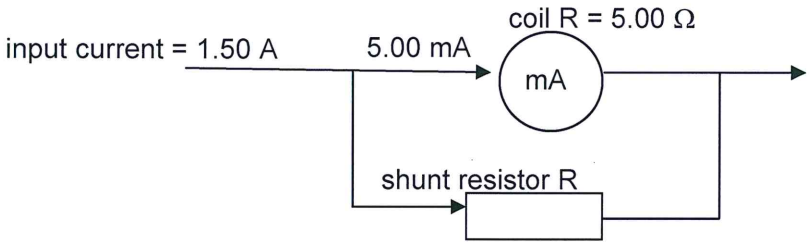
Exam Questions
Chapter 5.3 - Transformers
Question 1 2010:1:11

(5 marks)

The ammeter shown below can be used to measure a range of electric currents up to 500 mA by selecting the appropriate terminals.

The coil inside the meter is not designed to take large currents. If the ammeter is required to measure a maximum reading of 1.50 A, an additional resistor called a *shunt* has to be added as shown below. The meter has a coil resistance of 5.00 Ω. This arrangement is shown here:



Find the value of the shunt resistor R.

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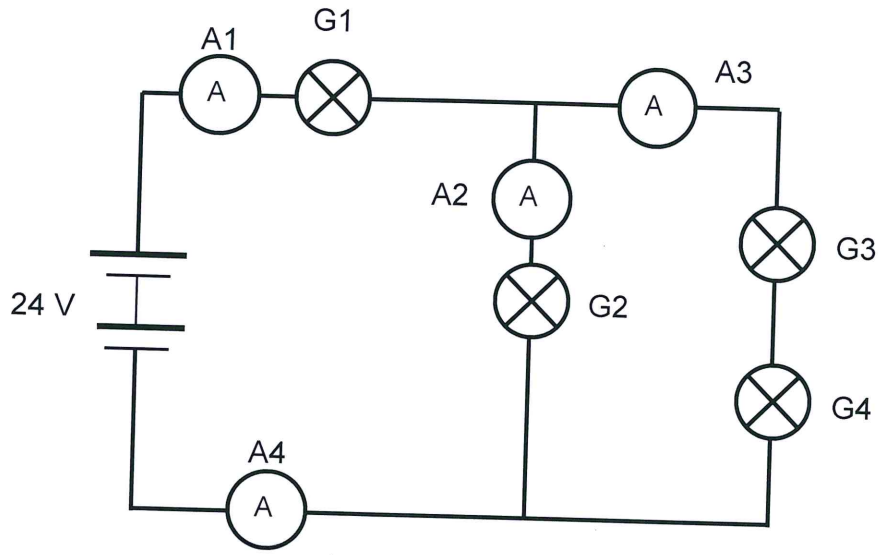
Question 2 2010:2:18

(14 marks)

Four identical light globes, G1, G2, G3 and G4, are connected in a circuit as shown below. The DC supply voltage is 24.0 V and ammeter A3 connected in the circuit reads 0.096 A.



(a) Calculate the current in each of the ammeters A1, A2 and A4. (3 marks)

(b) Calculate the resistance of each light globe. (3 marks)

(c) Which light globe will be the brightest? Justify your answer. (2 marks)

(d) Calculate the total power consumed by all four light globes. If you were unable to determine an answer to part (a) you should assume the current in ammeter A4 is 0.300 A. (2 marks)

(e) If globe G3 is broken, describe how the brightness of each of the light globes G1 and G2 changes. Give a reason in each case. (4 marks)

The brightness of G1 will _____

because _____

The brightness of G2 will _____

because _____

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Question 3 2010:3:22

(13 marks)

Generation and Transmission of Electricity

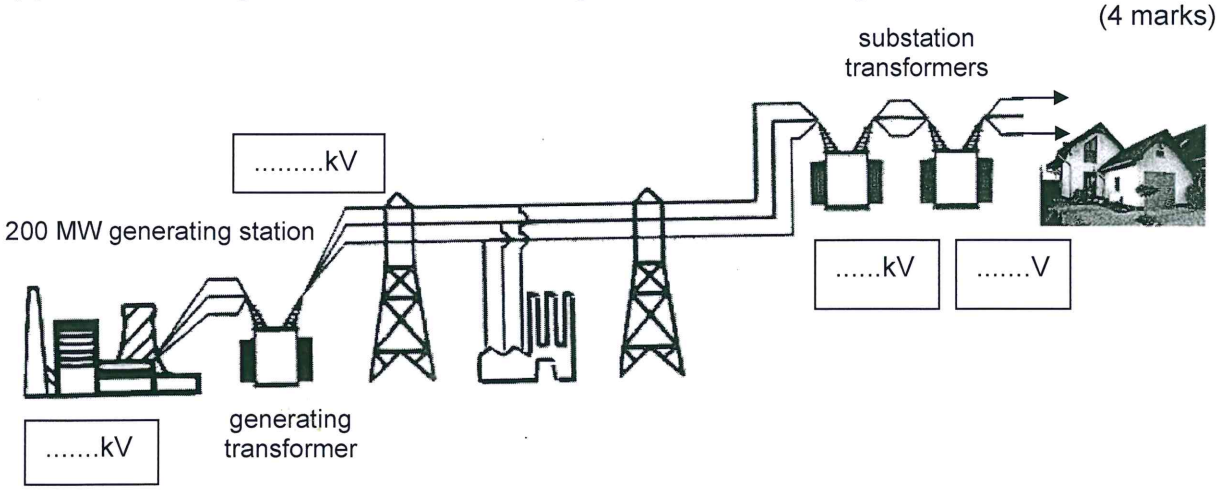
Approximately 30 per cent of the energy used in Australia is generated by power stations. The largest power station in Western Australia is Muja, which is situated close to the coalmining town of Collie.

At Muja coal is ground to the consistency of powder and then burned to heat water until it turns to steam. Steam at a temperature of 540°C and pressure of 16 MPa is used to drive turbines at a rate of 3000 revolutions per minute.

Muja power station generates at a total rate of 1040 MW from its 8 generators. There are four 60 MW generators and four 200 MW generators. The 60 MW generators produce power at 11.8 kV and the 200 MW generators produce power at 16 kV. Generators feed the electricity produced into transformers where the voltage can be increased or decreased.

Before the electricity is distributed, transformers are used to step up the voltage to 330 kV. High voltage transmission has advantages in reducing energy lost due to the resistance of the transmission lines. On the outskirts of Perth there is a substation that reduces the voltage to 11 kV and in the local park is a further small transformer that reduces the voltage to 240 V.

(a) On the diagram below show the voltages at the different stages of the transmission. (4 marks)



(b) Explain why the generator is designed to produce alternating current and not direct current. (2 marks)

(c) Calculate the current generated in one of the 200 MW generators. (2 marks)

(d) Explain why the voltage is increased to 330 kV before it is distributed to users. (2 marks)

(e) Calculate the turns ratio of a transformer used to increase the voltage from a 60 MW generator to 330 kV. (2 marks)

(f) Suggest a possible difference between the 60 MW and the 200 MW generators that would result in a difference in output voltage. (1 mark)

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Question 4 2011:2:18

(13 marks)

This photograph shows the information on a compliance plate on the outside of a small transformer used in a house in another country.

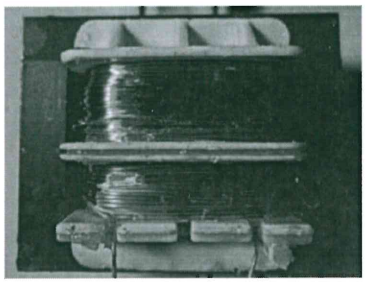
(a) Determine the ratio of windings of primary:secondary coils in the transformer. (2 marks)

(b) Using the information on the compliance plate, calculate the power output of the transformer and use this information to determine the percentage efficiency of the transformer.

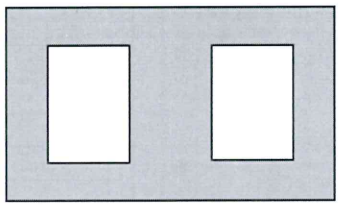
(3 marks)

(c) Explain why the input voltage must consist of an alternating current rather than direct current. (2 marks)

(d) The following photograph shows the coils and core inside the transformer case.



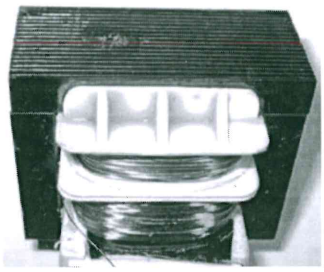
For small commercial transformers, the coils are placed around the centre pillar of the core, which is shaped like this:



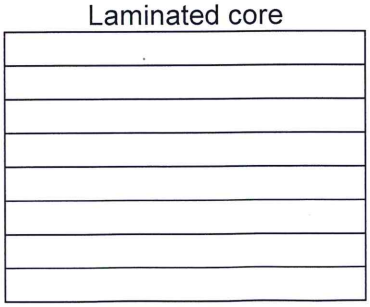
Describe the purpose and properties of the core. (2 marks)

(e) The photograph below shows the laminae (a number of thin iron sheets separated by non-electrically conductive material, such as plastic) that make up the core. These laminae are used to reduce 'eddy currents' or 'back emf' and make transformers more efficient.

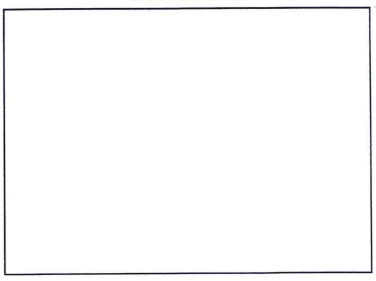
Use the following diagrams representing the centre pillar of the transformer and any relevant formula to explain why a transformer with a laminated core is more efficient than a transformer with a solid core. (4 marks)



Laminated core



Solid core



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Question 5 2013:1:3

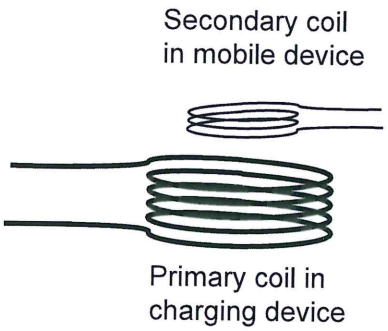
(3 marks)

Explain, using an appropriate formula, why high-voltage power lines are used when transporting electrical power over large distances.

Question 6 2013:1:11

(6 marks)

Inductive charging is becoming more popular for mobile devices such as phones. A simplified diagram of the charging system is shown below.



(a) Assume that one such charging system runs directly from the mains power (240 V AC) to charge a device that requires an input of 4 V. Describe the transformer and the relationship between the two coils. (3 marks)

(b) Use appropriate formulae or relationships to explain how this inductive charging system works. (3 marks)