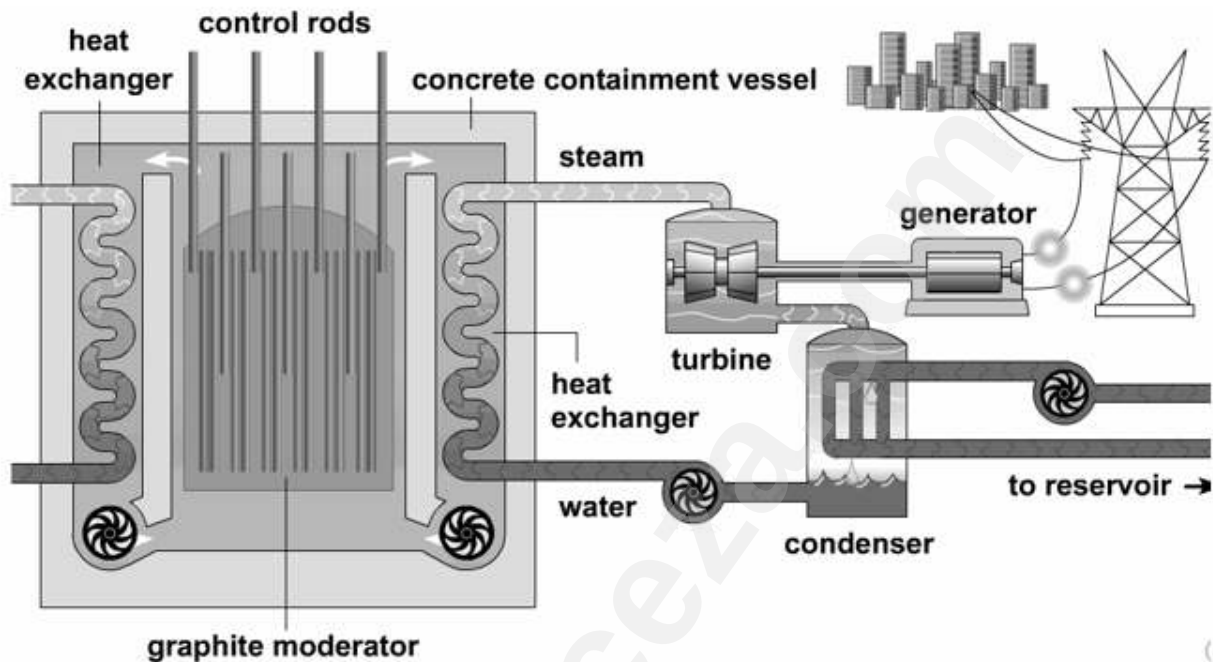
- 8.1. Two long straight current carrying conductors are placed a distance J apart as shown below. A current in wire X is $6,3\text{ A}$ and the current in wire Y is $9,6\text{ A}$.



- 8.1.1. In your answer booklet, sketch a block for PQRS and in the plane of your page as seen from the top. Sketch the magnetic field lines due to the current in each wire. (3)
- 8.1.2. Will there be an attraction or a repulsion force between the wires? (1)
- 8.1.3. How will the force experienced by wire X compare with the force experienced by wire Y? (2)
- 8.2. An electromagnet is made by winding a current carrying conductor around an iron core as shown. The direction of the current flow (I) is indicated.
- 8.2.1. Why is an iron core used? (2)
- 8.2.2. State the polarity of the left hand side of the electromagnet labelled **K**. (Only write North or South) (1)



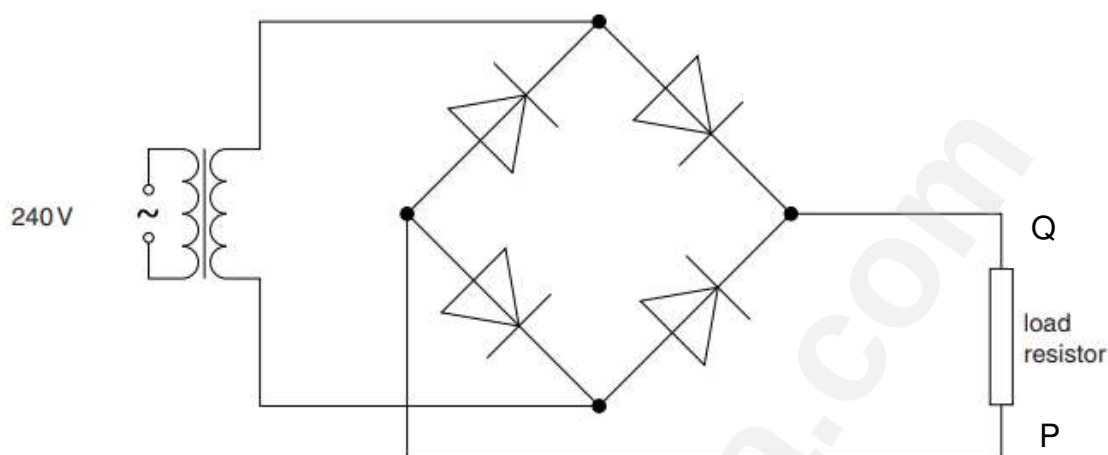
- 8.3. At Eskom, electricity is generated using the simplified method shown below. The steam is sent to a turbine which turns a coil in a magnetic field in the generator. The generator has an output of AC that is stepped up for transmission to towns and cities.



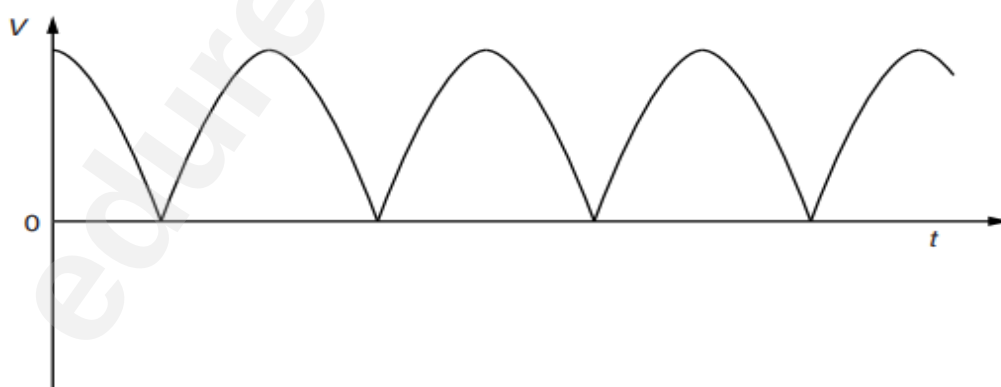
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- 8.3.1. Use Faraday's law of electromagnetic induction to explain why the turbine must keep turning for the generator to function. (3)
- 8.3.2. Name 2 ways in which the output voltage from the generator can be increased. (2)
- 8.3.3. A transformer is used to step up the voltage to a higher value for transmission. Explain why the voltage needs to be stepped up before transmitting the electricity to the city. Use an appropriate equations to aid your explanation? (3)

- 8.4. When reaching the city the high voltage needs to be stepped down again using a transformer, sometimes more than once. The output of an ideal transformer is connected to a bridge rectifier as shown below.



- 8.4.1. What is meant by an IDEAL transformer? (2)
- 8.4.2. The input to the transformer is 240 V and the potential difference across the load resistor is 9,0 V. Calculate the ratio of the number of turns on the primary coil to the number of turns on the secondary coil. (3)
- 8.4.3. What is the function of the bridge rectifier? (2)
- 8.4.4. Indicate the current direction through the load by only writing from P to Q or from Q to P. (1)
- 8.4.5. The variation with time (t) of the output potential difference (V) across the load resistor is shown below.

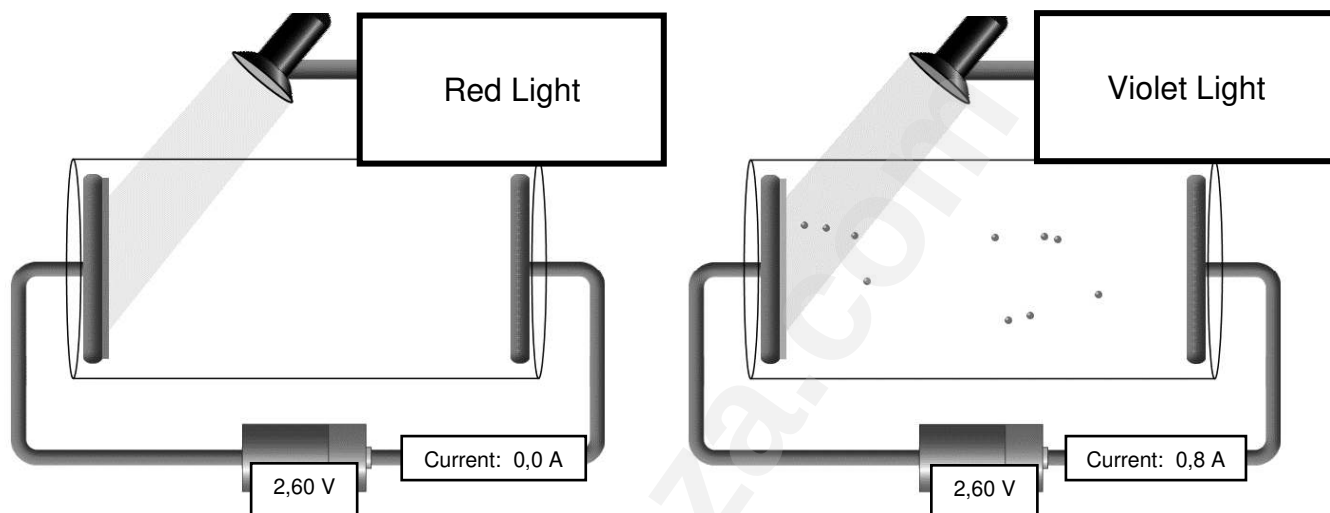


In your answer booklet sketch graphs for the **original input** of the transformer showing:

- 8.4.5.1. Voltage vs time. (add voltage values) (2)
- 8.4.5.2. Magnetic flux vs time. (no values required) (2)
(Draw 2 full cycles for both graphs)

Question 9: Photons and electrons**[21]**

The diagrams below shows a simulation of red light and violet light being shone onto a negatively charged plate of sodium metal.



When red light is shone on the negatively charged plate of sodium metal, nothing is observed. When violet light is shone onto the same plate, electrons are emitted and a reading is seen on the ammeter.

9.1. Name the phenomenon described. (2)

9.2. Explain why the red light has no effect while the violet light emits electrons. (3)

The work function of sodium is 2,28 eV.

9.3. Give the work function in joules. (1)

9.4. Calculate the maximum kinetic energy of an electron ejected from the sodium by a photon of wavelength 300 nm. (4)

9.5. The intensity of both lights are increased.

9.5.1. For each of the scenarios, explain how the current reading would change. Only write increase, decrease or remain the same in each case. (2)

9.5.2. Explain your answers in 9.5.1. (4)

9.6. Draw a sketch graph to represent the maximum kinetic energy of the photo electrons vs the frequency of the light used for sodium. On your graph indicate the axis labels and units, the threshold frequency, Planck's constant and the work function for sodium. (No values are required) (5)

Answer sheet for Question 4.2

