PEAK
PHYSICS & CHEMISTRY

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Module 6: Electromagnetism

Topic 3.2: Electromagnetic Induction

Foundation

1. State the purpose of transformers and identify the two types of transformers.

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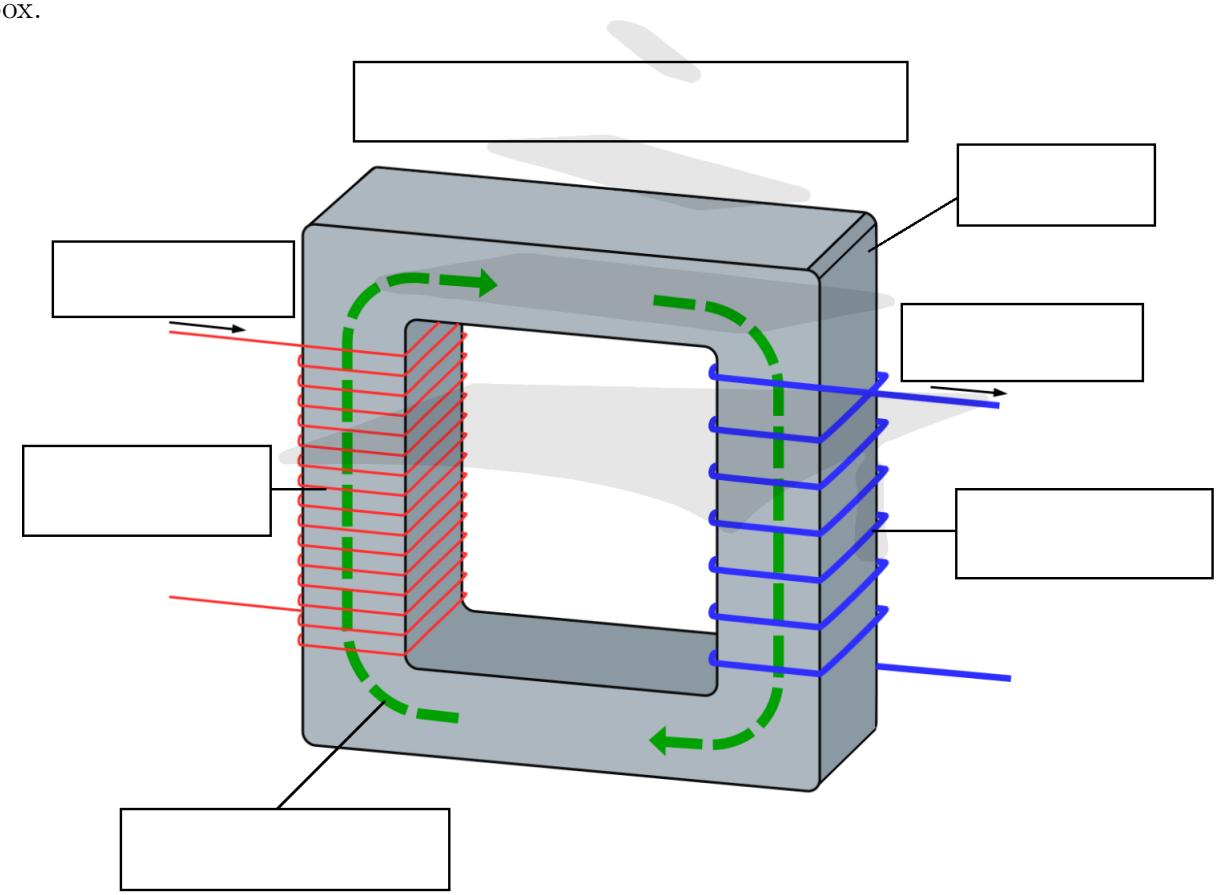
2. Label each component of the transformer below and identify the type of transformer in the top box.



3. Define flux linkage and include a relevant formula in your definition.

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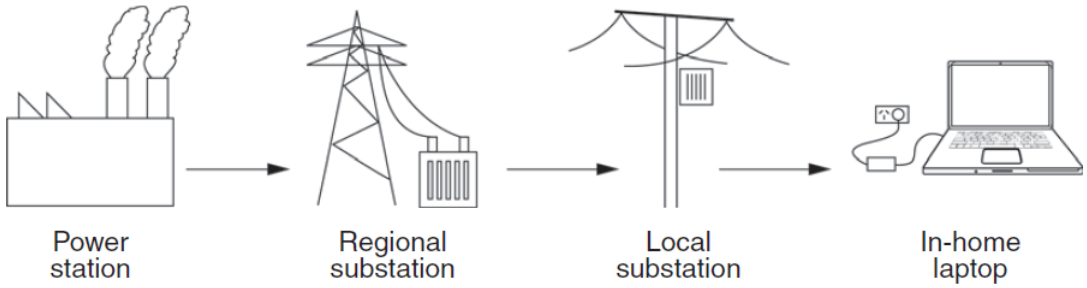
4. Circle the appropriate options to represent the correct use of transformers in the following electrical transfer.



Step-up/Step-down Step-up/Step-down Step-up/Step-down Step-up/Step-down

5. Identify which transformer is used before transmitting energy between the power station and local substations and outline why it is used.

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Development

1. Eddy currents are a major source of energy loss in an iron core transformer.

   What is one way to minimise this energy loss?

   (a) Laminating the iron core with an insulator

   (b) Decrease the number of turns in the primary coil

   (c) Replace the iron core with a copper core

   (d) Decrease the distance between the primary and secondary coils

2. A transformer changes 240 V to 24000 V.

   Which of the following statements is true?

   (a) It is a step-down transformer

   (b) The primary coil has more turns than the secondary coil

   (c) There is a greater current flowing through the secondary coil than in the primary coil

   (d) The ratio of turns in the primary coil to the secondary coil is 1:100

3. The primary coil of a transformer contains 5000 turns. The primary AC voltage is 5×10^4 V and the output voltage is 9.9×10^5 V .

   (a) Calculate the number of turns on the secondary winding. **1**

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   (b) Given the input current is 100 A, and the secondary winding has a resistance of 2500 Ω, calculate the power loss in the secondary winding, assuming there is zero power loss in the primary winding. **3**

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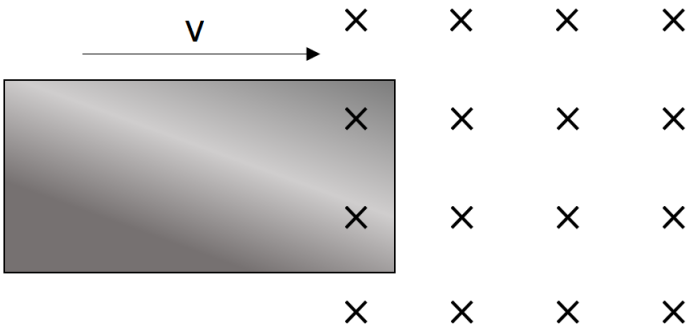
   ★ 99000, 63769 W ★

4. A metallic sheet enters a magnetic field which runs into the page as shown.



(a) Draw the induced eddy current on the diagram above and clearly indicate the direction of the eddy current. **1**

(b) Explain the change in motion experienced by the sheet upon entering the magnetic field. **2**

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(c) Explain what would be observed if a plastic sheet was used instead of a metallic sheet. **1**

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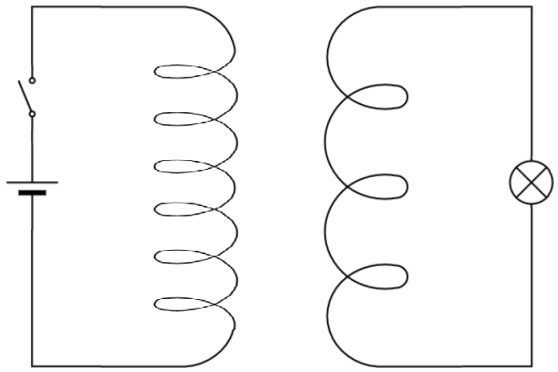
5. An early physicist patents his prototype transformer where two coils are situated in vicinity, with one connected to a DC supply and the other to a light bulb as shown below. The switch is initially open.



(a) Explain why the bulb lights up only for a brief moment when the switch closes. **2**

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(b) The DC supply is now changed to an AC supply. **2**

Given that the secondary coil has half the turns of the primary coil, and that the input current is 50 A, calculate the current flowing through the bulb.

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★ 100 A ★

6. One of the many limitations of the iron core transformer is the unwanted production of eddy currents. **4**

Explain the effect of eddy currents on an iron core transformer and the strategies employed to alleviate the problem.

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7. An air core transformer has an input power of 500 MW and an efficiency of 33.33%.

(a) If the primary current is 300 kA, calculate the primary voltage. **1**

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(b) Given the secondary voltage is 3.2 kV, calculate the secondary current. **2**

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(c) What is the output power if an ideal transformer with 100% efficiency was used instead? **1**

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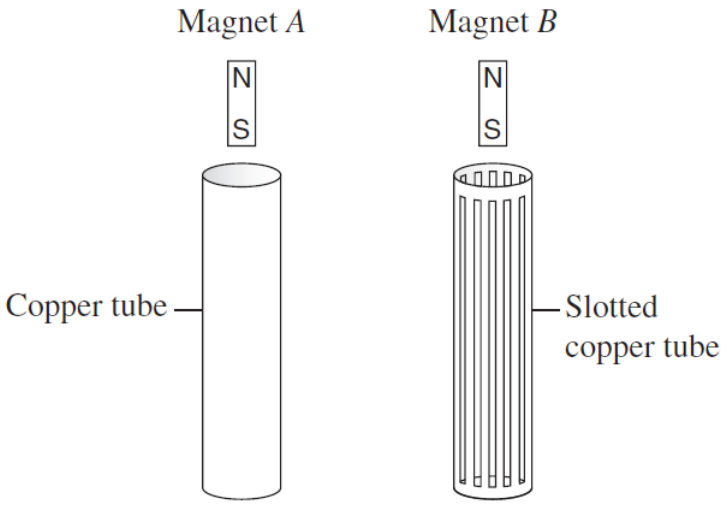
★ 1667 V, 52083 A ★

8. Identical magnets A and B are suspended above vertical copper tubes as shown in the diagram. **4**



The magnets are dropped simultaneously. Each magnet falls straight through its tube without touching the tube walls.

Identify which magnet leaves the tube first and explain why with reference to relevant physics principles.

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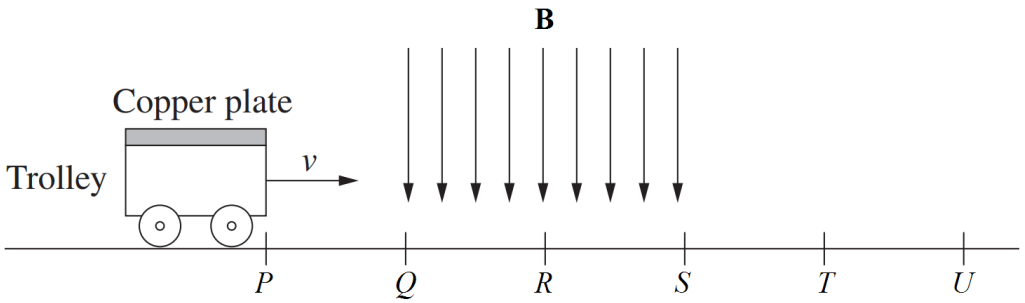
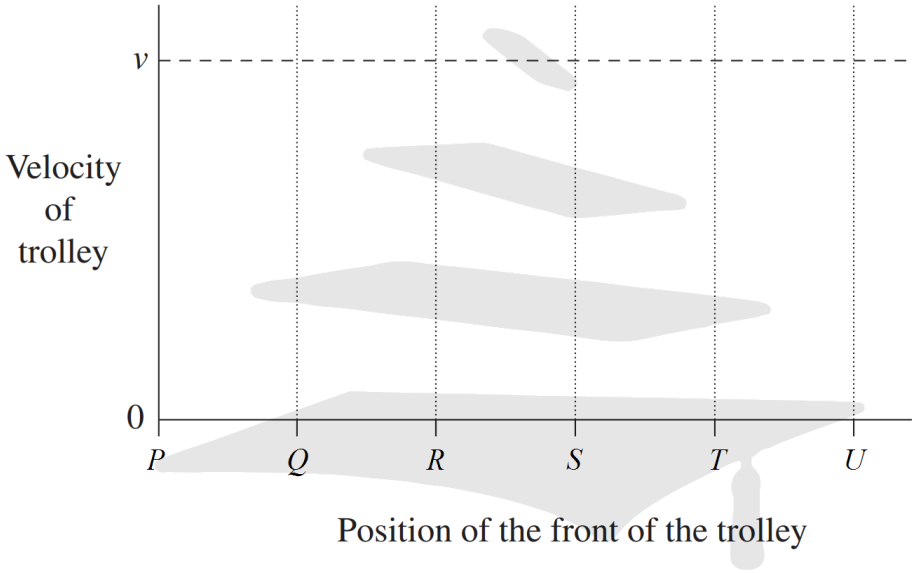
9. A copper plate is attached to a lightweight trolley. The trolley moves at an initial velocity, v, across a smooth table. There is a strong magnetic field **B** pointing downwards in between positions Q and S. **5**



The dashed line on the graph shows the velocity of the trolley when the magnetic field is not present.

On the axes, sketch the graph of the velocity of the trolley as it travels from P to U under the magnetic field, and justify your graph.



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