Physics · Electric Current and Electromagnetism · Electromagnetic Induction

The Transformer

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Multiple choice questions — 104 questions

1 The transformer does not do its job when the current flowing in its primary coil is .....

(A) varying in magnitude and in one direction

(B) alternating

(C) constant in magnitude and in one direction

(D) of high frequency

---

2 Which of the following choices describes the parts of a step-up transformer?

(A) Input voltage: direct, core: steel, primary coil: 100 turns, secondary coil: 10 turns

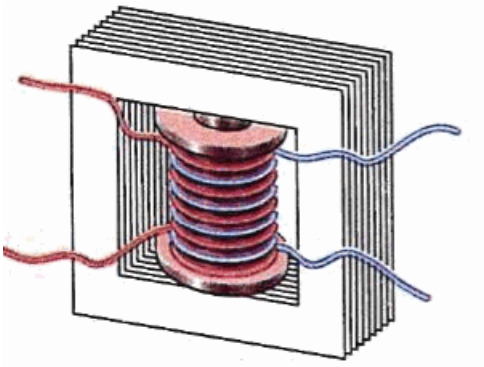
(B) Input voltage: direct, core: soft iron, primary coil: 10 turns, secondary coil: 100 turns

(C) Input voltage: alternating, core: soft iron, primary coil: 100 turns, secondary coil: 10 turns

(D) Input voltage: alternating, core: soft iron, primary coil: 10 turns, secondary coil: 100 turns

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3 The transformer is designed so that the turns of its primary and secondary coils are insulated and interleaved as in the opposite figure. This reduces the electrical energy lost due to .....



(A) eddy currents

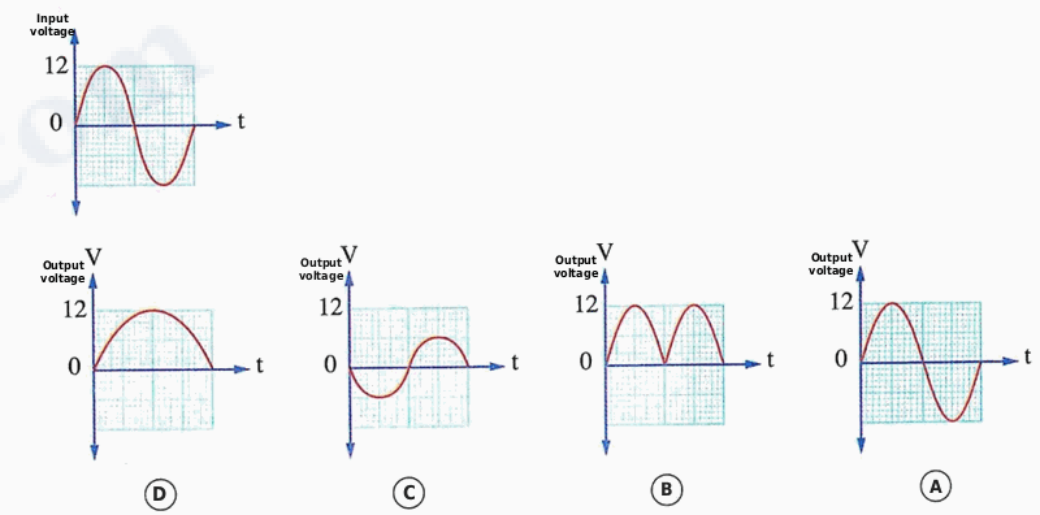
(B) electrical resistance

(C) magnetic flux leakage

(D) self-induction

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4 The opposite figure shows the input voltage of a step-down transformer during a certain time interval, so the output voltage during the same time interval is .....



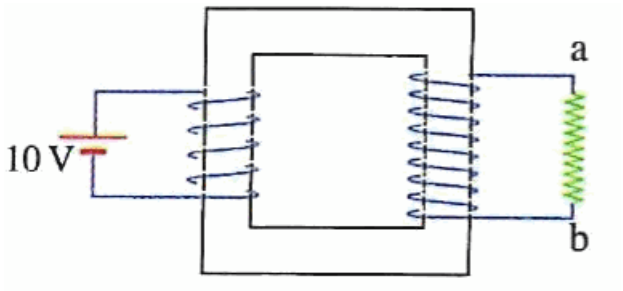
5 The physical quantity that is smaller in the secondary coil of an ideal step-up transformer than in the primary coil is .....

(A) the electric power
(B) the maximum value of the current
(C) the frequency of the current
(D) the magnetic flux

6 The physical quantity that increases in the secondary coil of an ideal step-down transformer is .....

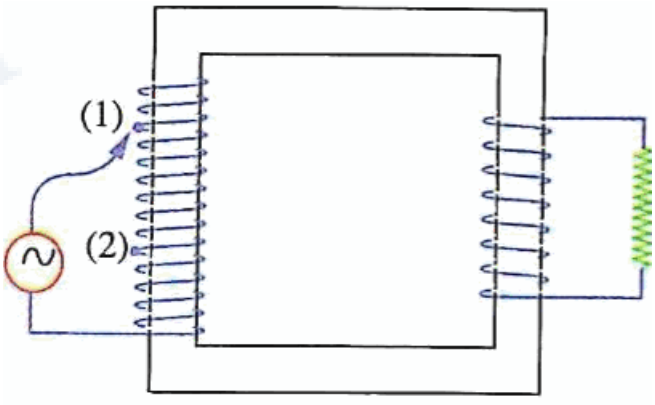
(A) the electric power
(B) the current
(C) the frequency of the current
(D) the magnetic flux

7 In the figure shown, the potential difference between points a, b is .....



(A) less than 10 V
(B) greater than 10 V
(C) equal to 10 V
(D) equal to zero

8 The opposite figure shows an ideal transformer. If the slider is moved from point (1) to point (2), then .....



(A) current in the secondary coil: increases, electric power drawn from the AC source: increases

(B) current in the secondary coil: increases, electric power drawn from the AC source: decreases

(C) current in the secondary coil: decreases, electric power drawn from the AC source: increases

(D) current in the secondary coil: decreases, electric power drawn from the AC source: decreases

---

9 An ideal transformer has an input power of 300 Watt and its secondary current is 5 A, so the voltage of its secondary coil equals .....

(A) 20 V (B) 40 V (C) 60 V (D) 100 V

---

10 An ideal transformer is to be used to step up the voltage from 10 V to 50 V. If the number of turns of the primary coil is 80 turns, the number of turns of the secondary coil equals .....

(A) 400 turns (B) 250 turns (C) 200 turns (D) 150 turns

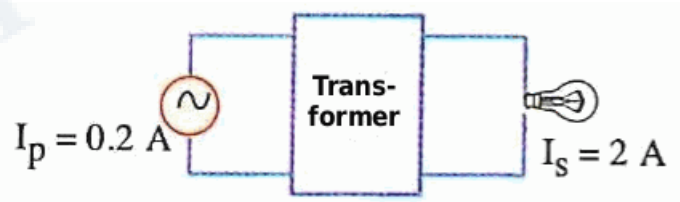
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11 A step-down transformer has an efficiency of 90% and the ratio between the numbers of turns of its two coils is 2 : 33. If the potential difference across its secondary coil is 12 V, the source voltage equals .....

(A) 440 V (B) 244 V (C) 220 V (D) 110 V

---

12 In the opposite figure, an ideal transformer is connected to an AC source and a lamp, so the type of the transformer and the ratio between the numbers of turns of its two coils (N_s/N_p) are .....



(A) step-down, *10/1* (B) step-down, *1/10* (C) step-up, *1/10* (D) step-up, *10/1*

13 An ideal transformer works on a primary voltage of 240 V. If the number of turns of the secondary coil is twice the number of turns of the primary coil and the primary current is 3 A, then:

(1) the potential difference across the secondary coil equals .....

(A) 480 V (B) 240 V (C) 160 V (D) 120 V

14 An ideal transformer works on a primary voltage of 240 V. If the number of turns of the secondary coil is twice the number of turns of the primary coil and the primary current is 3 A, then:

(2) the current in the secondary coil equals .....

(A) 6 A (B) 4.5 A (C) 3 A (D) 1.5 A

15 An ideal transformer works on a primary voltage of 240 V. If the number of turns of the secondary coil is twice the number of turns of the primary coil and the primary current is 3 A, then:

(3) the output electric power equals .....

(A) 720 W (B) 360 W (C) 320 W (D) 240 W

16 An ideal step-down transformer has 5000 turns in its primary coil and 250 turns in its secondary coil. If the voltage of its primary coil is 240 volts, then:

(1) the induced emf across its secondary coil equals .....

(A) 12 V (B) 7 V (C) 6 V (D) 3 V

17 An ideal step-down transformer has 5000 turns in its primary coil and 250 turns in its secondary coil. If the voltage of its primary coil is 240 volts, then:

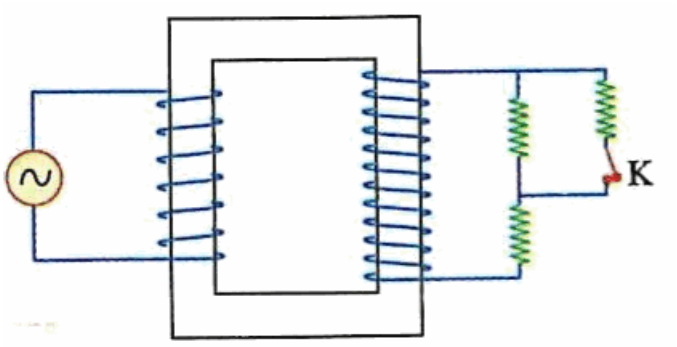
(2) the ratio of the primary current to the secondary current (I_p/I_s) equals .....

(A) *1/20* (B) *20/1* (C) *25/24* (D) *24/25*

---

18 The opposite figure represents an ideal transformer. After opening switch (K):

(1) the potential difference across the secondary coil .....



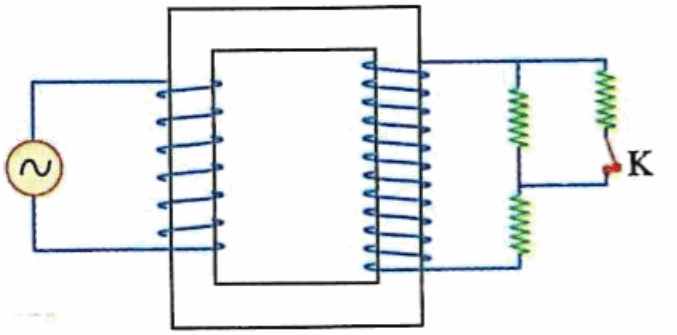
(A) increases (B) decreases

(C) does not change (D) the answer cannot be determined

---

19 The opposite figure represents an ideal transformer. After opening switch (K):

(2) the current flowing in the primary coil .....



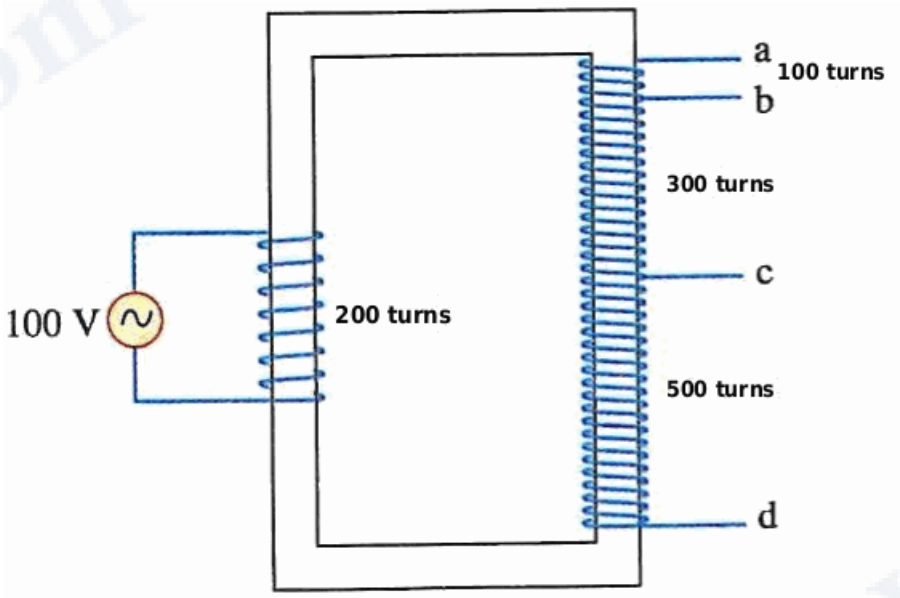
(A) increases (B) decreases

(C) does not change (D) the answer cannot be determined

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20 The opposite figure represents an ideal transformer to be used to operate an electrical device. Which two points can the device be connected to if the device works on:

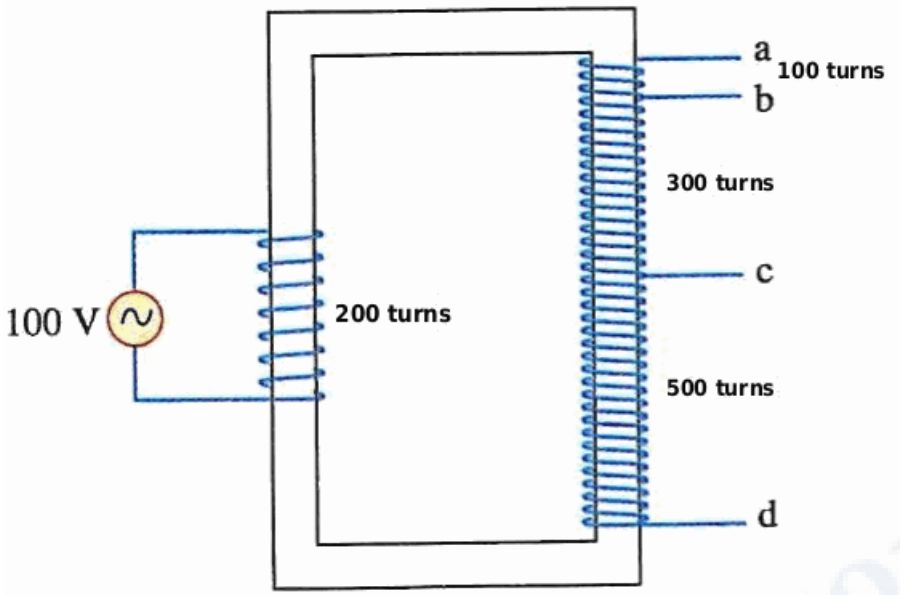
(1) a potential difference of 50 V?



(A) a, b (B) a, c (C) b, d (D) a, d

21 The opposite figure represents an ideal transformer to be used to operate an electrical device. Which two points can the device be connected to if the device works on:

(2) a potential difference of 400 V?



(A) a, c (B) b, c (C) b, d (D) c, d

22 An ideal transformer is connected to an AC source of 50 V and raises the voltage by 25 V. When 40 turns are cut from the secondary coil and the rest of it is connected to the transformer, the transformer lowers the voltage by 25 V. The number of turns of the primary coil equals .....

(A) 20 (B) 40 (C) 60 (D) 80

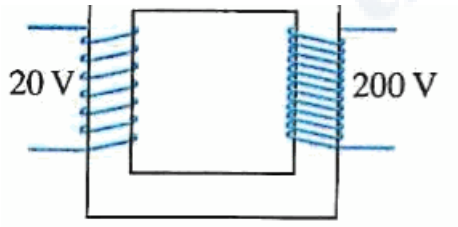
23 A transformer is used to step up the voltage from 120 V to 3000 V. The current in its primary coil is 2 A and the current in its secondary coil is 0.06 A, so the efficiency of this transformer equals .....

(A) 75% (B) 80% (C) 85% (D) 100%

24 A transformer changes the alternating voltage from 220 V to 17.6 V and the ratio between the numbers of turns of its two coils is 10 : 1, so the efficiency of the transformer equals .....

(A) 80% (B) 40% (C) 8% (D) 0.8%

25 The opposite figure shows a step-down transformer with an efficiency of 80%. If the number of turns of the primary coil is 640 turns, the number of turns of the secondary coil equals .....



(A) 80 turns (B) 70 turns (C) 40 turns (D) 20 turns

26 A transformer efficiency of 80% means that .....

(A) the electric power lost in it is 80%

(B) the power of the secondary coil is 20% of the power of the primary coil

(C) the electric power lost in it is 20%

(D) the power of the primary coil is 80% of the power of the secondary coil

27 A transformer has an efficiency of 80%. Its primary coil is connected to an AC source of power 40 kW, so the power of the secondary coil equals .....

(A) 38 kW (B) 8 kW (C) 48 kW (D) 32 kW

28 In an ideal transformer, the ratio of the number of turns of the secondary coil to the number of turns of the primary coil is *3/2*. If the output power of the transformer is P_w, then the input power in its primary coil equals .....

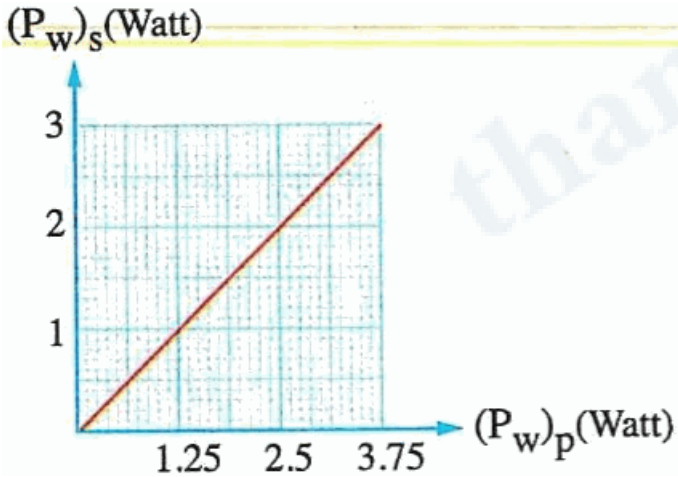
(A) P_w (B) $1.5\ P_w$ (C) $2/3\ P_w$ (D) $5\ P_w$

29 A transformer has an efficiency of 96% and the ratio between the numbers of turns of its two coils is $N_p/N_s = 8/5$, so the ratio between the currents in the two coils of the transformer (I_p/I_s) equals .....

(A) *8/5* (B) *3/5* (C) *5/3* (D) *5/8*

30 The opposite graph represents the relation between the power of the secondary coil $(P_w)_s$ and the power of the primary coil $(P_w)_p$ of a step-down transformer. The ratio between the numbers of turns of its two coils is *1/20*, so:

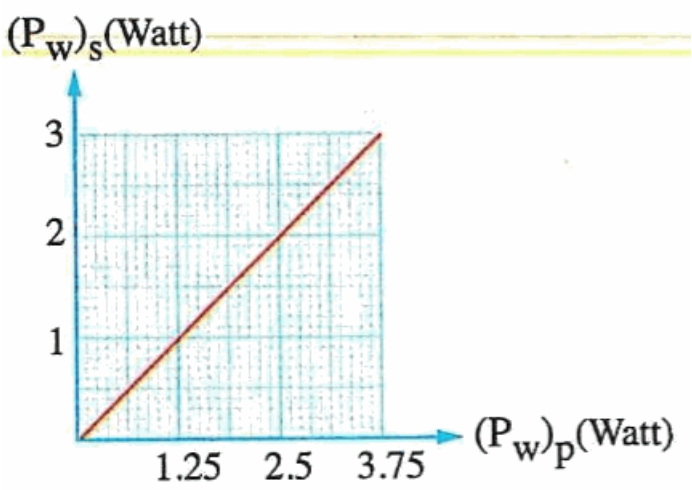
(1) the efficiency of the transformer equals .....



(A) 100% (B) 95% (C) 80% (D) 75%

31 The opposite graph represents the relation between the power of the secondary coil $(P_w)_s$ and the power of the primary coil $(P_w)_p$ of a step-down transformer. The ratio between the numbers of turns of its two coils is *1/20*, so:

(2) the current in the primary coil, if the current in the secondary coil is 2 A, equals .....



(A) 0.1 A (B) 0.2 A (C) 0.3 A (D) 0.4 A

---

32 A step-up transformer has an efficiency of 80% and the ratio between the number of turns of its primary coil and the number of turns of its secondary coil is 1 : 16, so the ratio between the frequency of the current in its primary coil and in its secondary coil is .....

(A) 16 : 1 (B) 10 : 8 (C) 1 : 16 (D) 1 : 1

---

33 A transformer with an efficiency of 90% is connected to an AC source of 110 V. If the currents in its primary and secondary coils are 2 A and 18 A respectively, then:

(1) the output power of the secondary coil equals .....

(A) 120 W (B) 150 W (C) 167 W (D) 198 W

---

34 A transformer with an efficiency of 90% is connected to an AC source of 110 V. If the currents in its primary and secondary coils are 2 A and 18 A respectively, then:

(2) the ratio of the number of turns of the primary coil to the number of turns of the secondary coil equals .....

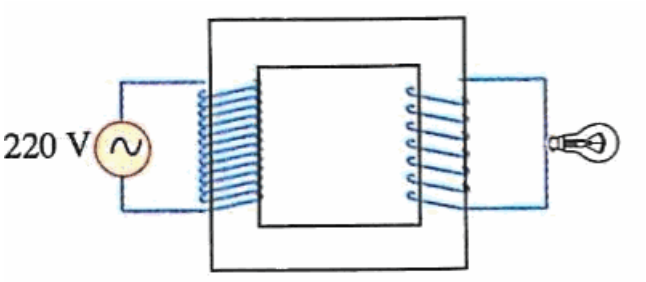
(A) *9/1* (B) *1/9* (C) *10/1* (D) *1/10*

---

35 A transformer with an efficiency of 96% is connected to ten electric ovens connected in parallel. Each works on a potential difference of 220 V and carries a current of 15 A, so the electric power consumed in the primary coil equals .....

(A) 3.9×10^4 W (B) 3.8×10^4 W (C) 3.6×10^4 W (D) 3.4×10^4 W

36 In the opposite figure, a transformer with an efficiency of 96% has 440 turns in its primary coil. Its secondary coil is connected to a lamp of power 36 W that works on a potential difference of 24 V, so the number of turns of the secondary coil connected to the lamp, so that the lamp works at its full power, equals .....

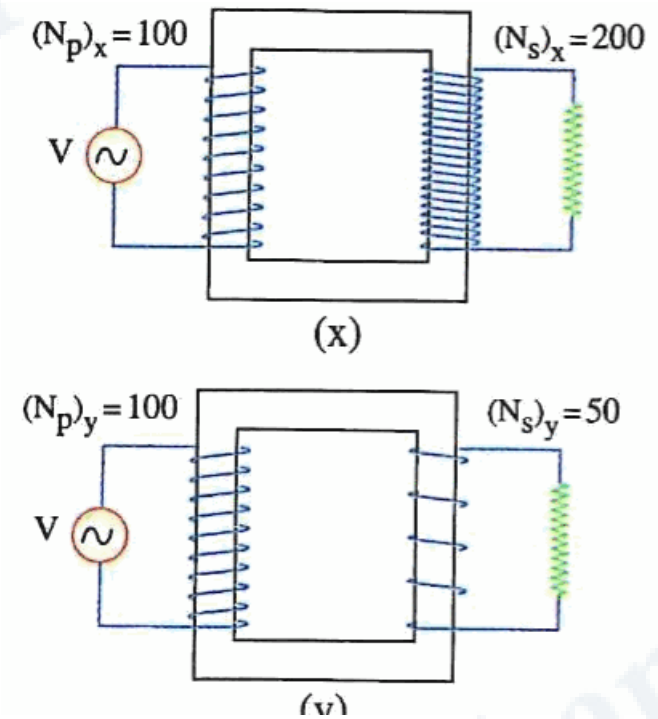


(A) 36 turns (B) 50 turns (C) 110 turns (D) 220 turns

37 An ideal transformer is connected to an AC source of 30 V, and the potential difference across each turn of the secondary coil is 0.3 V, so the number of turns of the primary coil equals .....

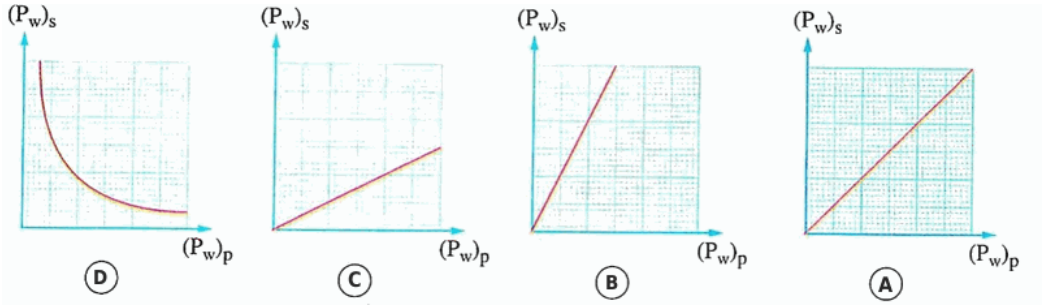
(A) 50 (B) 100 (C) 150 (D) 200

38 In the opposite figure, two transformers (x), (y) have efficiencies of 80%, 90% respectively, and each is connected to a source of voltage V. The ratio of the potential difference per turn of the secondary coil of transformer (x) to that of transformer (y) is .....

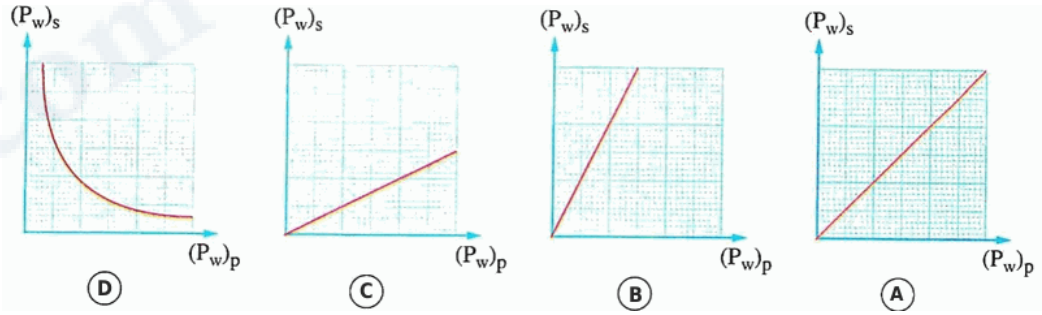


(A) *1/4* (B) *4/1* (C) *8/9* (D) *9/8*

39 Which of the following graphs represents the relation between the power of the secondary coil $(P_w)_s$ and the power of the primary coil $(P_w)_p$ in an ideal transformer? (note that the two quantities are drawn on the two axes with the same scale)



40 Which of the following graphs represents the relation between the power of the secondary coil $(P_w)_s$ and the power of the primary coil $(P_w)_p$ in a non-ideal transformer? (note that the two quantities are drawn on the two axes with the same scale)



41 An ideal step-down transformer has 100 turns and 80 turns in its two coils. If an electrical device of power 1.5 kW, working on a potential difference whose maximum value is $60\sqrt{(2)}$ V, is connected to the secondary coil, then the effective value of the current in the primary coil equals .....

(A) 31.25 A (B) 27.25 A (C) 22 A (D) 20 A

42 A transformer with an efficiency of 80% is connected to an AC source whose effective voltage is 240 V. If the power consumed in the primary coil is 120 W, the number of turns of the primary coil is 3000 turns and the number of turns of the secondary coil is 1500 turns, then the type of the transformer and the current flowing in the secondary coil respectively are .....

(A) step-down transformer, 0.6 A (B) step-down transformer, 1 A
(C) step-up transformer, 1 A (D) step-up transformer, 0.6 A

43 A step-down transformer with an efficiency of 100% has 600 turns in its secondary coil. It is used to operate a device of power 48 W and potential difference 24 V, using a source of emf 200 V, so:

(1) the number of turns of the primary coil equals .....

(A) 10000 turns (B) 5000 turns (C) 2500 turns (D) 1250 turns

44 A step-down transformer with an efficiency of 100% has 600 turns in its secondary coil. It is used to operate a device of power 48 W and potential difference 24 V, using a source of emf 200 V, so:

(2) the current flowing in the secondary coil equals .....

(A) 2 A (B) 1.5 A (C) 1 A (D) 0.5 A

45 A step-down transformer with an efficiency of 100% has 600 turns in its secondary coil. It is used to operate a device of power 48 W and potential difference 24 V, using a source of emf 200 V, so:

(3) the current flowing in the primary coil equals .....

(A) 0.06 A (B) 0.12 A (C) 0.18 A (D) 0.24 A

46 The ratio between the numbers of turns of the two coils of an ideal step-up transformer is 100 : 1. If its primary coil is connected to an AC source of 200 volts, then:

(1) the induced emf in the secondary coil equals .....

(A) 2×10^4 V (B) 2×10^3 V (C) 2×10^2 V (D) 2 V

47 The ratio between the numbers of turns of the two coils of an ideal step-up transformer is 100 : 1. If its primary coil is connected to an AC source of 200 volts, then:

(2) the ratio of the current in the primary coil to the current in the secondary coil respectively equals .....

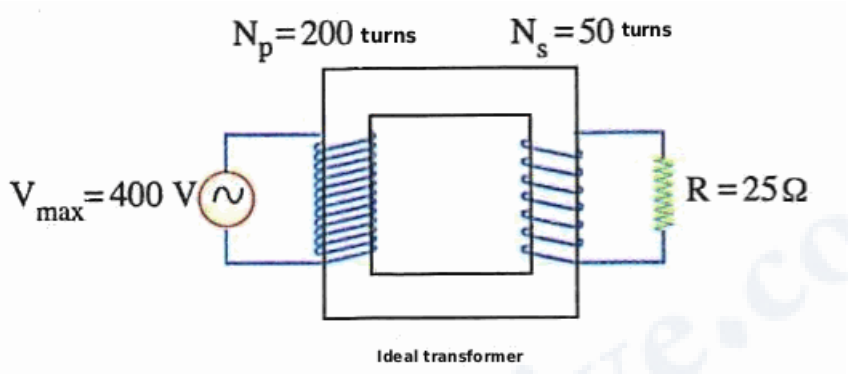
(A) *1/200* (B) *1/100* (C) *100/1* (D) *200/1*

48 The ratio between the numbers of turns of the two coils of an ideal step-up transformer is 100 : 1. If its primary coil is connected to an AC source of 200 volts, then:

(3) the output power in the secondary coil, if the resistance of its circuit is 10 kΩ, equals .....

(A) 4 W (B) 400 W (C) 4×10^3 W (D) 4×10^4 W

49 In the opposite figure, the primary coil of an ideal transformer is connected to an AC source whose maximum voltage is 400 V, so the electric power consumed in resistor R equals .....



(A) 100 W (B) 200 W (C) 300 W (D) 400 W

50 A transformer loses 36 kJ of electrical energy during one hour of operation. The potential difference across its secondary coil is 5 V and the current in its secondary coil is 8 A, so the efficiency of the transformer equals .....

(A) 25% (B) 40% (C) 80% (D) 90%

---

51 The secondary coil of an ideal transformer is connected to a lamp of resistance 10 ohm that consumes 3000 joules of electrical energy in 5 minutes. If the emf of the source connected to the primary coil is 200 volts, then:

(1) the effective value of the current in the primary coil equals .....

(A) 2.22×10^{-4} A (B) 0.013 A (C) 0.05 A (D) 3 A

---

52 The secondary coil of an ideal transformer is connected to a lamp of resistance 10 ohm that consumes 3000 joules of electrical energy in 5 minutes. If the emf of the source connected to the primary coil is 200 volts, then:

(2) the effective value of the current in the secondary coil equals .....

(A) 0.25 A (B) 1 A (C) 1.25 A (D) 2 A

---

53 The secondary coil of an ideal transformer is connected to a lamp of resistance 10 ohm that consumes 3000 joules of electrical energy in 5 minutes. If the emf of the source connected to the primary coil is 200 volts, then:

(3) the potential difference across the secondary coil equals .....

(A) 2.5 V (B) 5 V (C) 10 V (D) 20 V

---

54 A transformer is connected to an AC source of 220 V and a current of effective value 10 A flows in its primary coil. If the output power in the secondary coil is 1980 W and the induced potential difference across it is 22 V, then:

(1) the efficiency of the transformer equals .....

(A) 30% (B) 45% (C) 75% (D) 90%

---

55 A transformer is connected to an AC source of 220 V and a current of effective value 10 A flows in its primary coil. If the output power in the secondary coil is 1980 W and the induced potential difference across it is 22 V, then:

(2) the resistance of the secondary coil circuit equals .....

(A) 0.24 Ω (B) 0.12 Ω (C) 0.11 Ω (D) 0.01 Ω

---

56 A step-down transformer has an efficiency of 90%, a primary voltage of 200 V and a secondary voltage of 9 V. If the current in the primary coil is 0.5 A and the number of turns of the secondary coil is 90 turns, then the current in the secondary coil and the number of turns of the primary coil respectively are .....

(A) 10 A, 1800 turns (B) 10 A, 900 turns (C) 5 A, 1800 turns (D) 5 A, 900 turns

57 A step-down transformer with an efficiency of 80% works on a source of emf 2500 V. Its secondary coil gives a current of 80 A and the ratio of the number of turns of the primary coil to that of the secondary coil is 20 : 1, so the emf across the secondary coil and the current flowing in the primary coil respectively are .....

(A) 100 V, 4 A (B) 50 V, 2 A (C) 100 V, 2 A (D) 50 V, 4 A

58 A transformer with an efficiency of 80% works on an AC source of emf 200 V to give an emf of 8 V. If the number of turns of the primary coil is 1600 turns and the current in it is 0.2 A, then:

(1) the number of turns of the secondary coil equals .....

(A) 100 turns (B) 80 turns (C) 60 turns (D) 20 turns

59 A transformer with an efficiency of 80% works on an AC source of emf 200 V to give an emf of 8 V. If the number of turns of the primary coil is 1600 turns and the current in it is 0.2 A, then:

(2) the electric power lost in the transformer equals .....

(A) 8 W (B) 25.6 W (C) 32 W (D) 40 W

60 A transformer with an efficiency of 80% works on an AC source of emf 200 V to give an emf of 8 V. If the number of turns of the primary coil is 1600 turns and the current in it is 0.2 A, then:

(3) the current in the secondary coil equals .....

(A) 16 A (B) 5.3 A (C) 4 A (D) 3.2 A

61 An ideal transformer has 1100 turns in its primary coil and works on a potential difference of 220 V. It has two secondary coils x, y. Coil x is connected to a small electric fan that works on (6 V, 0.4 A) and coil y is connected to an electric bell that works on (12 V, 0.35 A), so:

(1) the numbers of turns of the two secondary coils x, y respectively are .....

(A) 30 turns, 60 turns
(B) 20 turns, 60 turns
(C) 15 turns, 30 turns
(D) 15 turns, 20 turns

---

62 An ideal transformer has 1100 turns in its primary coil and works on a potential difference of 220 V. It has two secondary coils x, y. Coil x is connected to a small electric fan that works on (6 V, 0.4 A) and coil y is connected to an electric bell that works on (12 V, 0.35 A), so:

(2) the current of the primary coil when the fan and the bell work together equals .....

(A) 0.06 A
(B) 0.04 A
(C) 0.03 A
(D) 0.015 A

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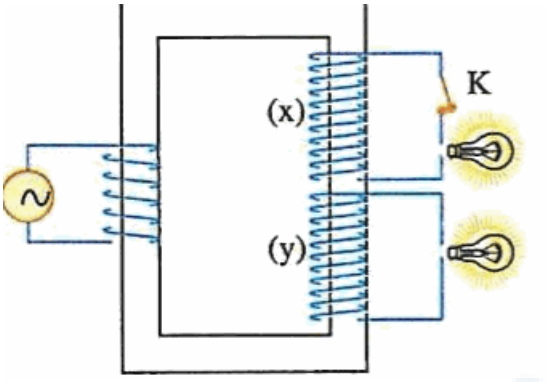
63 A television works on an alternating voltage of maximum value 550 V and frequency 50 Hz. It gets this voltage through a step-up transformer whose primary coil is connected to the terminals of an AC dynamo whose coil has dimensions 20 cm, 10 cm and a flux density of 0.14 Tesla. If the number of turns of the dynamo coil equals half the number of turns of the primary coil of the transformer, then the number of turns of the secondary coil of the transformer equals ..... (assume the efficiency of the transformer is 100%)

(A) 1250 turns
(B) 625 turns
(C) 312 turns
(D) 12.5 turns

---

64 An ideal transformer has (N) turns in its primary coil and two secondary coils (x), (y), each of (2 N) turns and each connected to a lamp of resistance (R) as in the opposite figure. After opening switch (K):

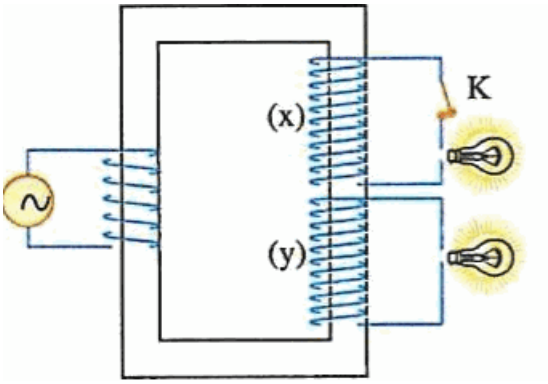
(1) the brightness of the lamp connected to coil (y) .....



(A) increases
(B) decreases but does not become zero
(C) becomes zero
(D) does not change

65 An ideal transformer has (N) turns in its primary coil and two secondary coils (x), (y), each of (2 N) turns and each connected to a lamp of resistance (R) as in the opposite figure. After opening switch (K):

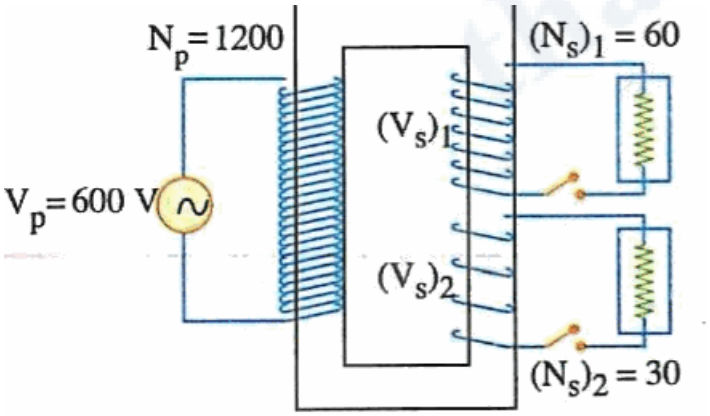
(2) the electric power drawn from the AC source .....



(A) is doubled
(B) is halved
(C) increases to four times
(D) decreases to a quarter

---

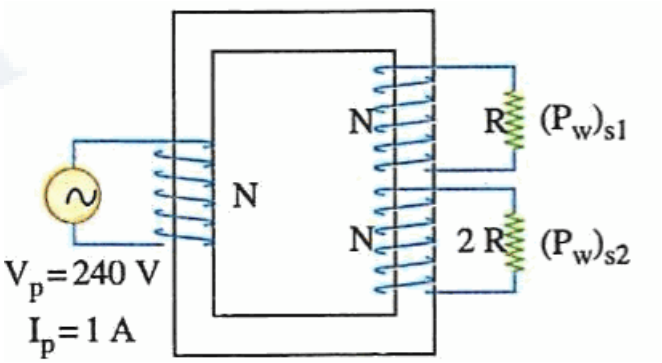
66 The opposite figure shows an ideal transformer with two secondary coils. When each device is operated alone, the values of $(V_s)_1$, $(V_s)_2$ respectively are .....



(A) 300 V, 150 V
(B) 120 V, 60 V
(C) 30 V, 50 V
(D) 30 V, 15 V

---

67 The opposite figure shows a non-ideal transformer with two secondary coils. What are the possible values of the electric power in the two secondary coils of this transformer?



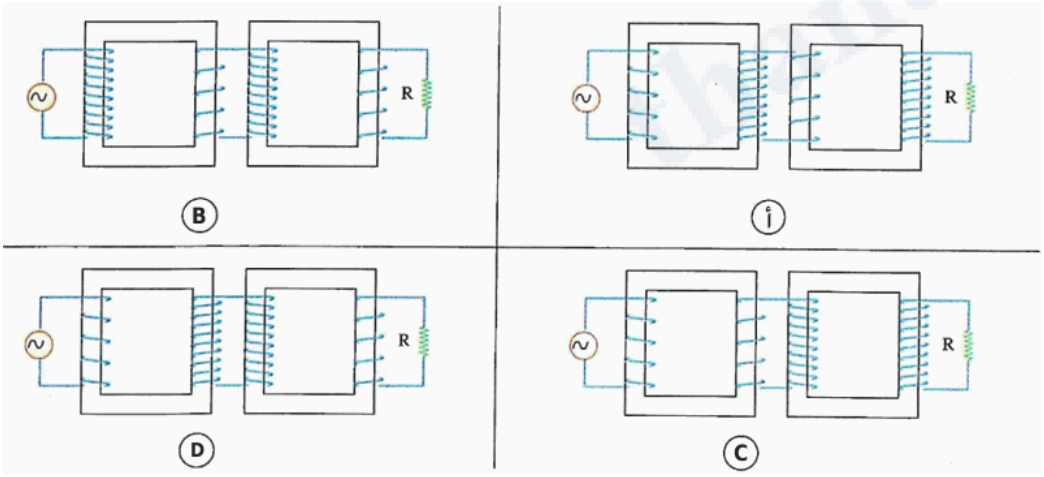
(A) $(P_w)_{s1}$: 120 W, $(P_w)_{s2}$: 120 W

(B) $(P_w)_{s1}$: 100 W, $(P_w)_{s2}$: 100 W

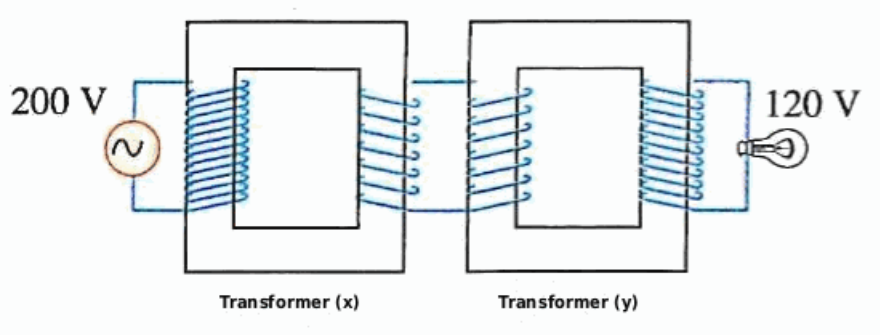
(C) $(P_w)_{s1}$: 80 W, $(P_w)_{s2}$: 160 W

(D) $(P_w)_{s1}$: 120 W, $(P_w)_{s2}$: 60 W

68 An AC source, a resistor (R) and four coils of 50, 50, 100, 100 turns were used four times to form two ideal transformers connected to each other each time, as in the following figures. In which of these figures is the potential difference across resistor (R) the greatest?

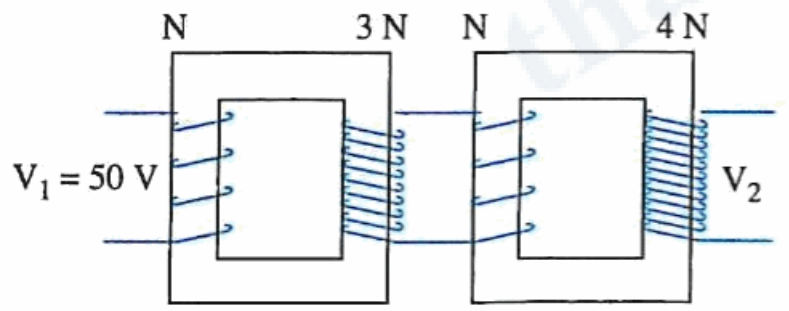


69 In the opposite figure, two ideal transformers x, y are connected together. The primary coil of transformer x is connected to an AC source of 200 V and the secondary coil of transformer y is connected to a lamp that works on a potential difference of 120 V. If the ratio between the numbers of turns of the two coils of transformer x is $(((N_s)_x)/((N_p)_x) = 1/3)$, then the ratio between the numbers of turns of the two coils of transformer y $(((N_p)_y)/((N_s)_y))$ equals .....



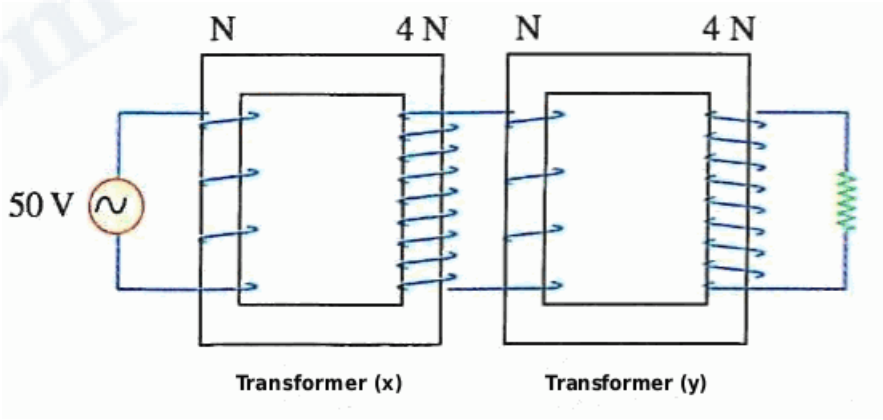
(A) 3/8 (B) 2/5 (C) 4/7 (D) 5/9

70 In the opposite figure, two ideal transformers are connected in series, so the value of V_2 equals .....



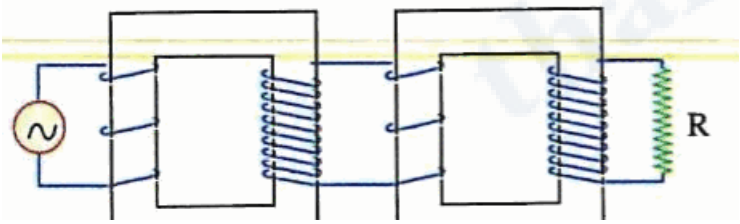
(A) 300 V (B) 450 V (C) 600 V (D) 900 V

71 Two transformers (x), (y) are connected together, each has an efficiency of 75%, and their numbers of turns are as in the opposite figure. If the voltage of the AC source is 50 V, then the potential difference across the secondary coil of transformer (y) equals .....



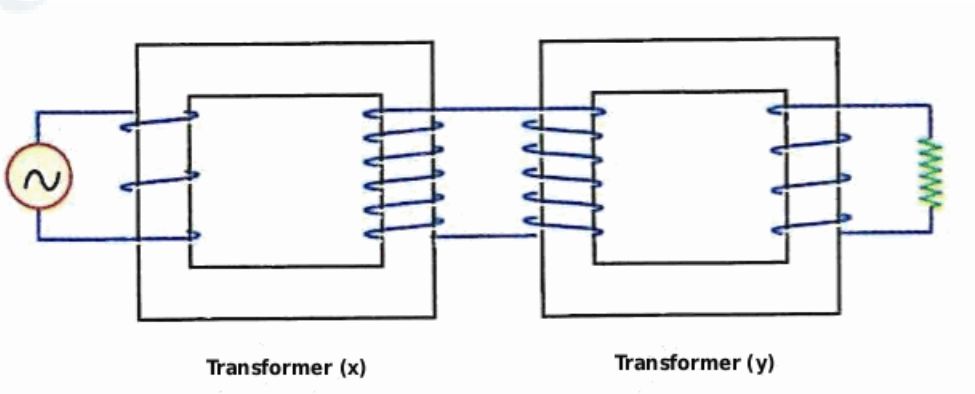
(A) 150 V (B) 450 V (C) 600 V (D) 800 V

72 Two transformers, each with an efficiency of 90%, are connected together as in the opposite figure, so the ratio between the electric power consumed in resistor (R) and the electric power drawn from the source equals .....



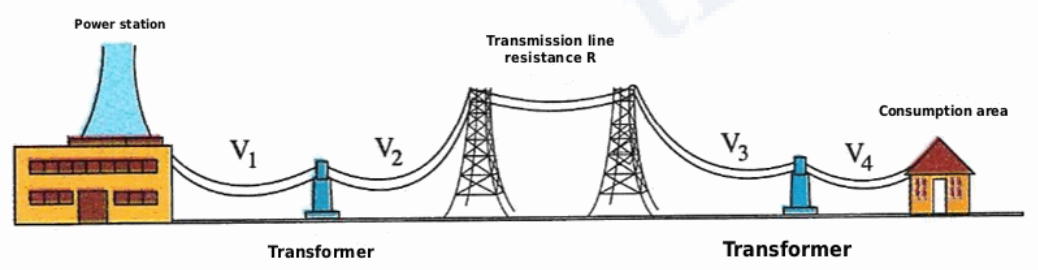
(A) *9/10* (B) *9/100* (C) *81/10* (D) *81/100*

73 In the opposite figure, two transformers (x), (y) are connected together. Transformer (x) has a turns ratio of *1/2* and works on an AC source of 220 V, and transformer (y) has a turns ratio of *3/2* and the potential difference across its secondary coil is 110 V. If the ratio between the efficiencies of the two transformers $((eta_x)/(eta_y))$ is *3/2*, then the potential difference across the primary coil of transformer (y) equals .....



(A) 165 V (B) 330 V (C) 440 V (D) 660 V

74 The following figure represents the transmission of electrical energy from the power stations to the areas of consumption. Which of the potential differences shown on the figure has the greatest value?



(A) V_1 (B) V_2 (C) V_3 (D) V_4

75 When electrical energy is transmitted to far places using transformers, if the voltage at the start of the transmission lines is raised to ten times its value, the power lost in the connecting wires decreases to ..... of the power lost at first.

(A) *1/10* (B) *1/100* (C) *1/1000* (D) *1/10000*

76 A power station generates an electric power of 100 kilowatt at a potential difference of 200 volt and is connected to a transformer whose turns ratio is 1 : 5. If wires of resistance 4 ohm are used to transmit this power, the transmission efficiency equals .....

(A) 80% (B) 75% (C) 60% (D) 40%

77 An electric power of 200 kW is to be transmitted from a power station to a factory through a line of resistance 0.5 Ω. If the potential difference at the station is 1000 V, then:

(1) the current in the transmission line equals .....

(A) 200 A (B) 20 A (C) 2×10^{-3} A (D) 2×10^{-4} A

78 An electric power of 200 kW is to be transmitted from a power station to a factory through a line of resistance 0.5 Ω. If the potential difference at the station is 1000 V, then:

(2) the voltage drop across the transmission line equals .....

(A) 10^{-4} V (B) 0.01 V (C) 10 V (D) 100 V

79 An electric power of 200 kW is to be transmitted from a power station to a factory through a line of resistance 0.5 Ω. If the potential difference at the station is 1000 V, then:

(3) the power lost in the transmission line equals .....

(A) 2×10^{4} W (B) 200 W (C) 2×10^{-6} W (D) 2×10^{-8} W

80 Electrical energy is transmitted from a power station by cables (wires) of total resistance 200 Ω. If the potential difference at the station is 2×10^{4} V and its output power is 400 kW, then the power lost in the wires as heat equals .....

(A) 8×10^{4} W (B) 4×10^{3} W (C) 800 W (D) 2 W

81 An ideal transformer has N turns in its primary coil and two secondary coils (x), (y) of 2 N, 4 N turns respectively, each connected across a resistor (R). If the circuits of the two secondary coils are closed together, a current I_p flows in the primary coil, so the currents flowing in coils (x), (y) respectively are .....

(A) $1/4\ I_p$, $1/16\ I_p$ (B) $1/2\ I_p$, $1/8\ I_p$ (C) $1/3\ I_p$, $2/3\ I_p$ (D) $1/10\ I_p$, $1/5\ I_p$

82 The device in which electrical energy changes into mechanical energy is .....

(A) the transformer (B) the electric motor

(C) the electric generator (D) the electric lamp

83 The current flowing in the coil of an electric motor while it rotates is .....

(A) constant in magnitude and direction

(B) varying in magnitude and constant in direction

(C) changing its direction every half cycle

(D) directly proportional to the angle of rotation

---

84 In an electric motor, the current in the coil becomes zero at the moment when .....

(A) the magnetic flux through the coil becomes zero

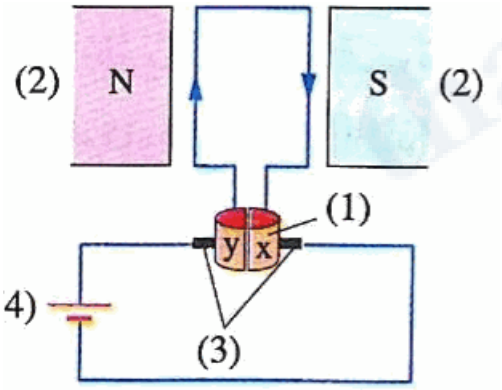
(B) the magnetic flux density reaches its smallest value

(C) the magnetic torque acting on the coil becomes zero

(D) the torque reaches half its maximum value

---

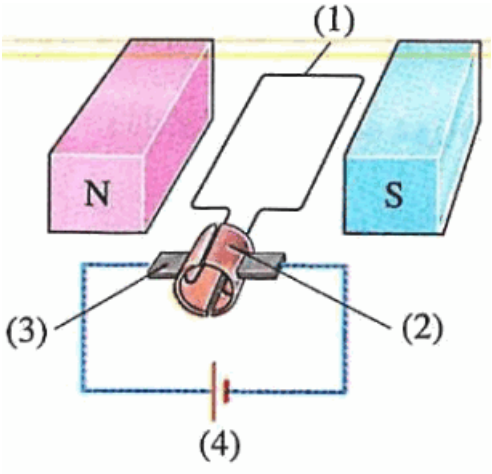
85 The opposite figure shows the structure of the motor. The component that supplies the motor coil with the energy needed for its rotation is .....



(A) component (1) (B) component (2) (C) component (3) (D) component (4)

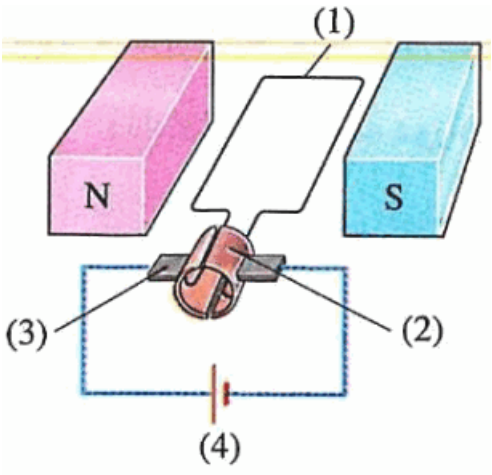
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86 The opposite figure shows the structure of a simple electric motor. Which of the parts shown in the figure can be modified or replaced with another component so that the device can be: (1) of greater mechanical power?



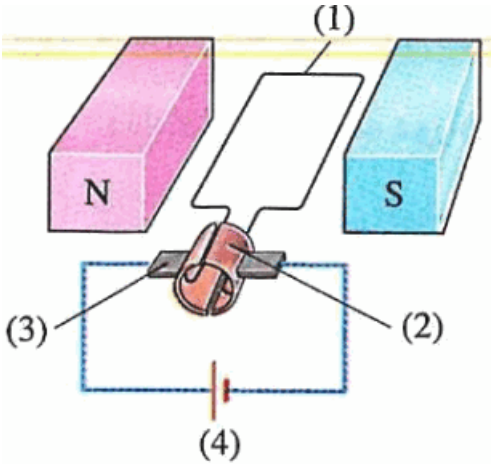
(A) part (2) only
(B) parts (1), (3) together
(C) parts (1), (2) together
(D) parts (2), (3) together

87 The opposite figure shows the structure of a simple electric motor. Which of the parts shown in the figure can be modified or replaced with another component so that the device can be: (2) usable to get an electric current in one direction with varying magnitude?



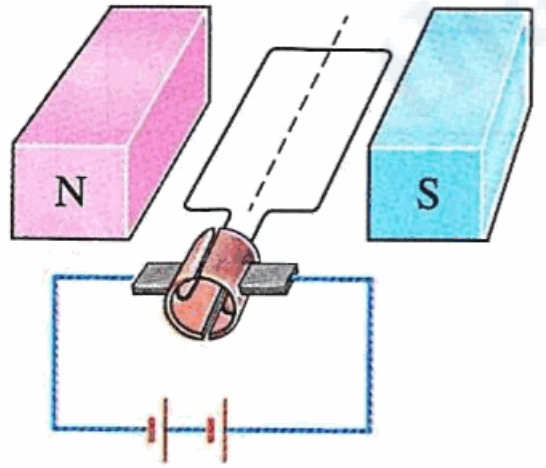
(A) part (1)
(B) part (2)
(C) part (3)
(D) part (4)

88 The opposite figure shows the structure of a simple electric motor. Which of the parts shown in the figure can be modified or replaced with another component so that the device can be: (3) usable to get an alternating current?



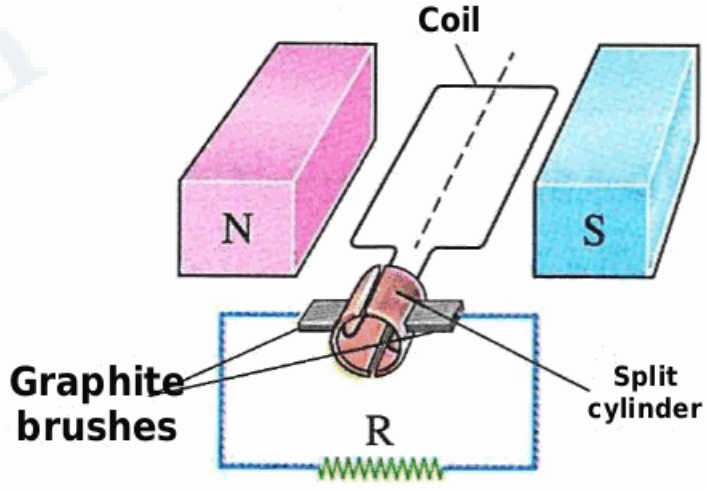
(A) parts (1), (3) together
(B) parts (2), (4) together
(C) parts (1), (2) together
(D) parts (2), (3) together

89 The opposite figure shows the structure of a simple motor, so the coil .....



(A) rotates clockwise
(B) rotates anticlockwise
(C) does not rotate
(D) the answer cannot be determined

90 The opposite schematic diagram shows the structure of an electrical device. What happens if a cell is used instead of resistor R?



(A) the two brushes start rotating

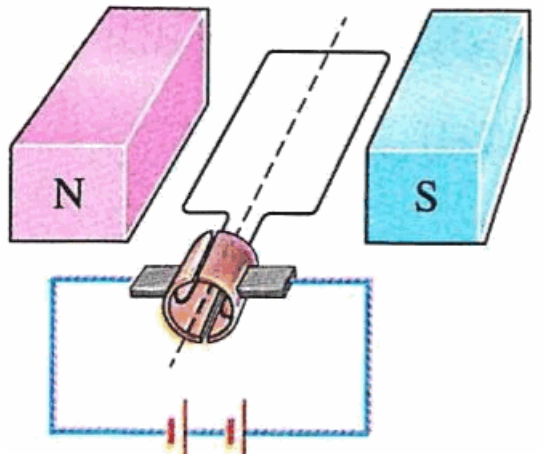
(B) the cylinder starts rotating

(C) the coil stays fixed and does not rotate

(D) the current flows in the coil in one direction

---

91 The opposite figure represents an electric motor whose coil is in a certain position, so the coil:
(1) moves from this position due to .....



(A) the magnetic torque

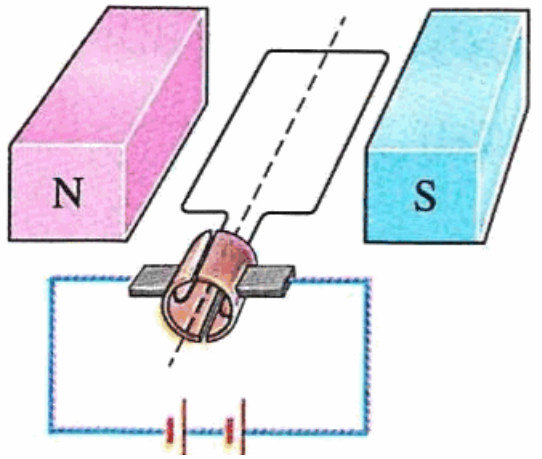
(B) inertia

(C) electromagnetic induction

(D) eddy currents

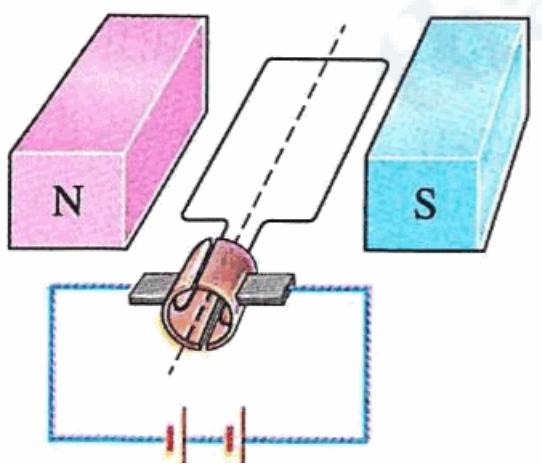
---

92 The opposite figure represents an electric motor whose coil is in a certain position, so the coil:
(2) keeps moving a quarter of a cycle after the position shown due to .....



(A) the magnetic torque
(B) inertia
(C) electromagnetic induction
(D) eddy currents

93 The opposite figure represents an electric motor whose coil is in a certain position, so the coil:
(3) its speed becomes steady after some time of rotation due to .....



(A) the magnetic torque
(B) inertia
(C) eddy currents
(D) an induced back emf

94 An electric motor has a coil resistance of 20 Ω and is connected to a DC source of emf 220 V with negligible internal resistance. If the rotation speed of the motor coil becomes steady when the induced back emf in the coil is 180 V, then the current in its coil after its speed becomes steady is .....

(A) 2 A
(B) 4 A
(C) 20 A
(D) 40 A

95 When an electric motor is started, its speed increases gradually until it becomes steady at a certain value during a time interval t_o. What happens to the induced back emf in the coil and to the current flowing in it during the interval t_o?

(A) induced back emf in the coil: increases until steady, current in the coil: increases until steady

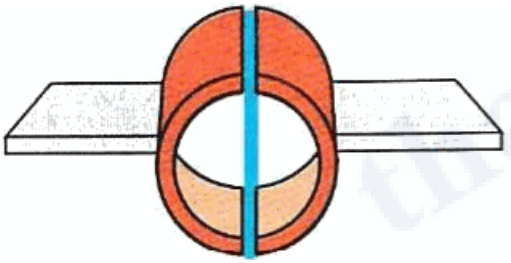
(B) induced back emf in the coil: increases until steady, current in the coil: decreases until steady

(C) induced back emf in the coil: decreases until steady, current in the coil: increases until steady

(D) induced back emf in the coil: decreases until steady, current in the coil: decreases until steady

---

96 The opposite figure shows one position of the split metal cylinder relative to the two graphite brushes in the motor, so the torque produced in this position is .....



(A) a maximum value

(B) *1/2* the maximum value

(C) *2/3* the maximum value

(D) zero

---

97 If the motor coil starts rotating from the moment its plane is parallel to the magnetic field, then the quantity that decreases gradually until it reaches the perpendicular position is .....

(A) the torque acting on the coil

(B) the magnetic force on the two long sides

(C) the magnetic flux density acting on the coil

(D) the magnetic dipole moment of the coil

---

98 While the motor coil rotates from the perpendicular position to the parallel position, the magnitude that increases is .....

(A) the magnetic flux density acting on the coil

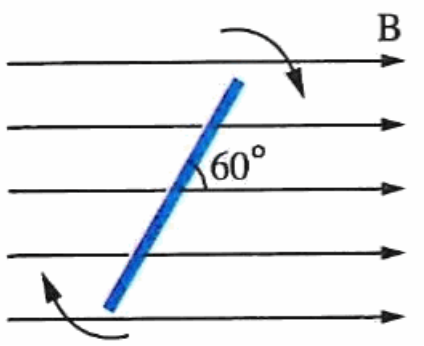
(B) the magnetic flux through the coil

(C) the force acting on its two sides perpendicular to its axis

(D) the torque acting on the coil

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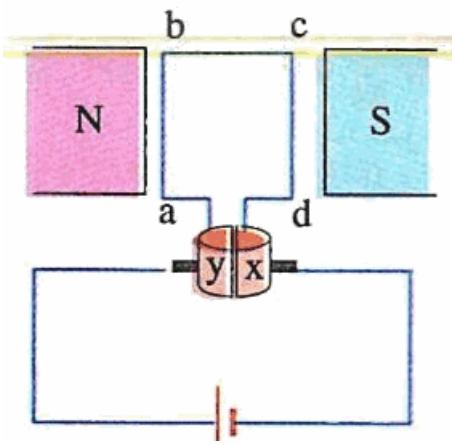
99 The opposite figure shows a motor coil rotating clockwise from this position, so the current in the coil reverses after the coil rotates from this position through an angle of .....



(A) 60° (B) 90° (C) 120° (D) 150°

---

100 The opposite figure shows a square motor coil rotating between the poles of a magnet. The magnetic force acting on side ab becomes zero when the plane of the coil is .....

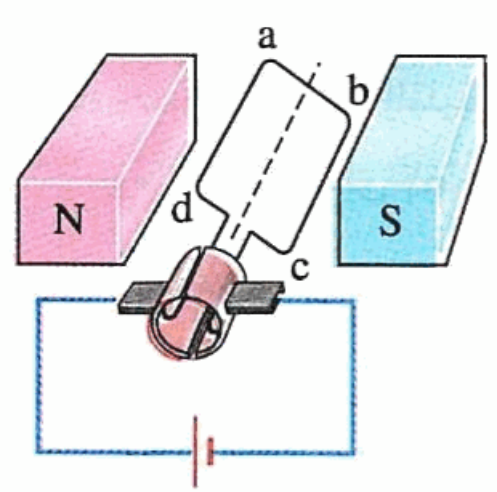


(A) perpendicular to the magnetic field (B) parallel to the magnetic field

(C) inclined at 45° to the magnetic field (D) in all positions

---

101 In the opposite figure, an electric motor has a coil of dimensions ℓ, 2 ℓ, and its plane is inclined at 30° to the direction of the magnetic field. If the motor coil rotates at a constant speed, then in the position shown in the figure the ratio between the magnetic forces acting on sides ab, bc $((F_{ab})/(F_{bc}))$ is .....



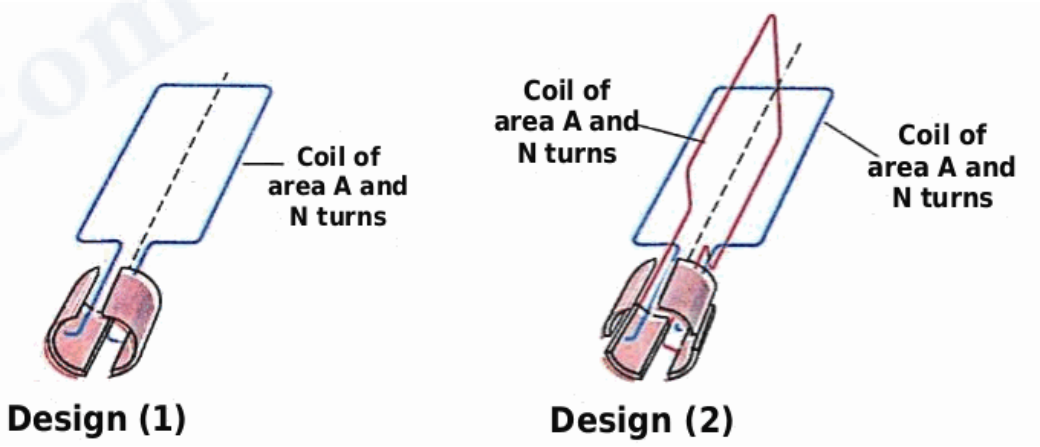
(A) *1/2* (B) *1/4* (C) *(√(3))/2* (D) *1/1*

102 What happens to the maximum speed at which the coil of an electric motor rotates when the emf of the source is increased?

(A) increases (B) decreases

(C) it stays constant (D) the answer cannot be determined

103 Which of the two designs (1), (2) of an electric motor coil shown in the opposite figures can give greater mechanical power when connected to the same DC source and placed in the same magnetic field?



(A) design (1)

(B) design (2)

(C) both designs give the same power

(D) neither design is suitable as a motor coil

104 Figure (1) shows the structure of an electric motor connected to a battery. Two changes were made to the motor: a cylinder of soft iron divided into insulated discs was placed in the core of the coil, and a magnet with concave poles was used, as in figure (2). What is the effect of this on the efficiency of the electric motor? And why?

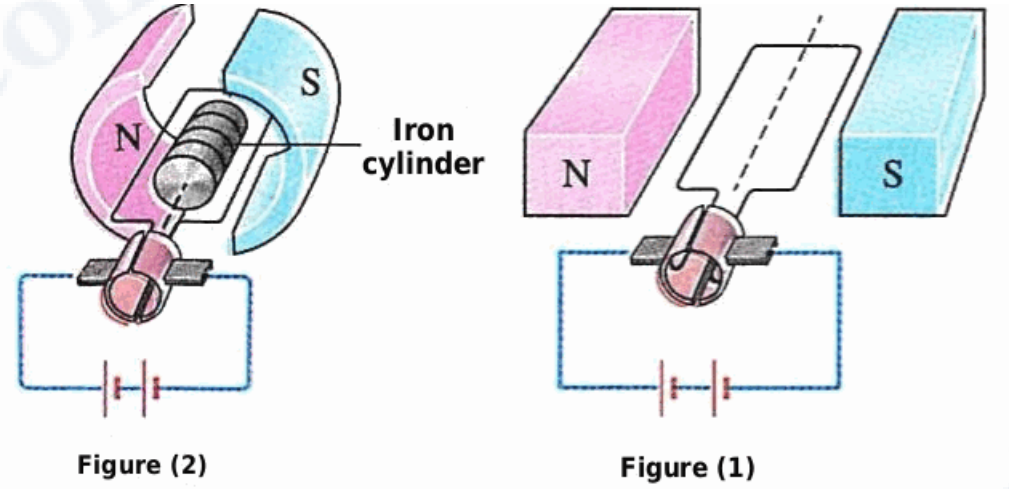


Figure (2) Figure (1)

(A) The efficiency increases, because in any position the coil is perpendicular to the direction of the field

(B) The efficiency increases, because in any position the coil is parallel to the direction of the field

(C) The efficiency decreases, because in any position the coil is perpendicular to the direction of the field

(D) The efficiency decreases, because in any position the coil is parallel to the direction of the field

Essay questions — 26 questions

1. Show, with two examples, how choosing certain materials to make the parts of a transformer increases its efficiency.

2. In a transformer, explain the reason for each of:
   (1) the different numbers of turns in the two coils.
   (2) using an AC source.

3. A mobile phone charger contains a step-down transformer. Why does its temperature rise when it works? And what is the effect of this on the efficiency of the transformer?

4. In most coils carrying an alternating current, the core of the coil is made of thin parallel sheets of soft iron electrically insulated from each other, not one piece of iron. Explain the practical benefit of this.

5. A transformer has an efficiency of 80%. Its secondary coil has fewer and thicker turns than its primary coil:
   (1) Is the transformer step-down or step-up?
   (2) Why are the turns of the secondary coil made thicker than the turns of the primary coil?

6. Explain how the current flowing in the primary coil of a transformer causes an induced emf in the secondary coil.

7. Show why an ideal step-down transformer steps up the current, while an ideal step-up transformer steps down the current.

8. In a step-up transformer, the potential difference across the secondary coil is greater than the potential difference across the primary coil. Does this contradict the law of conservation of energy? Give a reason for your answer.

9. An ideal transformer has 800 and 400 turns in its two coils and is connected to an AC source of emf 100 V. Calculate the largest and the smallest emf that can be obtained using this transformer.

10 Find the ratio between the potential difference across one turn of the primary coil and one turn of the secondary coil $((V_p)_1)/((V_s)_1)$ if the efficiency of the transformer is:

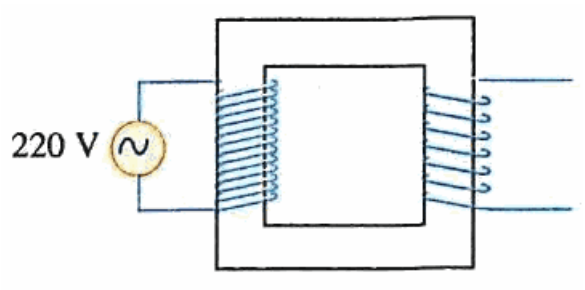
(1) 100%

(2) 90%

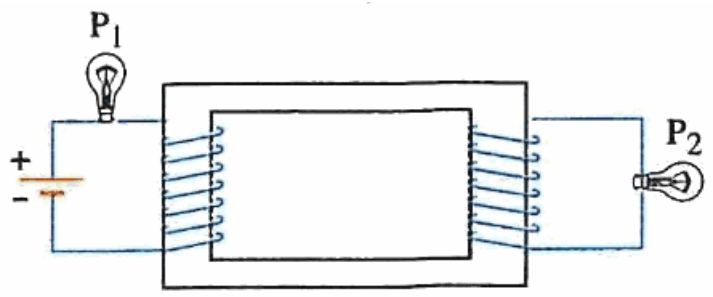
11 In the opposite figure, the primary coil of an ideal transformer is connected to an AC dynamo of voltage 220 V and frequency 50 Hz:

(1) What are the properties of the induced voltage across the secondary coil?

(2) Explain what happens to this voltage when the rotation frequency of the dynamo coil is increased.



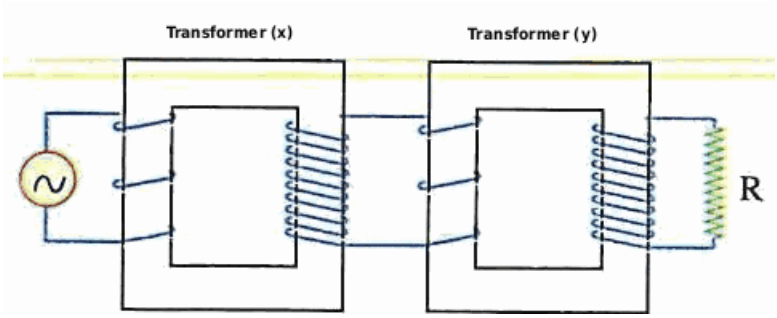
12 In the opposite figure, a transformer has two coils with the same number of turns, and its primary coil is connected to a DC source. Which of the two lamps P_1, P_2 is lit? Give a reason for your answer.



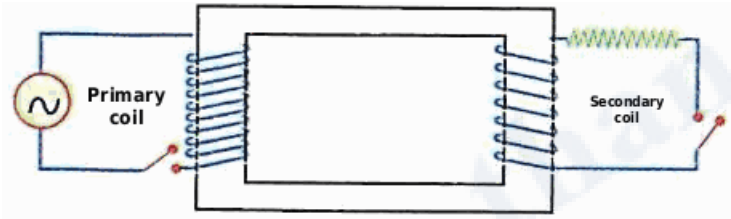
13 The opposite figure shows two ideal transformers x, y, each with a turns ratio $N_p/N_s = 1/3$. Find the ratio between:

(1) the power consumed in resistor (R) and the power drawn from the source.

(2) the potential difference across the secondary coil of transformer (y) and the potential difference across the primary coil of transformer (x).



14 In the opposite figure of a transformer, explain what happens to the energy consumed in the primary coil when the primary coil circuit is closed and the secondary coil circuit is open.



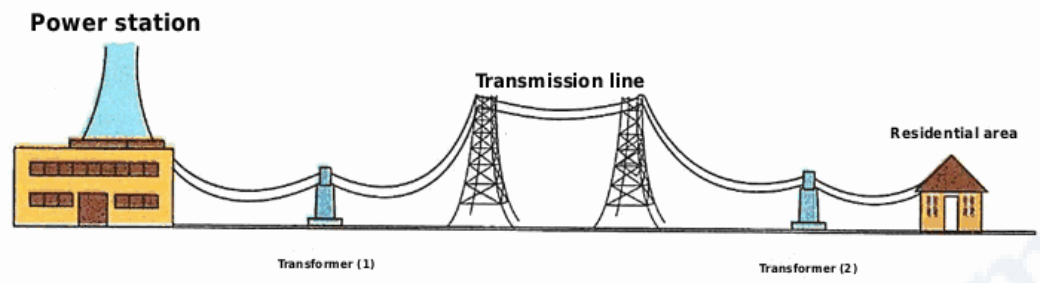
15 The following figure shows the transmission of electrical energy over a long distance.

(1) Give a reason: two different types of transformers are used during transmission.

(2) What are the expected results for the transmission efficiency, assuming:

(A) the positions of transformers (1), (2) are swapped?

(B) no transformers are used while transmitting the electric power over long distances?



16 Why does the coil of an electric motor keep rotating when it passes the position perpendicular to the magnetic field?

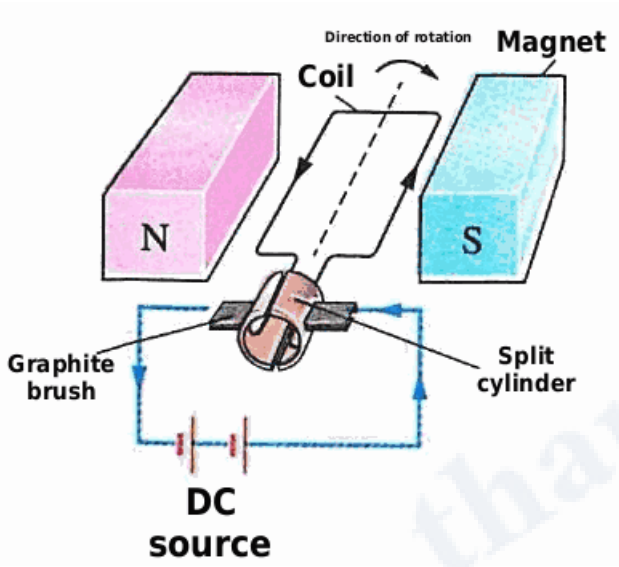
17 Why does the rotation speed of the coil of an electric motor become steady after some time of operation?

18 How can the power of an electric motor be increased?

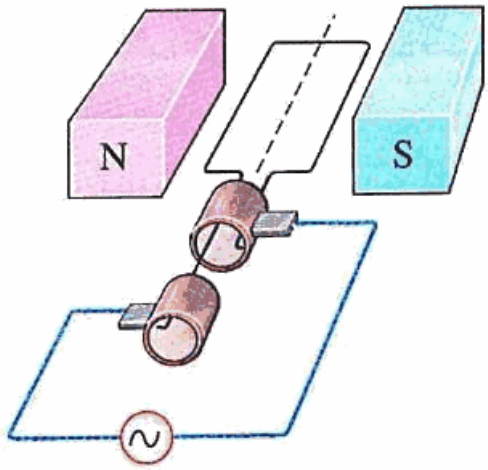
19 The opposite figure shows the structure of an electric motor:

(1) Why does the motor coil rotate in one direction?

(2) How can the direction of rotation of the motor coil be reversed?



20 The opposite figure represents a suggested model of an electric motor. State two changes that should be made to this model so that its coil rotates in one direction.

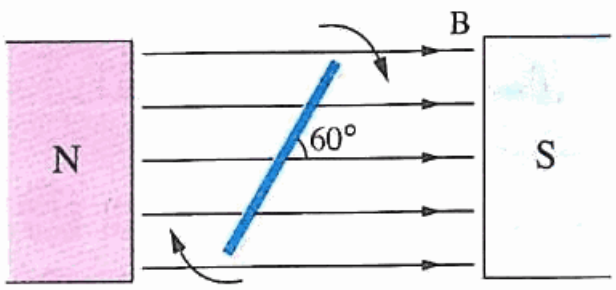


21 Explain: the direction of the current in the coil of an electric motor reverses although it is connected to a DC voltage source.

22 The opposite figure shows the coil of an electric motor rotating at a constant speed with a period T in a uniform magnetic field. What is the shortest time, in terms of T, the coil takes from the position shown until the torque acting on it is:

(1) zero?

(2) a maximum value?



23 Explain: the coil of an electric motor connected to a DC voltage source gets damaged when it is forcibly stopped from rotating.

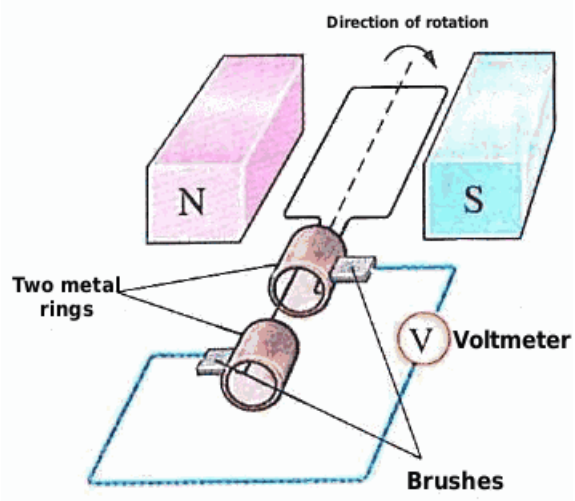
24 Compare: the dynamo and the motor (in terms of: the role of the cylinder split into two insulated halves).

25 Compare: the reason for having several coils with small angles between them in both the DC dynamo and the electric motor.

26 The opposite figure represents a simple dynamo. A student wanted to turn it into a motor to drive a light fan, so he replaced the voltmeter with a battery and a switch. When he closed the switch, the motor could not drive the fan:

(1) What reason do you see in the structure of the motor that stopped its coil from rotating normally?

(2) How would you help the student so that the coil rotates as in ordinary electric motors?



Past exam questions — 33 questions

1 An electric bell of power 1 W when a current of 0.5 A flows through it is connected to a transformer of efficiency 95%, and the number of turns of its secondary coil is $1/100$ of the number of turns of its primary coil, so the voltage of the source connected to the primary coil for the bell to work at that power equals ..... (Trial exam / May 2021)

(A) 105.26 V (B) 110.34 V (C) 210.53 V (D) 215.62 V

---

2 An ideal step-up transformer has a turns ratio of $3/2$. Its secondary coil is connected to a device that works on a voltage of 300 V, so the values of V_p, $((P_w)_s)/((P_w)_p)$ respectively are ..... (Trial exam / June 2021)

(A) V_p = 200 V, ratio = $2/3$
(B) V_p = 450 V, ratio = $3/2$
(C) V_p = 200 V, ratio = $1/1$
(D) V_p = 450 V, ratio = $1/1$

---

3 An ideal step-down transformer has a turns ratio of $4/1$. Its secondary coil is connected to a lamp marked (60 V, 20 A) and works at its full power, so the choice that gives the primary current and the primary voltage respectively is ..... (1st session 2021)

(A) current 40 A, voltage 150 V
(B) current 5 A, voltage 240 V
(C) current 80 A, voltage 240 V
(D) current 5 A, voltage 15 V

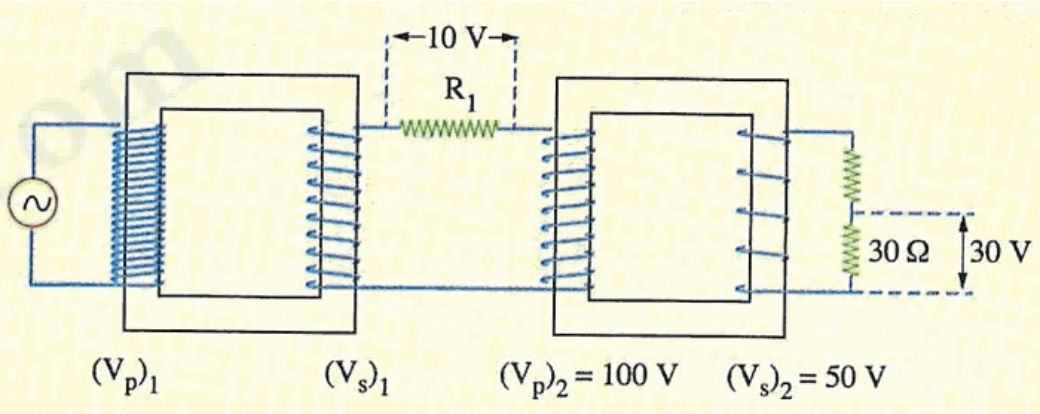
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4 A step-down transformer has an efficiency of 90%, the ratio between the potential differences across its two coils is $4/7$ and the current in the primary coil is 10 A. If the number of turns of the primary coil is 400 turns, then the correct choice for the values of I_s and N_s respectively is ..... (2nd session 2021)

(A) 15.75 A, 229 turns
(B) 17.5 A, 229 turns
(C) 15.75 A, 254 turns
(D) 17.5 A, 254 turns

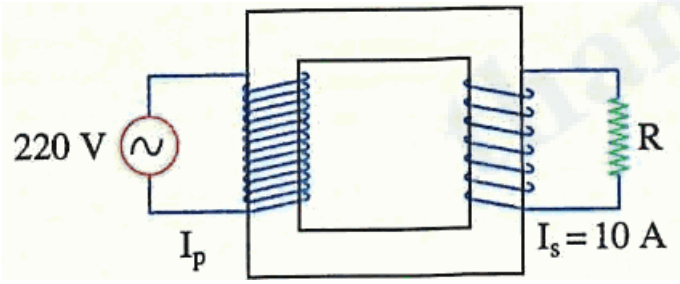
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5 The figure shows two ideal transformers connected together. Using the data shown, the electric power dissipated in resistor (R_1) equals ..... (1st session 2022)



(A) 10 Watt (B) 50 Watt (C) 55 Watt (D) 5 Watt

6 The figure shows a step-down transformer with an efficiency of 80% and a turns ratio of *3/5*, so the output voltage at the secondary coil and the current in the primary coil respectively are ..... (2nd session 2022)

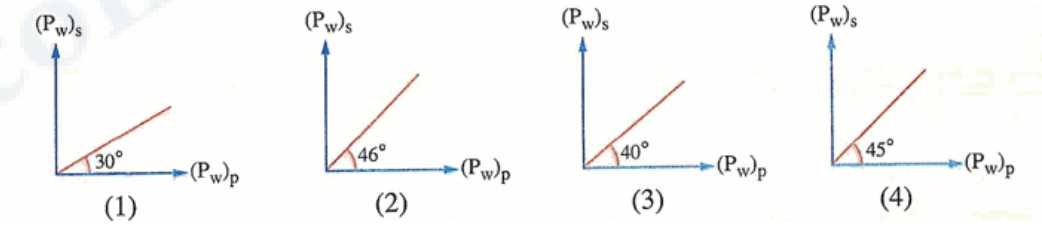


(A) voltage 108.3 V, current 6 A (B) voltage 105.6 V, current 8 A
(C) voltage 108.3 V, current 8 A (D) voltage 105.6 V, current 6 A

7 A step-down transformer with an efficiency of 90% was used to operate an electric bell. When the transformer was connected to an AC source of 220 V, a current of 0.5 A flowed in the bell and it consumed a power of 60 W, so the turns ratio of the transformer (N_s/N_p) equals ..... (1st session 2024)

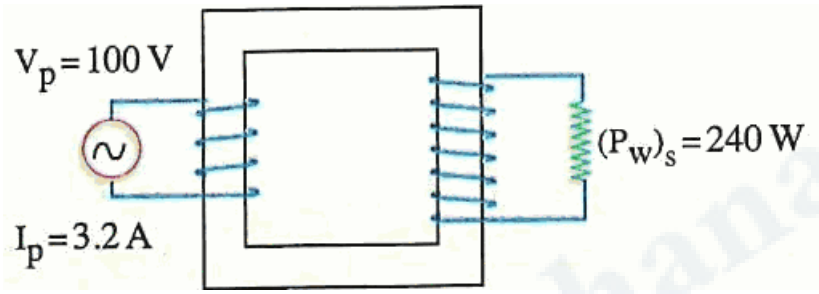
(A) *33/20* (B) *6/11* (C) *11/6* (D) *20/33*

8 Each of the following graphs represents the relation between the power of the secondary coil $(P_w)_s$ and the power of the primary coil $(P_w)_p$ of a transformer, drawn on the two axes with the same scale. Which of these graphs represents the highest theoretically possible efficiency of the transformer? (1st session 2024)



(A) graph (1) (B) graph (2) (C) graph (3) (D) graph (4)

9 From the data shown on the figure, ... (2nd session 2024)



(A) the efficiency of the transformer is 100%, step-up

(B) the efficiency of the transformer is 100%, step-down

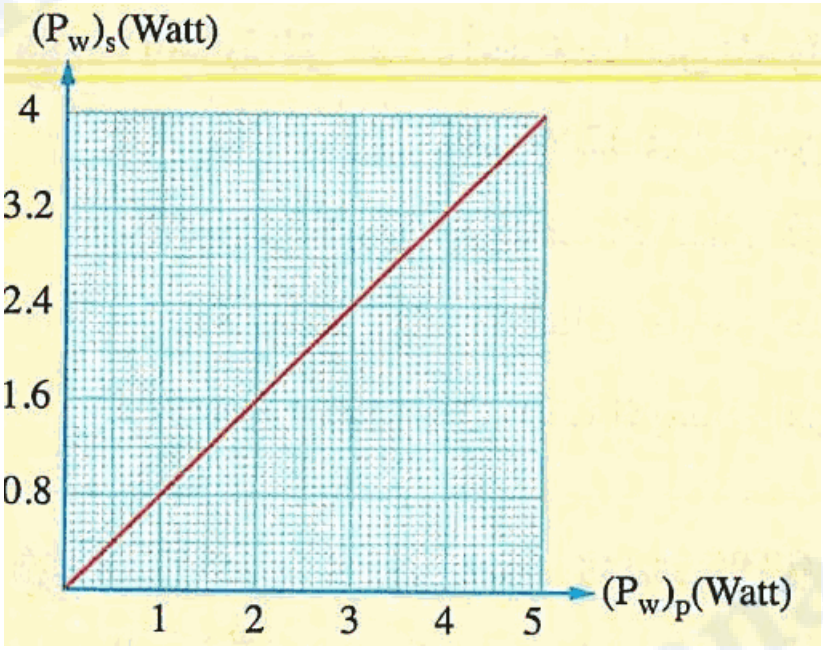
(C) the efficiency of the transformer is 75%, step-up

(D) the efficiency of the transformer is 75%, step-down

10 A transformer with an efficiency of 90% is connected to an AC source of power 60 kW, so the output power of the secondary coil = ... (2nd session 2024)

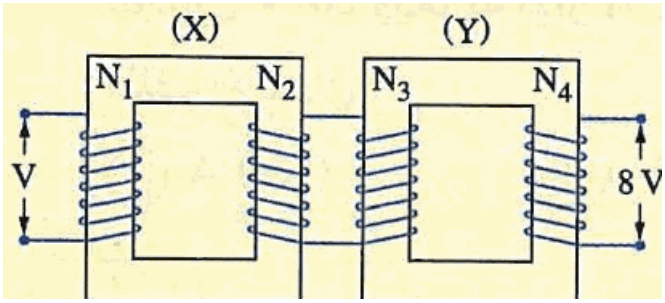
(A) 54 kW (B) 60 kW (C) 45 kW (D) 66.66 kW

11 The opposite graph represents the relation between the output power $(P_w)_s$ of a transformer and its input power $(P_w)_p$. If the voltage applied to the primary coil is 15 V, the induced voltage across the secondary coil is 72 V and the current in the secondary coil is 2 A, then the current in the primary coil equals ..... (Sample exam 2025)



(A) 2.5 A (B) 7.68 A (C) 9.6 A (D) 12 A

12 The figure shows two ideal transformers (X, Y). If the output voltage is 8 times the input voltage, then the turns ratio in each transformer may be ..... (Sample exam 2025)
(note that the numbers of turns drawn on the figure do not represent the real numbers of turns in the two transformers)

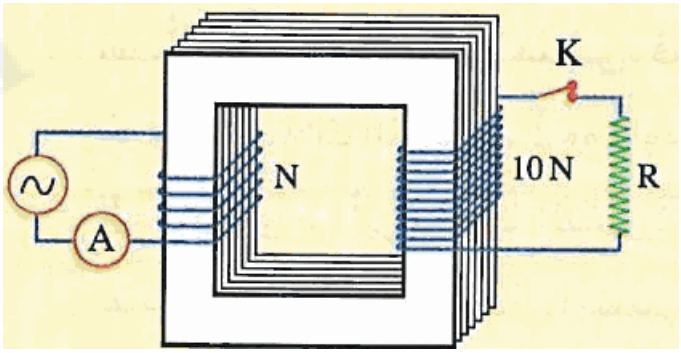


(A) $N_2 = 2N_1, N_4 = 4N_3$ (B) $N_2 = 2N_1, N_4 = 3N_3$
(C) $N_1 = 3N_2, N_3 = 2N_4$ (D) $N_1 = 2N_2, N_3 = 4N_4$

13 A transformer steps up the voltage from 120 V to 10^3 V and steps down the current from 10^3 A to 110 A, so the electric power lost is ..... (Sample exam 2025)

(A) 5×10^3 W (B) 5×10^4 W (C) 10^3 W (D) 10^4 W

14 In the figure, an ideal transformer: if the primary current is 1 A with switch (K) closed, then the primary current after opening the switch ..... (Sample exam 2025)



(A) stays 1 A (B) becomes 10 A (C) becomes 5 A (D) approaches zero

---

15 The following choices relate to the electrical conductivity of the materials from which the transformer core and the wires of its two coils are made. Which choice can improve the efficiency of the transformer greatly? (1st session 2025)

(A) metal core: high conductivity, wires of the two coils: high conductivity

(B) metal core: high conductivity, wires of the two coils: low conductivity

(C) metal core: low conductivity, wires of the two coils: high conductivity

(D) metal core: low conductivity, wires of the two coils: low conductivity

---

16 Which statement describes one of the properties of the transformer used at electrical energy distribution areas? (2nd session 2025)

(A) The current in the primary coil is less than the current in the secondary coil

(B) The voltage across the primary coil is less than the voltage across the secondary coil

(C) The number of turns of the primary coil is less than the number of turns of the secondary coil

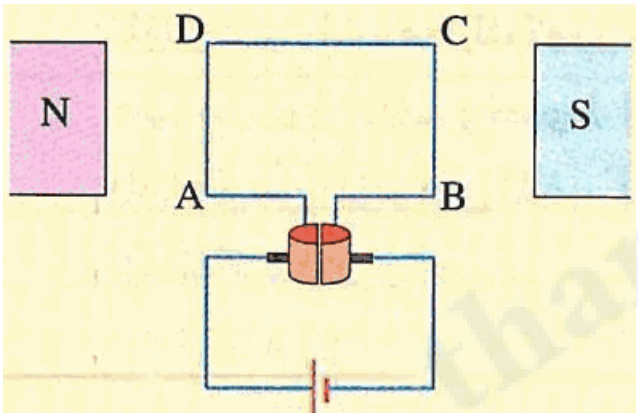
(D) The electric power in the primary coil is less than the electric power in the secondary coil

---

17 A step-down transformer with an efficiency of 100% works on an alternating potential difference of 220 V and has two secondary coils (X, Y). Coil (X) is connected to an electric bell and coil (Y) is connected to a lamp. When the bell and the lamp work together, the potential difference across the bell is 20 V and it carries a current of 1 A, and the potential difference across the lamp is 19 V and it carries a current of 0.8 A. What is the current flowing in the primary coil? (2nd session 2025)

(A) 0.09 A (B) 0.2 A (C) 0.11 A (D) 0.16 A

18 The figure shows the structure of a simple electric motor. When the coil rotates through an angle of 45° from the parallel position, the magnitude of the force acting on wire AD ..... (Trial exam / June 2021)



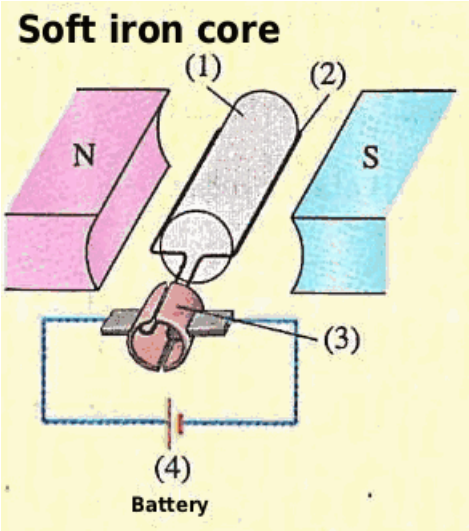
(A) stays at a maximum value

(B) stays zero

(C) increases from zero to a maximum value

(D) decreases from a maximum value to zero

19 The figure shows the structure of a simple electric motor. To reduce the eddy currents produced in the soft iron core ..... (1st session 2021)



(A) we replace part number (3) with two metal rings

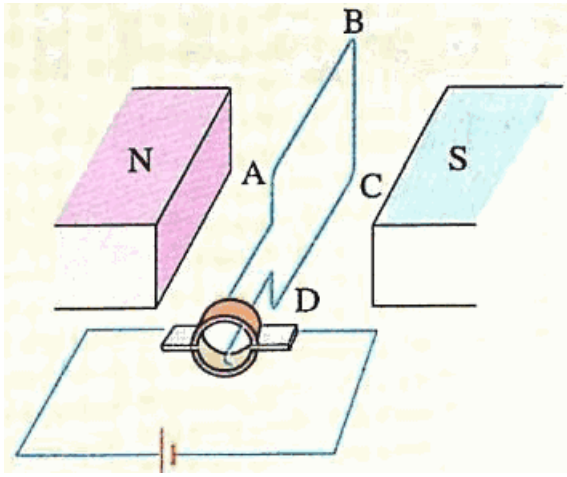
(B) we replace part number (1) with an iron core divided into insulated discs

(C) we replace part number (4) with a battery of higher emf

(D) we replace part number (2) with several coils with small angles between them

---

20 The figure shows the structure of a simple electric motor. Coil ABCD keeps rotating when it passes the perpendicular position because of ..... (2nd session 2021)



(A) the force acting on wire AB

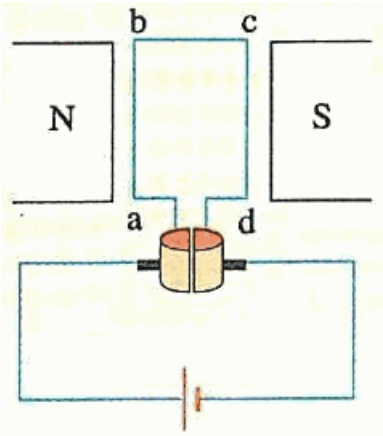
(B) the force acting on wire BC

(C) the inertia of the coil

(D) the force acting on the coil

---

21 You have a DC electric motor made of one coil that started moving from the position parallel to the magnetic flux lines as in the figure. After this coil rotates through an angle of 60° from the position shown, ... (1st session 2023)



(A) the magnetic torque stays constant

(B) the magnetic force acting on side bc becomes half its maximum value

(C) the magnetic torque becomes $(\sqrt{(3)})/2$ of its maximum value

(D) the magnetic force acting on side ab stays constant

---

22 An electric motor made of one coil is connected to a DC source. Which of the following quantities is not zero when the plane of the coil becomes perpendicular to the magnetic field lines? (2nd session 2023)

(A) the magnetic dipole moment of the coil

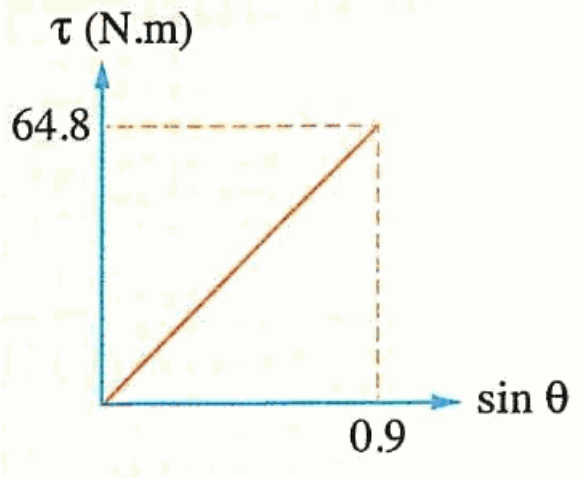
(B) the rotation speed of the coil

(C) the magnetic torque acting on the coil

(D) the magnetic force acting on the sides of the coil

---

23 The opposite graph represents the relation between the magnetic torque (τ) acting on the coil of an electric motor and the sine of the angle $(\sin \theta)$ between the normal to the plane of the coil and the magnetic flux lines. If the magnetic flux density acting on the coil is 0.3 T, then the magnetic dipole moment of the coil equals ..... (Sample exam 2025)



(A) $180\ A.m^2$ (B) $200\ A.m^2$ (C) $240\ A.m^2$ (D) $280\ A.m^2$

24 The role of the cylinder split into two insulated halves in the operation of the electric motor is ..... (Sample exam 2025)

(A) changing direct current into alternating current

(B) changing alternating current into direct current

(C) reversing the direction of the current in the coil every half cycle

(D) producing a current in one direction

25 Increasing the number of coils and dividing the split cylinder lengthwise into a number of parts equal to twice the number of coils in the electric motor is done ..... (Sample exam 2025)

(A) to make the coil rotate in one direction

(B) to keep an almost constant torque at the maximum value

(C) to make the coil keep rotating

(D) to make the coil rotate at an increasing speed

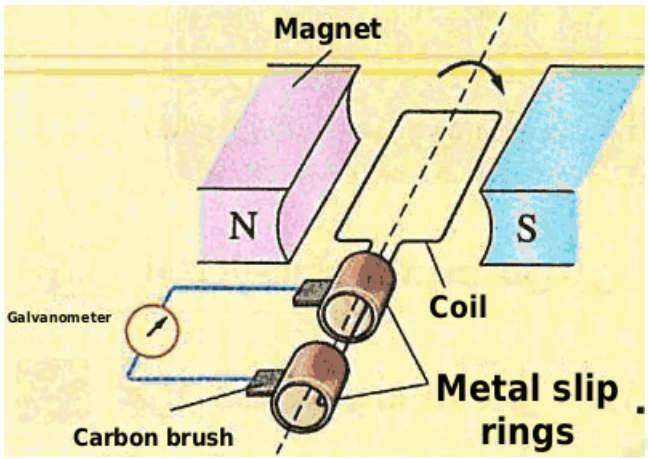
26 The schematic diagram shows an electric generator whose coil is connected to a galvanometer. You have three suggested changes: (1st session 2025)

(I) putting an AC source instead of the galvanometer.

(II) putting a battery instead of the galvanometer.

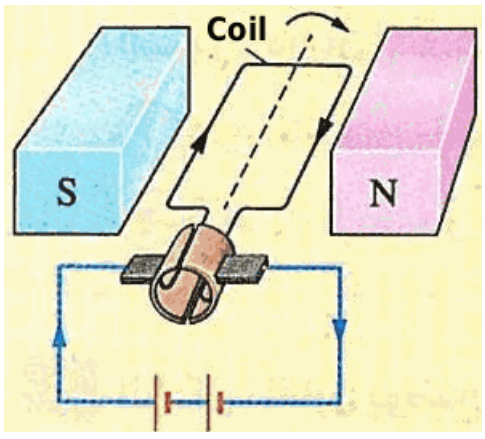
(III) putting a metal cylinder split into two halves instead of the two metal rings.

Which of the previous changes are needed to turn the generator shown in the figure into an electric motor?



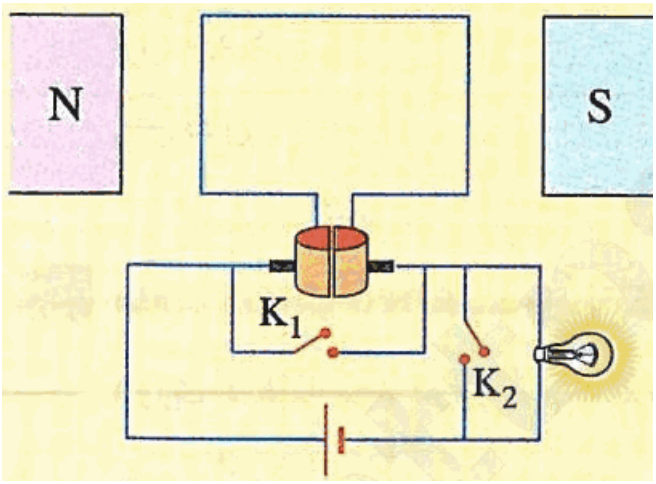
(A) change (II) only
(B) change (I) only
(C) changes (II), (III) together
(D) changes (I), (III) together

27 The opposite schematic diagram shows a certain position of the coil of an electric motor between the poles of the magnet. What physical property is responsible for the coil continuing to rotate after it rotates 90° from the position shown in the figure? (2nd session 2025)



(A) the magnetic torque
(B) electromagnetic induction
(C) inertia
(D) eddy currents

28 In the opposite figure, a simple electric motor has a coil of resistance (R) and starts rotating from the position parallel to the magnetic field. The coil is connected to a battery, a lamp and two switches K_1, K_2. Which of the following choices is correct when switches (K_1), (K_2) are closed, each one alone? (Sample exam 2026)



(A) closing K_1 only: the lamp goes off and the rotation speed of the motor decreases, closing K_2 only: the motor stops and the lamp becomes brighter

(B) closing K_1 only: the lamp goes off and the rotation speed of the motor decreases, closing K_2 only: the lamp goes off and the rotation speed of the motor increases

(C) closing K_1 only: the motor stops and the lamp becomes brighter, closing K_2 only: the motor stops and the lamp becomes brighter

(D) closing K_1 only: the motor stops and the lamp becomes brighter, closing K_2 only: the lamp goes off and the rotation speed of the motor increases

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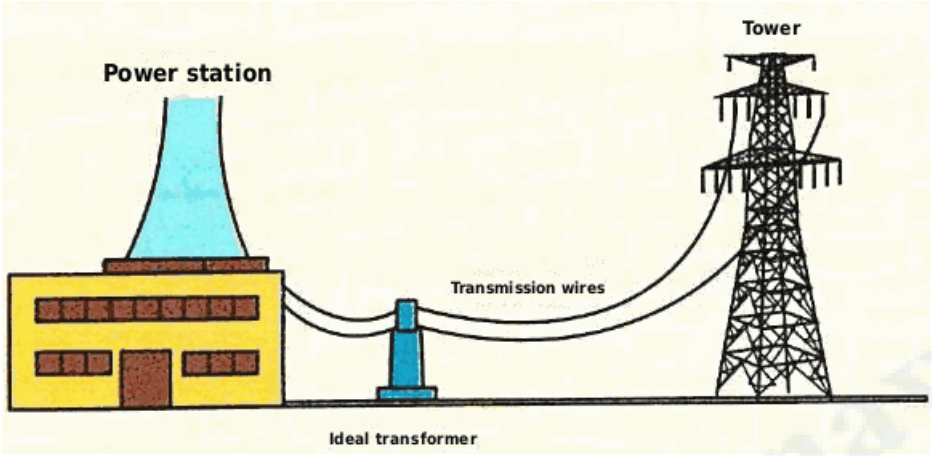
29 The primary coil of an ideal transformer is connected to an AC source of potential difference 120 V and its secondary coil is connected to a lamp that works on a potential difference of 12 V with a power of 60 W. Calculate the current flowing in each of the primary and secondary coils of the transformer. (Trial exam 2023)

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30 In the opposite figure, when electrical energy is transmitted from the power station, where the potential difference is 25×10^3 V, an ideal transformer was used. If the current in the transmission wires is 2 A, the resistance of the transmission wires between the transformer and one of the towers of the transmission line is 7500 Ω and the potential difference at the tower is 132×10^3 V, calculate: (1st session 2023)

(1) the potential difference across the secondary coil of the transformer.

(2) the current of the primary coil of the transformer.



31 An ideal transformer has 1100 turns in its primary coil and works on a potential difference of 220 V. It has two secondary coils; the first is connected to an electric bell that works on (6 V, 0.4 A) and the other is connected to a lamp that works on (12 V, 0.35 A). Find: (Sample exam 2025)

(1) the numbers of turns of the two secondary coils.

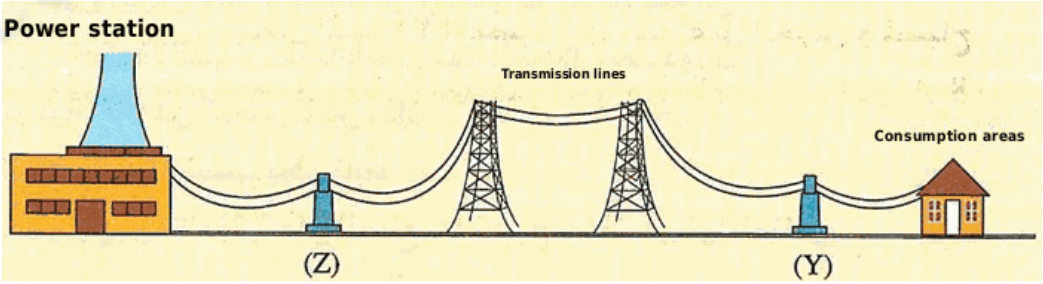
(2) the current of the primary coil when the bell and the lamp work together.

32 A power station generates an electric power of 100 kilowatt at a potential difference of 200 volt and is connected to an ideal transformer whose turns ratio is 1 : 5. Find the transmission efficiency if wires of resistance 4 ohm are used to transmit this power. (Sample exam 2025)

33 The schematic diagram shows the transmission of electrical energy from the power station to the areas of consumption. (1st session 2025)

(1) What is the type of each of transformer (Y) and transformer (Z) used in this process?

(2) Explain how the efficiency of transmitting electrical energy can be improved by controlling two physical quantities related to the transmission lines.



Answer key and solutions

Multiple choice questions

1 C	2 D	3 C	4 C	5 B	6 B	7 D	8 A	9 C	10 A
11 C	12 B	13 A	14 D	15 A	16 A	17 A	18 C	19 B	20 A
21 C	22 B	23 A	24 A	25 A	26 C	27 D	28 A	29 D	30 C
31 A	32 D	33 D	34 A	35 D	36 B	37 B	38 C	39 A	40 C
41 D	42 B	43 B	44 A	45 D	46 A	47 C	48 D	49 B	50 C
51 C	52 B	53 C	54 D	55 A	56 A	57 A	58 B	59 A	60 C
61 A	62 C	63 A	64 D	65 B	66 D	67 D	68 A	69 D	70 C
71 B	72 D	73 B	74 B	75 B	76 C	77 A	78 D	79 A	80 A
81 D	82 B	83 C	84 C	85 D	86 C	87 D	88 B	89 A	90 B
91 A	92 B	93 D	94 A	95 B	96 A	97 A	98 D	99 D	100 A
101 B	102 A	103 B	104 B						

1 **Answer (C)**

The transformer works by mutual induction and needs a changing flux; a current constant in magnitude and direction (steady) does not change the flux

2 **Answer (D)**

A step-up transformer works on alternating voltage, its core is soft iron, and the secondary has more turns than the primary: $N_s = 100 > N_p = 10$

3 **Answer (C)**

Interleaving the two coils makes almost all the flux passing through the primary pass through the secondary, so the magnetic flux leakage decreases

4 **Answer (C)**

The transformer is step-down, so the output voltage is less than 12 V, with the same frequency and the same waveform

5 **Answer (B)**

The power is constant in an ideal transformer $P_p = P_s$, and the frequency and the flux do not change

$V_s > V_p$, so $I_s < I_p$, i.e. the maximum value of the current decreases

6 **Answer (B)**

The power is constant $P_p = P_s$, and the frequency and the flux do not change

$V_s < V_p$, so $I_s > I_p$, i.e. the current increases

7 **Answer (D)**

The source is a battery (direct voltage), so the flux is constant and no voltage is induced in the secondary, so the difference is zero

8 **Answer (A)**

Moving the slider from (1) to (2) decreases N_p, so $V_s = V_p\, N_s/N_p$ increases

$I_s = V_s/R$ increases and $P = V_s I_s$ increases

9 **Answer (C)**

$V_s = P/I_s = 300/5 = 60$ V

10 **Answer (A)**

$N_s/N_p = V_s/V_p \Rightarrow N_s = 80 \times 50/10 = 400$ turns

11 **Answer (C)**

$eta = (V_s\, N_p)/(V_p\, N_s) \Rightarrow 0.9 = (12 \times 33)/(V_p \times 2)$

$V_p = 220$ V

12 **Answer (B)**

$N_s/N_p = I_p/I_s = 0.2/2 = 1/10$, so the transformer is step-down (the secondary current is larger)

13 **Answer (A)**

$V_s = V_p\, N_s/N_p = 240 \times 2 = 480$ V

14 **Answer (D)**

$I_s = I_p N_p/N_s = 3 \times 1/2 = 1.5$ A

15 **Answer (A)**

$P = V_p I_p = 240 \times 3 = 720$ W

16 **Answer (A)**

$V_s = V_p N_s/N_p = 240 \times 250/5000 = 12$ V

17 **Answer (A)**

$I_p/I_s = N_s/N_p = 250/5000 = 1/20$

18 **Answer (C)**

The secondary voltage is set by the source voltage and the turns ratio $V_s = V_p N_s/N_p$ and is not affected by the load, so it does not change

19 **Answer (B)**

Opening the switch increases the total resistance of the secondary, so I_s decreases

$P_p = P_s$ and the voltage is constant, so the primary current decreases

20 **Answer (A)**

$N_s/N_p = V_s/V_p \Rightarrow N_s = 200 \times 50/100 = 100$ turns, which is between a and b

21 **Answer (C)**

$N_s = 200 \times 400/100 = 800$ turns

$300 + 500 = 800$, which is between b and d

22 **Answer (B)**

Before cutting $V_s = 75$ V and after it 25 V, so $(N_s - 40)/N_p = 25/50 = 1/2$ and $N_s/N_p = 75/50 = 3/2$

Subtracting: $40/N_p = 1 \Rightarrow N_p = 40$ turns

23 **Answer (A)**

$eta = V_s I_s/V_p I_p = (3000 \times 0.06)/(120 \times 2) = 0.75 = 75\%$

24 **Answer (A)**

$eta = (V_s N_p)/(V_p N_s) = (17.6 \times 10)/(220 \times 1) = 0.8 = 80\%$

25 **Answer (A)**

The transformer is step-down, so the secondary voltage is 20 V and the primary voltage is 200 V

$eta = (V_s N_p)/(V_p N_s) \Rightarrow 0.8 = (20 \times 640)/(200 N_s) \Rightarrow N_s = 80$ turns

26 **Answer (C)**

$eta = P_s/P_p = 0.8$, i.e. the power lost is 20% of the primary power

27 **Answer (D)**

$P_s = eta P_p = 0.8 \times 40 = 32$ kW

28 **Answer (A)**

An ideal transformer has no losses, so $P_p = P_s = P_w$

29 **Answer (D)**

$I_p/I_s = N_s/N_p = 5/8$

30 **Answer (C)**

$eta = P_s/P_p = 3/3.75 = 0.8 = 80\%$

31 **Answer (A)**

$I_p = I_s N_s/N_p = 2 \times 1/20 = 0.1$ A

32 **Answer (D)**

The transformer does not change the frequency, so the ratio is $1 : 1$

33 **Answer (D)**

$P_s = eta V_p I_p = 0.9 \times 110 \times 2 = 198$ W

34 **Answer (A)**

$N_p/N_s = I_s/I_p = 18/2 = 9/1$

35 **Answer (D)**

$P_s = 10 \times 220 \times 15 = 33000$ W

$P_p = P_s/(eta) = 33000/0.96 \approx 3.4 \times 10^4$ W

36 **Answer (B)**

$eta = (V_s N_p)/(V_p N_s) \Rightarrow 0.96 = (24 \times 440)/(220 N_s)$

$N_s = 50$ turns

37 **Answer (B)**

The voltage per turn is the same in both coils $\Rightarrow N_p = 30/0.3 = 100$ turns

38 **Answer (C)**

The voltage per turn in the secondary $= eta\ V/N_p$ (because $eta = V_s N_p / V_p N_s$)

$x/y = 0.8/0.9 = 8/9$

39 **Answer (A)**

In an ideal transformer $P_s = P_p$, so the relation is a straight line making 45° with the two axes (slope 1)

40 **Answer (C)**

In a non-ideal transformer $P_s < P_p$, so the relation is a straight line through the origin with a slope less than 1

41 **Answer (D)**

$V_s = (60sqrt2)/(sqrt2) = 60$ V and $I_s = P/V_s = 1500/60 = 25$ A

$I_p = I_s\, N_s/N_p = 25 \times 80/100 = 20$ A

42 **Answer (B)**

$I_p = P_p/V_p = 120/240 = 0.5$ A and $N_s < N_p$, so the transformer is step-down

$I_s = I_p\, N_p/N_s = 0.5 \times 2 = 1$ A

43 **Answer (B)**

$N_p = N_s\, V_p/V_s = 600 \times 200/24 = 5000$ turns

44 **Answer (A)**

$I_s = P/V_s = 48/24 = 2$ A

45 **Answer (D)**

$I_p = I_s\, N_s/N_p = 2 \times 600/5000 = 0.24$ A

46 **Answer (A)**

$V_s = V_p\, N_s/N_p = 200 \times 100 = 2 \times 10^4$ V

47 **Answer (C)**

$I_p/I_s = N_s/N_p = 100/1$

48 **Answer (D)**

$P = (V_s^2)/R = ((2\times10^4)^2)/(10^4) = 4\times10^4$ W

49 **Answer (B)**

$V_{s,max} = 400\times50/200 = 100$ V

$P = (V_{rms}^2)/R = (V_{max}^2)/2R = (100^2)/(2\times25) = 200$ W

50 **Answer (C)**

Loss $= 36000/3600 = 10$ W and $P_s = V_sI_s = 5\times8 = 40$ W

$eta = P_s/(P_s + 10) = 40/50 = 80\%$

51 **Answer (C)**

$P_s = E/t = 3000/300 = 10$ W

The transformer is ideal, so $I_p = P/V_p = 10/200 = 0.05$ A

52 **Answer (B)**

$P_s = I_s^2R \Rightarrow I_s = \sqrt{(10/10)} = 1$ A

53 **Answer (C)**

$V_s = I_sR = 1\times10 = 10$ V

54 **Answer (D)**

$P_p = V_pI_p = 220\times10 = 2200$ W

$eta = P_s/P_p = 1980/2200 = 90\%$

55 **Answer (A)**

$I_s = P_s/V_s = 1980/22 = 90$ A

$R = V_s/I_s = 22/90 \approx 0.24\ \Omega$

56 **Answer (A)**

$I_s = (eta\ V_pI_p)/V_s = (0.9\times200\times0.5)/9 = 10$ A

$N_p = N_s\ I_s/I_p = 90\times10/0.5 = 1800$ turns

57 **Answer (A)**

$I_p = I_s\ N_s/N_p = 80\times1/20 = 4$ A

$eta = (V_s\ N_p)/(V_p\ N_s) \Rightarrow V_s = (0.8\times2500)/20 = 100$ V

58 **Answer (B)**

$eta = (V_s N_p)/(V_p N_s) \Rightarrow 0.8 = (8 \times 1600)/(200\ N_s)$

$N_s = 80$ turns

59 **Answer (A)**

$P_p = V_p I_p = 200 \times 0.2 = 40$ W

Loss $= (1\text{-}eta)P_p = 0.2 \times 40 = 8$ W

60 **Answer (C)**

$P_s = eta\ P_p = 0.8 \times 40 = 32$ W

$I_s = P_s/V_s = 32/8 = 4$ A

61 **Answer (A)**

Voltage per turn $= 220/1100 = 0.2$ V

$N_x = 6/0.2 = 30$ turns and $N_y = 12/0.2 = 60$ turns

62 **Answer (C)**

$P_s = 6 \times 0.4 + 12 \times 0.35 = 2.4 + 4.2 = 6.6$ W

The transformer is ideal, so $I_p = P/V_p = 6.6/220 = 0.03$ A

63 **Answer (A)**

$V_{max} = N\ BA\ \omega = N_d \times 0.14 \times (0.1 \times 0.2) \times 2\pi \times 50 \approx 0.88\ N_d$ for the dynamo, which is the maximum voltage on the primary $(N_p = 2N_d)$

$N_s = N_p\ 550/V_p = (2N_d \times 550)/(0.88\ N_d) \approx 1250$ turns

64 **Answer (D)**

Each secondary coil is independent, and its voltage $V_p\ N_s/N_p$ is set only by the voltage and the turns ratio; opening (K) does not change it, so the brightness stays constant

65 **Answer (B)**

Opening (K) switches off one of two identical lamps, so the power drawn decreases from $2P$ to P, i.e. it is halved

66 **Answer (D)**

Voltage per turn $= 600/1200 = 0.5$ V

$(V_s)_1 = 60 \times 0.5 = 30$ V and $(V_s)_2 = 30 \times 0.5 = 15$ V

67 **Answer (D)**

Both coils have N turns, so each has the same voltage V_s

$P_1 = (V_s^2)/R$ and $P_2 = (V_s^2)/2R$, i.e. $P_1 = 2P_2$, and the sum is less than 240 W, so 120 W and 60 W

68 **Answer (A)**

The voltage across R is greatest when each transformer steps up the voltage: $50 \rightarrow 100$ turns in each of them

$V_R/V = 100/50 \times 100/50 = 4$, and this is in figure (A)

69 **Answer (D)**

Secondary voltage of $x = 200 \times 1/3 = 200/3$ V, which is the primary voltage of y

$(N_p)/(N_s) = (200/3)/120 = 5/9$

70 **Answer (C)**

$V_2 = V_1 \times 3N/N \times 4N/N = 50 \times 3 \times 4 = 600$ V

71 **Answer (B)**

$V_s = eta\ V_p\ N_s/N_p$, so the first gives $0.75 \times 50 \times 4 = 150$ V

and the second gives $0.75 \times 150 \times 4 = 450$ V

72 **Answer (D)**

$P_R/(P_{source}) = eta_x\ eta_y = 0.9 \times 0.9 = 81/100$

73 **Answer (B)**

$V_{p,y} = V_{s,x} = eta_x \times 220 \times 2$ and $110 = eta_y\ V_{p,y} \times 2/3$

$eta_x eta_y = (110 \times 3)/(440 \times 2) = 0.375$ and $eta_x = 1.5\ eta_y \Rightarrow eta_x = 0.75$

$V_{p,y} = 0.75 \times 440 = 330$ V

74 **Answer (B)**

V_2 is the voltage after the step-up transformer, and it is the highest voltage in the figure (the voltage at the start of the transmission line)

75 **Answer (B)**

$I = P/V$ decreases to one tenth, and the loss $P_{loss} = I^2R$ decreases to $(1/10)^2 = 1/100$

76 **Answer (C)**

$V_{\text{line}} = 200 \times 5 = 1000$ V and $I = P/V = 100000/1000 = 100$ A

$P_{\text{loss}} = I^2R = 100^2 \times 4 = 40$ kW

$eta = (100\text{-}40)/100 = 60\%$

77 **Answer (A)**

$I = P/V = 200000/1000 = 200$ A

78 **Answer (D)**

$\Delta V = IR = 200 \times 0.5 = 100$ V

79 **Answer (A)**

$P_{\text{loss}} = I^2R = 200^2 \times 0.5 = 2 \times 10^4$ W

80 **Answer (A)**

$I = P/V = 400000/(2 \times 10^4) = 20$ A

$P_{\text{loss}} = I^2R = 20^2 \times 200 = 8 \times 10^4$ W

81 **Answer (D)**

$V_x = 2V_p$ and $V_y = 4V_p$, so $I_x = 2V_p/R$ and $I_y = 4V_p/R$

$V_pI_p = ((2V_p)^2 + (4V_p)^2)/R \Rightarrow I_p = 20V_p/R$

$I_x = 1/10I_p$ and $I_y = 1/5I_p$

82 **Answer (B)**

The electric motor changes electrical energy into mechanical energy (and the generator does the opposite)

83 **Answer (C)**

The commutator reverses the direction of the current in the coil every half cycle

84 **Answer (C)**

When the coil is perpendicular to the field $\theta = 0$, so the torque is $\tau = NBIAsin\theta = 0$ and the commutator cuts off the current

85 **Answer (D)**

The battery (4) is the source of electrical energy that the motor changes into mechanical energy

86 **Answer (C)**

87 **Answer (D)**

To get a current in one direction, the commutator (2) stays as it is, the battery (4) is replaced with a load (resistance) and the coil is rotated mechanically

88 **Answer (B)**

To get an alternating current, the commutator (2) is replaced with two separate rings, and the battery (4) is replaced with a load

89 **Answer (A)**

Applying Fleming's left-hand rule to the two sides of the coil, the two forces act so that the coil rotates clockwise

90 **Answer (B)**

When a battery is connected the device becomes a motor, so a current flows in the coil and the coil rotates with the split cylinder, while the two brushes are fixed

91 **Answer (A)**

The coil carries a current in a magnetic field, so a torque $\tau = NBIA\sin\theta$ acts on it and it moves

92 **Answer (B)**

After a quarter of a cycle the coil is perpendicular to the field, the current is cut off and the torque vanishes, so the coil keeps moving by inertia

93 **Answer (D)**

An induced back emf is produced in the coil, increasing with the speed until the torque equals the friction torque, so the speed becomes steady

94 **Answer (A)**

$I = (V - emf_b)/R = (220-180)/20 = 2$ A

95 **Answer (B)**

$I = (V - emf_b)/R$, so as the speed increases the back emf increases until it becomes steady, and the current decreases until it becomes steady

96 **Answer (A)**

The two brushes touch the two halves of the cylinder, so a current flows in the coil, and in this position the coil is parallel to the field $\theta = 90^\circ$, so the torque $\tau = NBIA\sin\theta$ is the greatest

97 **Answer (A)**

The torque $\tau = NBIA\sin\theta$ decreases from its greatest value to zero, while the flux density and the force on the two sides stay constant

98 **Answer (D)**

The torque $\tau = NBIA\sin\theta$ increases from zero to its greatest value, while the flux through the coil decreases

99 **Answer (D)**

The current reverses when the coil becomes perpendicular to the field

The present angle with the field is 60° and the rotation is clockwise, so it becomes parallel after 60° and then perpendicular after another 90°: $60^\circ + 90^\circ = 150^\circ$

100 **Answer (A)**

When the coil is perpendicular to the field the brushes are cut off from the current (the gap of the commutator), so the current becomes zero and the force becomes zero

101 **Answer (B)**

$F_{bc} = B\,I\,(2\ell)$ and side bc is perpendicular to the field

$F_{ab} = B\,I\,\ell\sin 30^\circ = (BI\ell)/2$

$(F_{ab})/(F_{bc}) = (1/2)/2 = 1/4$

102 **Answer (A)**

At maximum speed $emf_b \approx V$, so increasing the source emf increases the back emf needed, i.e. the maximum speed increases

103 **Answer (B)**

Design (2) has several coils and a commutator of many parts, so the torque stays large throughout the cycle and the power increases

104 **Answer (B)**

The iron core and the radial field keep the plane of the coil parallel to the field in every position, so the torque is always large and the efficiency increases

Essay questions

1 **Model answer**

1- The metal core is made of silicon soft iron because its magnetic permeability is high, so it concentrates the magnetic flux, and its high resistivity increases the resistance of the metal core to eddy currents.

2- The two coils are made of copper because the resistivity of copper is low, to reduce the resistance of the coils, so the energy lost in them as heat decreases.

2 **Model answer**

(1) So that the potential difference of the secondary coil (V_s) is different from the potential difference of the primary coil (V_p), so the transformer does its job of stepping the voltage up or down.

(2) So that the magnetic flux produced by the alternating current, which cuts the secondary coil, is changing, so mutual induction takes place between the two coils, which is the basis of how the transformer works.

3 **Model answer**

Because of the resistance of the wires of the two coils and the eddy currents produced in the iron core of the coils, as the core cuts the changing magnetic flux produced by the alternating current in the primary coil. So part of the electrical energy changes into heat energy, which raises the temperature of the charger and reduces the efficiency of the transformer.

4 **Model answer**

The core is made of insulated sheets to increase its resistance to eddy currents, which reduces them and reduces their heating effect.

5 **Model answer**

(1) The transformer is step-down.

(2) Because a step-down transformer steps up the current, so the current of the secondary coil is larger. So the resistance of the secondary coil wires must be reduced by making them thicker, so they can carry high currents and the power lost in the wires decreases.

6 **Model answer**

The alternating current flowing in the primary coil produces a changing magnetic flux that cuts the turns of the secondary coil, so it induces an emf in it.

7 **Model answer**

In an ideal transformer: $(P_w)_p = (P_w)_s$, $I_pV_p = I_sV_s$

$I_p/I_s = V_s/V_p$, $I \propto 1/V$

That is, since the power is constant, the current is inversely proportional to the potential difference, where $I = P_w/V$

8 **Model answer**

There is no contradiction, because in an ideal transformer the energy produced in the secondary coil in a certain time = the energy given to the primary coil in the same time, as the increase in the potential difference comes at the expense of the current, since the power consumed is constant $(P_w = VI)$.

9 **Model answer**

The largest emf is obtained when it is used as a step-up transformer: $V_s/100 = 800/400$, $V_s = 200\ V$

The smallest emf is obtained when it is used as a step-down transformer: $V_s/100 = 400/800$, $V_s = 50\ V$

10 **Model answer**

Potential difference per turn in the secondary = η × potential difference per turn in the primary.

(1) $((V_p)_1)/((V_s)_1) = 1/1$

(2) $(V_s)_1 = 90/100(V_p)_1$, $((V_p)_1)/((V_s)_1) = 10/9$

11 **Model answer**

(1) The induced voltage across the secondary coil: 1- is alternating. 2- its frequency equals the frequency of the source voltage. 3- its value is less than the source voltage.

(2) When the rotation frequency of the dynamo coil connected to the primary coil of the transformer is increased, the effective value of the source voltage increases and its frequency increases, so:

1- the induced voltage across the secondary coil increases according to the relation $V_s = V_p \times N_s/N_p$

2- the frequency of the induced voltage across the secondary coil increases and equals the frequency of the source in the new case.

12 **Model answer**

Lamp P_1 is lit because it is connected to a DC source, and lamp P_2 is not lit because the primary coil is connected to a DC source, so a direct current flows in the primary coil and the magnetic flux it produces, which cuts the secondary coil, does not change. So no induced emf is produced in the secondary coil and no current flows in it.

13 **Model answer**

(1) The two transformers are ideal: $(P_w)_R = (P_w)_{source}$, ratio = 1 : 1

(2) $((V_p)_x)/((V_s)_x) = 1/3$, $(V_p)_y = (V_s)_x$, $((V_s)_x)/((V_s)_y) = 1/3$

Multiplying the two equations: $((V_s)_y)/((V_p)_x) = 9/1$

14 **Model answer**

An induced back emf is produced in the primary coil by self-induction, almost equal to the emf of the source, so the energy consumed in the primary coil is almost zero.

15 **Model answer**

(1) Because transformer (1) is a step-up transformer that steps down the current, reducing the current before transmission to reduce the loss of electrical energy as heat, and transformer (2) is a step-down transformer that steps up the current so that the voltage and current become suitable for operating household devices.

(2) (A) The transmission efficiency decreases, as transformer (2) steps up the current, so the loss of electrical energy during transmission increases.

(B) The transmission efficiency decreases, because the current in the transmission lines is large, so the loss of electrical energy in the wires increases.

16 **Model answer**

Because of the inertia of the coil.

17 **Model answer**

Because an induced back emf is produced in the coil as it cuts the magnetic flux lines.

18 **Model answer**

By:

1- increasing the number of coils with small equal angles between them, and dividing the cylinder into several parts insulated from each other, their number being twice the number of coils used.

2- increasing the number of turns of each coil. 3- increasing the area of the coil face.

4- increasing the current flowing in the coil by using a battery of greater emf.

5- increasing the magnetic flux density by using a stronger magnet.

6- placing an iron core inside the coil. 7- using a magnet with concave poles.

19 **Model answer**

(1) Because of the cylinder split into two insulated halves, the current reverses its direction in the coil every half cycle, so the torque keeps acting on the coil in one direction.

(2) By: 1- reversing the two poles of the magnet. 2- reversing the polarity of the battery connected to the coil.

20 **Model answer**

1- Replacing the AC source with a DC source (battery).

2- Replacing the two metal rings with a cylinder split into two halves insulated from each other.

21 **Model answer**

Because every half cycle the positions of the two halves of the split metal cylinder relative to the two brushes are swapped, so the direction of the current in the coil reverses.

22 **Model answer**

(1) For the torque acting on the coil to become zero, the coil must reach the position where it is perpendicular to the direction of the magnetic field, i.e. the coil rotates from this position through an angle $\theta = 60 + 90 = 150^{\circ}$

$t = 150/360T = 5/12T$

(2) For the torque to become a maximum value, the coil must become parallel to the field, i.e. it rotates through an angle of 60°: $t = 60/360T = T/6$

23 **Model answer**

Because while the motor coil rotates, a back emf is induced in the coil that reduces the current flowing in it. When the coil is stopped from rotating, the back emf becomes zero, so the current in the coil becomes large and can damage it.

24 **Model answer**

In the dynamo: the split cylinder makes a current in one direction with varying magnitude flow in the external circuit of the dynamo.

In the motor: it reverses the direction of the current in the motor coil every half cycle, so a torque acts on the coil in the same direction and it rotates in one direction.

25 **Model answer**

DC dynamo: to make the current in one direction and almost constant in magnitude.

Electric motor: to increase the efficiency of the motor.

26 **Model answer**

(1) The reason is that the student is still using the system of two metal rings that rotate with the coil and two fixed brushes. As a result, the current flowing in the coil always stays in one direction and does not reverse every half cycle, so the direction of the magnetic force acting on the two long sides of the coil does not change. So the coil moves half a cycle and then returns to its first position without completing a full cycle.

(2) Replacing the two metal rings with two halves of a hollow insulated cylinder split lengthwise into two halves insulated from each other by an insulating gap, able to rotate about the same axis of rotation as the coil, with the insulating gap between the two halves of the cylinder perpendicular to the plane of the coil.

Past exam questions

1	2	3	4	5	6	7	8	9	10
C	C	B	C	D	D	D	D	C	A
11	12	13	14	15	16	17	18	19	20
D	A	D	D	C	A	D	A	B	C
21	22	23	24	25	26	27	28	29	30
D	B	C	C	B	C	C	D	—	—
31	32	33							
—	—	—							

1 **Answer (C)**

$V_s = P/I = 1/0.5 = 2\ V$

$V_s = eta\ V_pN_s/N_p,\ 2 = 0.95 \times V_p \times 1/100$

$V_p = 210.53\ V$

2 **Answer (C)**

$V_p = V_sN_p/N_s = 300 \times 2/3 = 200\ V$

The transformer is ideal: $(P_w)_s = (P_w)_p$, ratio = 1

3 **Answer (B)**

$V_p = 60 \times 4 = 240\ V$

$I_p = V_sI_s/V_p = (60 \times 20)/240 = 5\ A$

4 **Answer (C)**

$I_s = etaV_pI_p/V_s = 0.9 \times 7/4 \times 10 = 15.75\ A$

$V_s/V_p = etaN_s/N_p,\ 4/7 = 0.9 \times N_s/400,\ N_s = 254$ turns

5 **Answer (D)**

In the secondary of the second transformer: $I_s = 30/30 = 1\ A$, $P = 50 \times 1 = 50\ W$

$I_p = 50/100 = 0.5\ A$, which is the current flowing in R_1

$P_{R_1} = VI = 10 \times 0.5 = 5\ W$

6 **Answer (D)**

$V_s = eta\ V_p N_s/N_p = 0.8 \times 220 \times 3/5 = 105.6\ V$

$I_p = V_s I_s/(eta\ V_p) = (105.6 \times 10)/(0.8 \times 220) = 6\ A$

7 **Answer (D)**

$V_s = P/I = 60/0.5 = 120\ V$

$V_s = eta\ V_p N_s/N_p$, $N_s/N_p = 120/(0.9 \times 220) = 20/33$

8 **Answer (D)**

Slope = efficiency $((P_w)_s)/((P_w)_p)$, and the highest theoretically possible efficiency is 100%, i.e. slope = 1 (angle 45°): graph (4).

9 **Answer (C)**

$(P_w)_p = V_p I_p = 100 \times 3.2 = 320\ W$

$eta = 240/320 \times 100 = 75\%$

The secondary coil has more turns than the primary: a step-up transformer.

10 **Answer (A)**

$(P_w)_s = eta\ (P_w)_p = 0.9 \times 60 = 54\ kW$

11 **Answer (D)**

Efficiency = slope of the line $= 4/5 = 0.8$

$(P_w)_s = 72 \times 2 = 144\ W$, $(P_w)_p = 144/0.8 = 180\ W$

$I_p = 180/15 = 12\ A$

12 **Answer (A)**

$(V_{out})/(V_{in}) = N_2/N_1 \times N_4/N_3 = 2 \times 4 = 8$

13 **Answer (D)**

$(P_w)_p = 120 \times 10^3 = 1.2 \times 10^5\ W$, $(P_w)_s = 10^3 \times 110 = 1.1 \times 10^5\ W$

Power lost $= 10^4\ W$

14 **Answer (D)**

When the secondary circuit is opened, a back emf almost equal to the source emf is induced in the primary by self-induction, so the current approaches zero.

15 **Answer (C)**

A core of low conductivity (high resistivity) reduces the eddy currents.
and wires of high conductivity (such as copper) reduce the heat loss in them.

16 **Answer (A)**

At distribution areas a step-down (current step-up) transformer is used, so the primary current is less than the secondary current.

17 **Answer (D)**

$V_p I_p = (V_s I_s)_x + (V_s I_s)_y$
$220\, I_p = 20 \times 1 + 19 \times 0.8 = 35.2, I_p = 0.16\, A$

18 **Answer (A)**

Wire AD stays perpendicular to the field lines during rotation, so the force acting on it $F = BI\ell$ stays at a maximum value.

19 **Answer (B)**

Dividing the iron core into insulated discs (sheets) increases its resistance, so it reduces the eddy currents.

20 **Answer (C)**

At the perpendicular position the torque becomes zero, so the coil keeps rotating because of its inertia.

21 **Answer (D)**

Side ab stays perpendicular to the field lines during rotation, so the force acting on it $F = BI\ell$ stays constant.
while the torque becomes $\tau = \tau_{max} cos\, 60^\circ = 1/2 \tau_{max}$

22 **Answer (B)**

At the perpendicular position the torque becomes zero, but the coil keeps rotating because of inertia, so its rotation speed is not zero.

23 **Answer (C)**

$\tau = m_d B \sin\theta$, slope $= m_d B = 64.8/0.9 = 72$

$m_d = 72/0.3 = 240\ A.m^2$

24 **Answer (C)**

The split cylinder reverses the direction of the current in the coil every half cycle, so the torque stays in one direction.

25 **Answer (B)**

Several coils at small angles make one of the coils always close to the parallel position, so the torque stays almost constant at its maximum value.

26 **Answer (C)**

The electric motor needs a DC source (battery) and a split cylinder to reverse the current in the coil every half cycle: changes (II), (III).

27 **Answer (C)**

After 90° the coil becomes perpendicular to the field, so the torque becomes zero, and it keeps rotating because of inertia.

28 **Answer (D)**

Closing K_1 short-circuits the coil (connects its two ends), so the motor stops and all the current flows in the lamp, so it becomes brighter.

Closing K_2 short-circuits the lamp, so it goes off and a larger current flows in the motor, so its rotation speed increases.

29 **Model answer**

In an ideal transformer: $(P_w)_p = (P_w)_s$

$I_p V_p = 120\ I_p = 60, I_p = 0.5\ A$

$I_s V_s = 12\ I_s = 60, I_s = 5\ A$

30 **Model answer**

(1) Potential difference lost in the transmission wires: $V = IR = 2 \times 7500 = 15 \times 10^3\ V$

Potential difference across the secondary coil: $V_s = (15 \times 10^3) + (132 \times 10^3) = 147 \times 10^3\ V$

(2) The transformer is ideal: $V_s/V_p = I_p/I_s$, $(147 \times 10^3)/(25 \times 10^3) = I_p/2, I_p = 11.76\ A$

31 **Model answer**

(1) $V_p/((V_s)_x) = N_p/((N_s)_x)$, $220/6 = 1100/((N_s)_x)$, $(N_s)_x = 30$ turns

$220/12 = 1100/((N_s)_y)$, $(N_s)_y = 60$ turns

(2) $V_pI_p = (V_sI_s)_x + (V_sI_s)_y$, $220\ I_p = (6 \times 0.4) + (12 \times 0.35)$, $I_p = 0.03\ A$

32 **Model answer**

$(P_w)_p = V_pI_p$, $100 \times 10^3 = 200\ I_p$, $I_p = 500\ A$

$N_p/N_s = I_s/I_p$, $1/5 = I_s/500$, $I_s = 100\ A$

$(P_w)_{lost} = I_s^2R = (100)^2 \times 4 = 4 \times 10^4\ W$

Transmission efficiency $= ((100 \times 10^3) - (4 \times 10^4))/(100 \times 10^3) \times 100 = 60\%$

33 **Model answer**

(1) Transformer (Y): a step-down transformer (steps up the current).

Transformer (Z): a step-up transformer (steps down the current).

(2) The efficiency of transmitting electrical energy can be improved by:

- using wires made of materials with low resistivity.
- using thick wires of low resistance.
- raising the potential difference, which comes with lowering the current.