Physics · Electric Current and Electromagnetism · AC Circuits

Oscillating Circuit and Resonance Circuit

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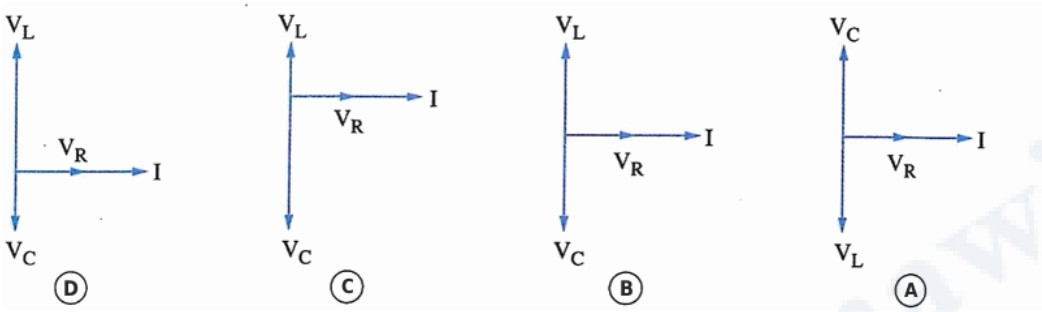
Multiple choice questions — 86 questions

1 When an RLC circuit is at resonance, the impedance is a ..... and equals the ..... of the circuit.

(A) minimum, ohmic resistance
(B) maximum, ohmic resistance
(C) minimum, inductive reactance
(D) maximum, capacitive reactance

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2 The following figures show the voltage and current vectors in an RLC circuit. Which of these figures shows a state of resonance?



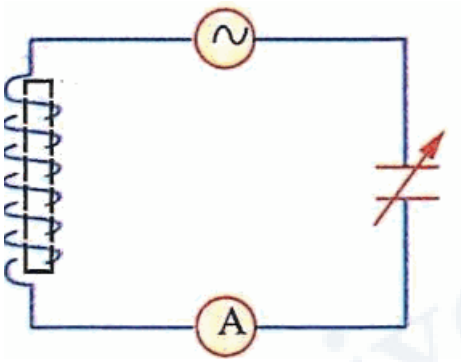
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3 In an AC circuit whose components are connected in series, it was noticed that as the frequency of the source increases, the effective current in the circuit increases up to a certain value and then starts to decrease. So this circuit contains .....

(A) an inductor, a capacitor and an ohmic resistor
(B) an ohmic resistor and an inductor
(C) an ohmic resistor and a capacitor
(D) an ohmic resistor only

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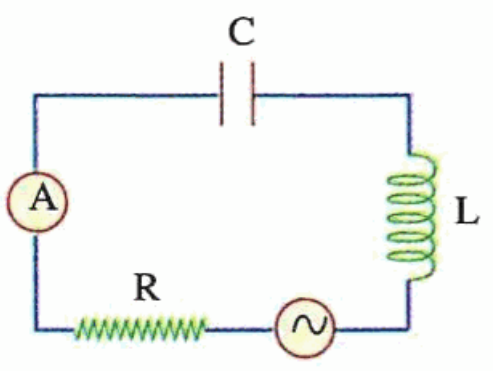
4 The figure shows an RLC circuit at resonance. When the iron core is removed from the coil, the reading of the hot-wire ammeter .....



(A) decreases
(B) increases
(C) stays constant
(D) becomes zero

5 The circuit shown in the figure is an RLC circuit at resonance, and the effective voltage of its AC source is constant. When the frequency of the source is increased:

(1) the ohmic resistance (R) .....

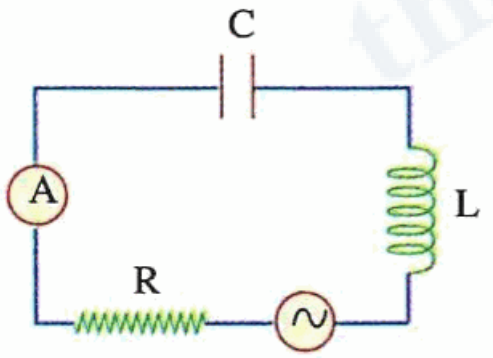


(A) stays constant
(B) is halved
(C) is doubled
(D) becomes three times as large

---

6 The circuit shown in the figure is an RLC circuit at resonance, and the effective voltage of its AC source is constant. When the frequency of the source is increased:

(2) the reading of the hot-wire ammeter (A) .....



(A) stays constant
(B) decreases because the impedance increases
(C) decreases because the impedance decreases
(D) increases because the impedance increases

---

7 The resonance frequency of an RLC circuit is determined by the value of .....

(A) the ohmic resistance and the self-inductance of the coil
(B) the self-inductance of the coil and the capacitance of the capacitor
(C) the ohmic resistance and the capacitance of the capacitor
(D) the ohmic resistance, the self-inductance of the coil and the capacitance of the capacitor

8 An RLC AC circuit is at resonance. The product of the self-inductance (L) of the coil and the capacitance (C) of the capacitor is .....

(A) the angular frequency of the current

(B) the square of the angular frequency of the current

(C) the reciprocal of the angular frequency of the current

(D) the reciprocal of the square of the angular frequency of the current

---

9 To decrease the frequency that gives resonance in an RLC circuit, we can .....

(A) spread the turns of the inductor apart

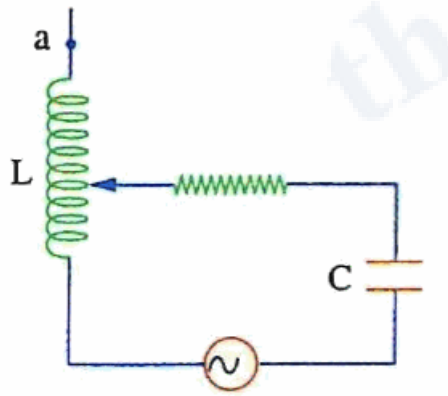
(B) cut off part of the coil and reconnect the rest in the circuit

(C) remove the capacitor (C) from the circuit

(D) connect an external capacitor in parallel with the circuit's capacitor

---

10 In the opposite RLC circuit, what happens to the frequency that gives resonance when the slider is moved towards point a?



(A) It increases

(B) It decreases

(C) It does not change

(D) It becomes zero

---

11 In a resonant circuit, the capacitance of the capacitor is doubled and the self-inductance of the coil is decreased to $1/8$ of its value. The frequency that gives resonance .....

(A) is doubled

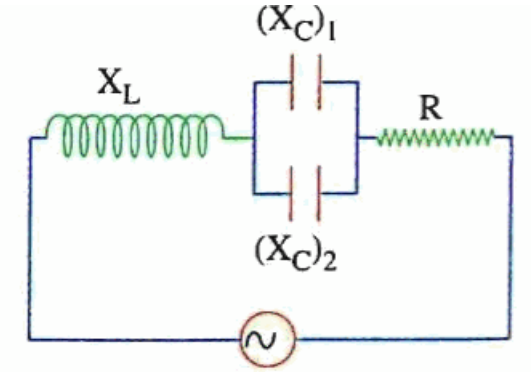
(B) is halved

(C) becomes four times the first case

(D) becomes $1/4$ of the first case

---

12 The opposite circuit is at resonance if .....



(A) $X_L = (X_C)_1 + (X_C)_2$

(B) $X_L = ((X_C)_1)/2 + ((X_C)_2)/4$

(C) $X_L = ((X_C)_1 (X_C)_2)/((X_C)_1 + (X_C)_2)$

(D) $X_L = (X_C)_1 = (X_C)_2$

---

13 An RLC AC circuit is connected in series, and the frequency of its source can be changed. When the frequency of the current is less than the resonance frequency of this circuit, the circuit has .....

(A) capacitive properties because $X_L > X_C$

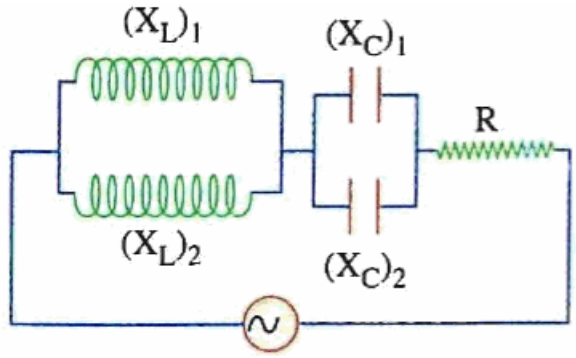
(B) capacitive properties because $X_L < X_C$

(C) inductive properties because $X_L > X_C$

(D) inductive properties because $X_L < X_C$

---

14 In the opposite circuit, if $(X_L)_1 = (X_L)_2 = (X_C)_1 = (X_C)_2 = R$, the circuit has ..... properties.



(A) inductive

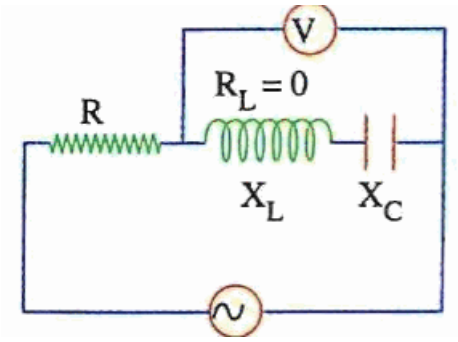
(B) ohmic

(C) capacitive

(D) inductive or capacitive

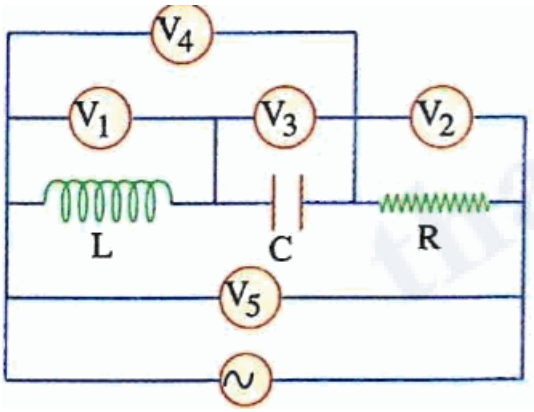
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15 The opposite figure shows an AC circuit. If the power consumed in the resistor (R) is the greatest possible, the voltmeter reads .....



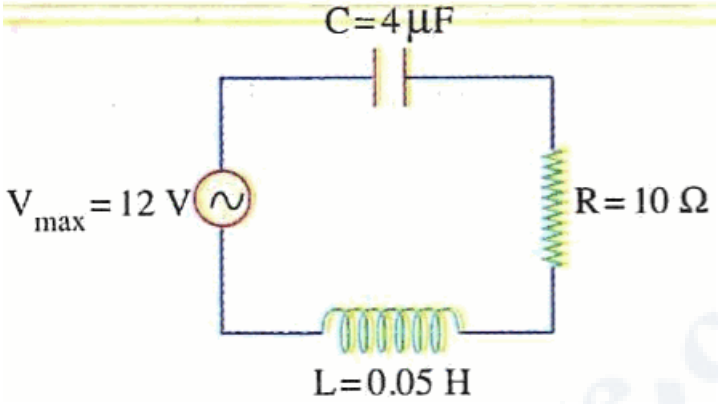
(A) $\sqrt{(2\ V_L^2 - V_C^2)}$
(B) $\sqrt{(V_R^2 + V_L^2)}$
(C) $\sqrt{(V_R^2 + (V_L - V_C)^2)}$
(D) 0

16 Which of the voltmeters shown in the opposite circuit reads zero at resonance?



(A) V_1, V_3
(B) V_2
(C) V_4
(D) V_5

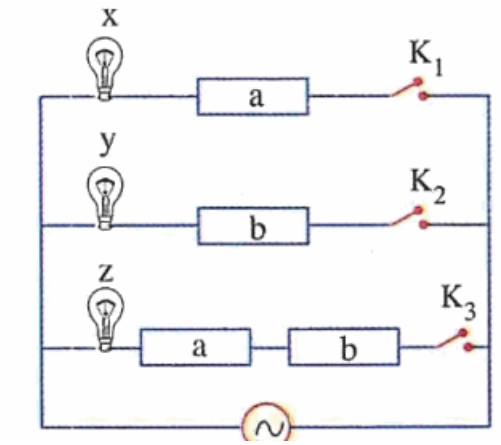
17 The opposite figure shows an AC circuit at resonance. The electric power consumed from the source is .....



(A) 0
(B) 3.6 W
(C) 7.2 W
(D) 14.4 W

18 In the opposite electric circuit, the two electric components (a) and (b) are pure, and the lamps (x), (y) and (z) are identical. After closing switch (K_1) only, the total voltage leads the current and lamp (x) consumes an electric power (P_w). After closing switch (K_2) only, the total voltage lags behind the current and lamp (y) also consumes an electric power (P_w). If switch (K_3) only is closed, then:

(1) lamp (z) consumes an electric power .....



(A) equal to (P_w)

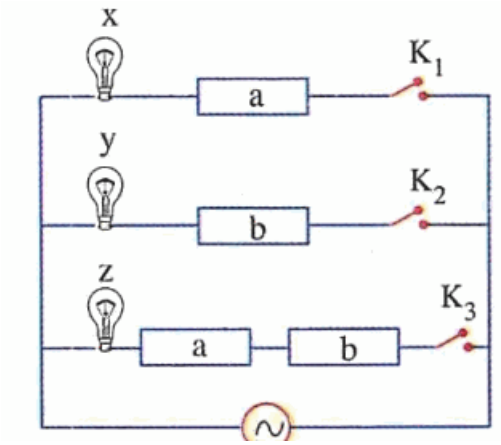
(B) greater than (P_w)

(C) less than (P_w)

(D) that cannot be determined

19 In the opposite electric circuit, the two electric components (a) and (b) are pure, and the lamps (x), (y) and (z) are identical. After closing switch (K_1) only, the total voltage leads the current and lamp (x) consumes an electric power (P_w). After closing switch (K_2) only, the total voltage lags behind the current and lamp (y) also consumes an electric power (P_w). If switch (K_3) only is closed, then:

(2) the total voltage .....



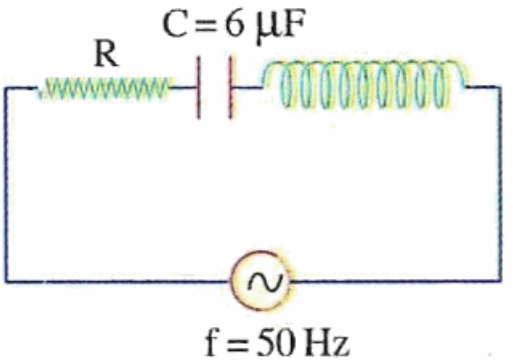
(A) leads the current in phase

(B) lags behind the current in phase

(C) is in phase with the current

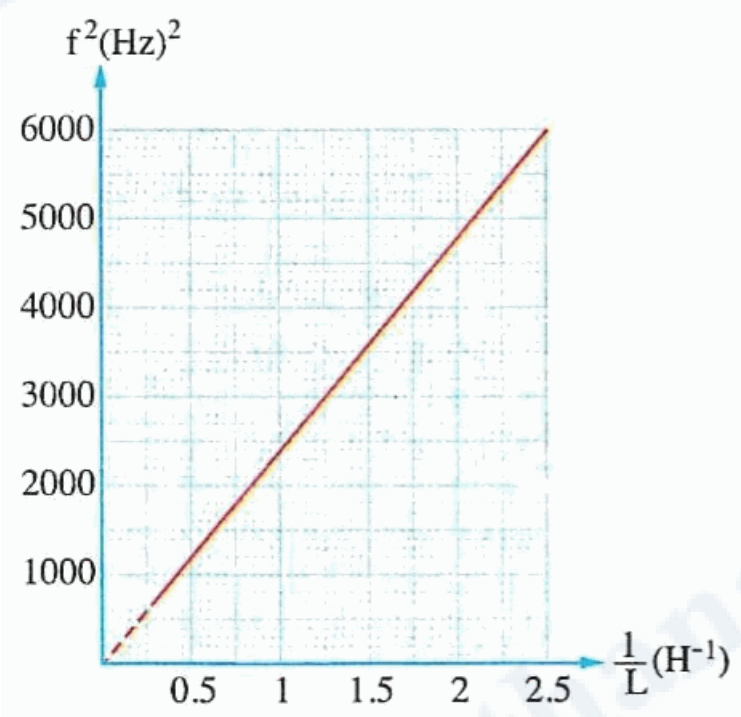
(D) has a phase relative to the current that cannot be determined

20 In the circuit shown, if the impedance of the circuit equals R, the self-inductance of the coil equals .....



(A) 6 H (B) 1.69 H (C) 60.731 H (D) 80.41 H

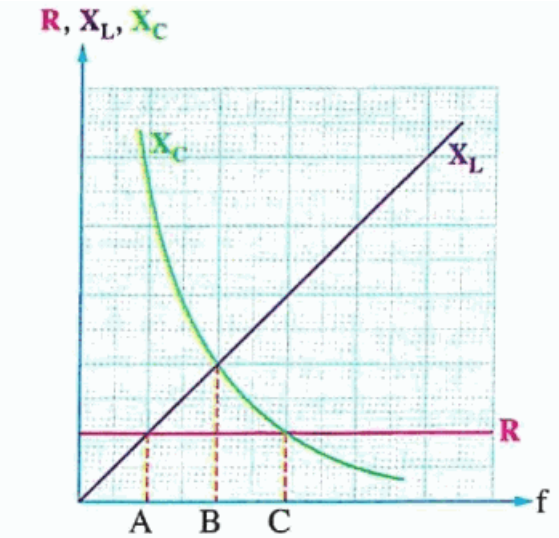
21 A capacitor of fixed capacitance is connected in series with an inductor whose self-inductance can be changed and an AC source. The opposite graph shows the relation between the square of the resonance frequency (f^2) of the circuit and the reciprocal of the self-inductance of the coil $(1/L)$. The capacitance of the capacitor is .....



(A) 0.85×10^{-5} F (B) 1.05×10^{-5} F (C) 2.02×10^{-5} F (D) 3.06×10^{-5} F

22 The opposite graph shows how the inductive reactance of a pure inductor (X_L), the capacitive reactance of the capacitor (X_C) and the ohmic resistance (R) change with frequency (f) in an (RLC) AC circuit whose components are connected in series:

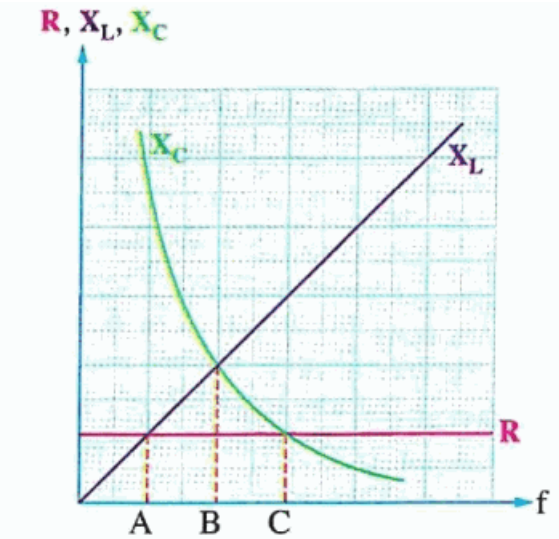
(1) At which of the following frequencies is the voltage across the resistor equal to the voltage across the coil?



(A) A (B) B (C) C (D) A, B, C

23 The opposite graph shows how the inductive reactance of a pure inductor (X_L), the capacitive reactance of the capacitor (X_C) and the ohmic resistance (R) change with frequency (f) in an (RLC) AC circuit whose components are connected in series:

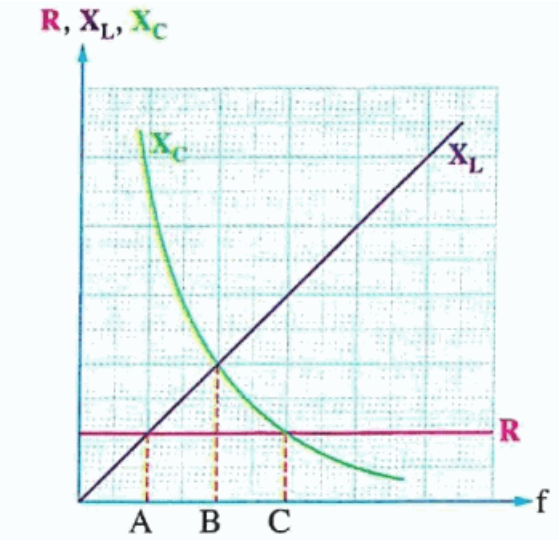
(2) At which of the following frequencies does the circuit have capacitive properties?



(A) A (B) B (C) C (D) A, B, C

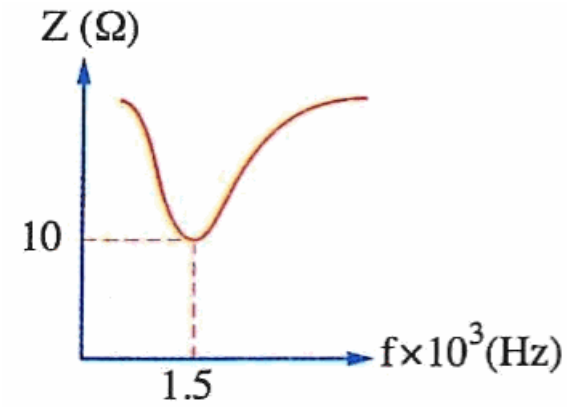
24 The opposite graph shows how the inductive reactance of a pure inductor (X_L), the capacitive reactance of the capacitor (X_C) and the ohmic resistance (R) change with frequency (f) in an (RLC) AC circuit whose components are connected in series:

(3) What is the impedance of the circuit at frequency (B) in terms of the ohmic resistance (R) of the circuit?



(A) R (B) $\sqrt{(2)}$ R (C) $\sqrt{(3)}$ R (D) 2 R

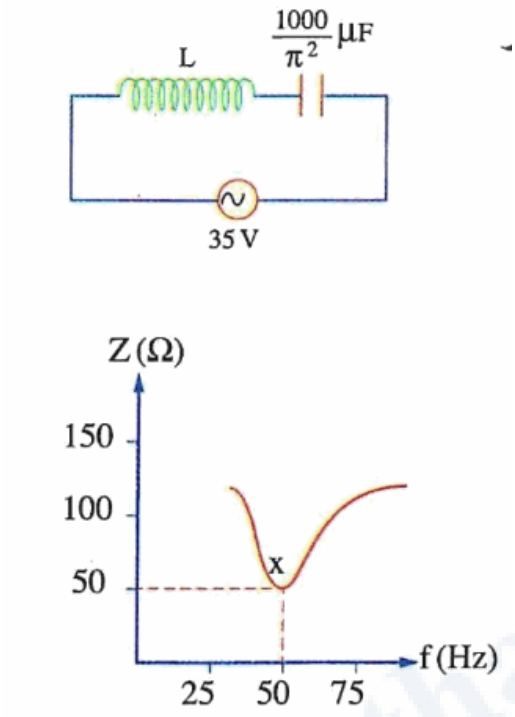
25 An AC circuit consists of a resistor, a capacitor and an inductor connected in series with an AC source whose frequency can be changed. The opposite graph shows the relation between the impedance of the circuit (Z) and the frequency of the current (f). The ohmic resistance of this circuit equals .....



(A) 1.5 Ω (B) 5 Ω (C) 6.67 Ω (D) 10 Ω

26 When studying the impedance of the circuit shown in the figure by changing the frequency of the AC source, we obtained the graph shown. If the internal resistance of the source is negligible:

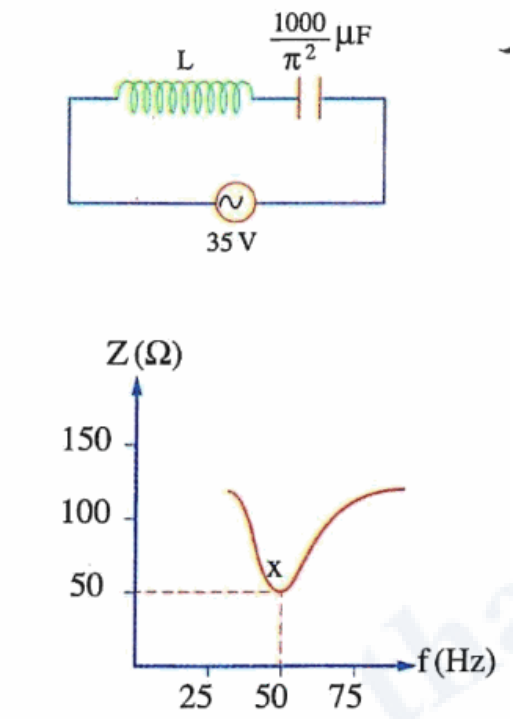
(1) the self-inductance of the coil equals .....



(A) 0.1 H (B) 0.2 H (C) 2 H (D) 1 H

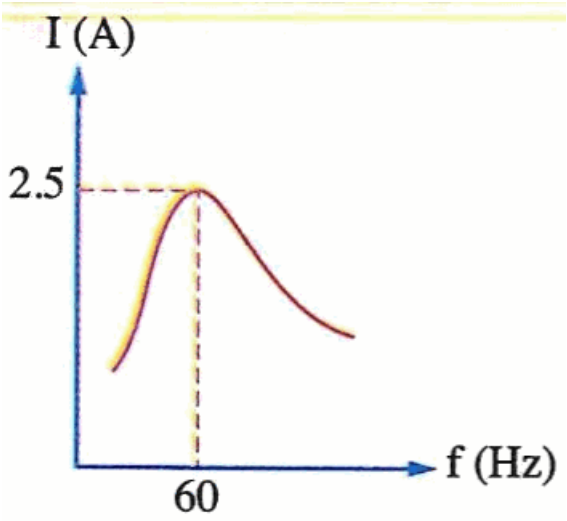
27 When studying the impedance of the circuit shown in the figure by changing the frequency of the AC source, we obtained the graph shown. If the internal resistance of the source is negligible:

(2) the potential differences across the coil and the capacitor at position x are respectively .....



(A) 22 V, 22 V
(B) 41.34 V, 22 V
(C) 41.34 V, 41.34 V
(D) 22 V, 41.34 V

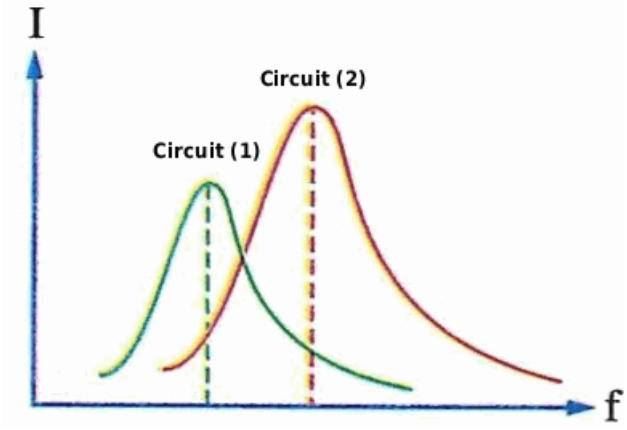
28 The opposite figure shows the graph of the effective current (I) in an RLC AC circuit against the frequency of the source (f). If the capacitance of the capacitor is 2.58×10^{-4} F, the self-inductance of the coil that puts the circuit at resonance is approximately .....



(A) 15 mH (B) 22 mH (C) 27 mH (D) 32 mH

29 Two (RLC) AC circuits each have a source of constant voltage (V) whose frequency can be changed. The opposite graph shows the relation between the current (I) in each circuit and the frequency (f) of the source. If the equivalent capacitances in the two circuits are equal, which circuit:

(1) has the greater ohmic resistance?

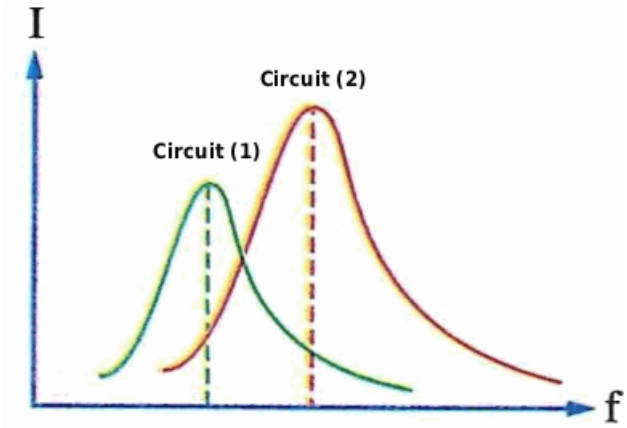


(A) Circuit (1) (B) Circuit (2)

(C) They are equal in both circuits (D) The answer cannot be determined

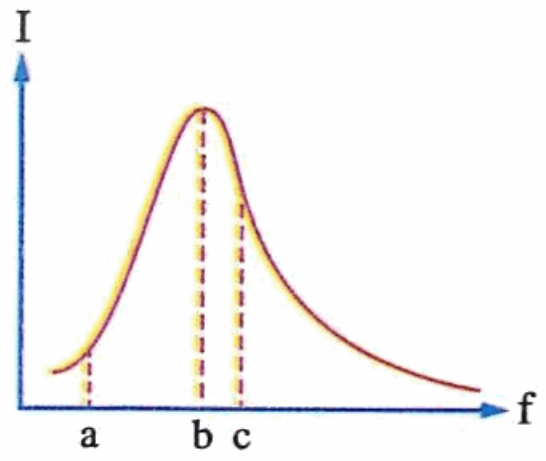
30 Two (RLC) AC circuits each have a source of constant voltage (V) whose frequency can be changed. The opposite graph shows the relation between the current (I) in each circuit and the frequency (f) of the source. If the equivalent capacitances in the two circuits are equal, which circuit:

(2) has the greater total self-inductance?



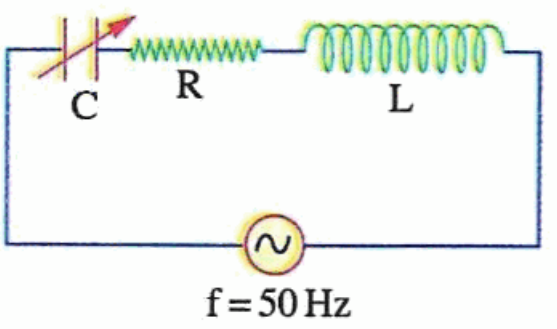
(A) Circuit (1)
(B) Circuit (2)
(C) They are equal in both circuits
(D) The answer cannot be determined

31 An RLC AC circuit has its components connected in series, and the frequency of its source can be changed while its effective voltage stays constant. The opposite graph shows the relation between the current (I) in the circuit and the frequency (f) of its source. The frequency at which the phase angle between the total voltage and the current is .....



(A) greatest: a, smallest: b
(B) greatest: a, smallest: c
(C) greatest: b, smallest: c
(D) greatest: c, smallest: b

32 In the figure shown, if the circuit is at resonance and then the capacitance of the capacitor is doubled, the new frequency that gives resonance is .....



(A) 500 Hz (B) $25\sqrt{2}$ Hz (C) 50 Hz (D) $100\sqrt{2}$ Hz

33 An RLC AC circuit has its components connected in series, and the frequency of its source can be changed while its effective voltage stays constant. Figure (1) shows the graph of the impedance (Z) of the circuit against the frequency (f) of the source, and figure (2) shows the graph of the current (I) in the circuit against the frequency (f) of the source. If the coil has negligible ohmic resistance and the capacitance of the capacitor is $1/(\pi)$ μF, then:
(1) the voltage across the coil at a frequency of 500 Hz equals .....

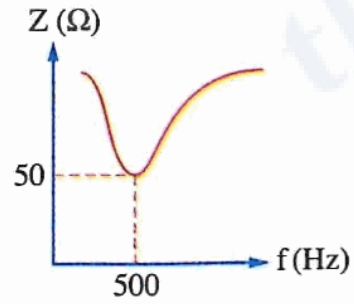


Figure (1)

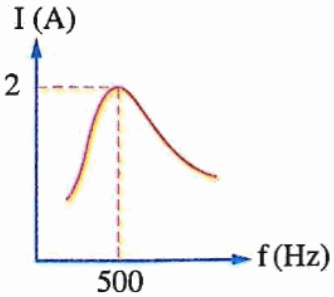


Figure (2)

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

34 An RLC AC circuit has its components connected in series, and the frequency of its source can be changed while its effective voltage stays constant. Figure (1) shows the graph of the impedance (Z) of the circuit against the frequency (f) of the source, and figure (2) shows the graph of the current (I) in the circuit against the frequency (f) of the source. If the coil has negligible ohmic resistance and the capacitance of the capacitor is $1/(\pi)$ μF, then:
(2) the voltage across the capacitor at a frequency of 250 Hz is approximately .....

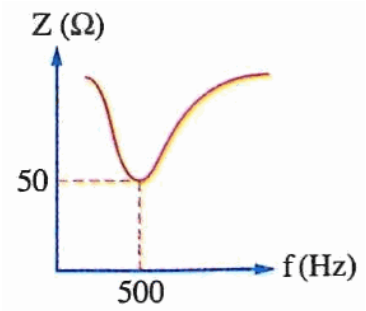


Figure (1)

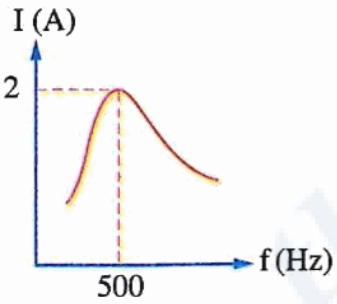
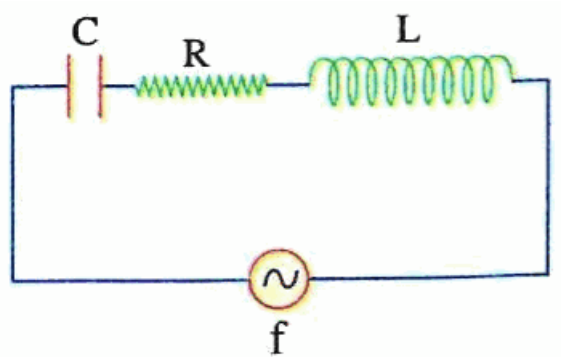


Figure (2)

(A) 33 V (B) 66 V (C) 133 V (D) 166 V

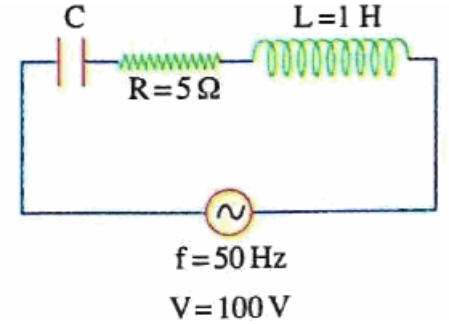
35 In the circuit shown, which of these choices gives resonance?



(A) L: 1 H, C: 1 μF, f: 1000 Hz
(B) L: 10 H, C: 10 μF, f: 100 Hz
(C) L: 2 H, C: 2 μF, f: 400 Hz
(D) L: $7/22$ H, C: $7/22$ μF, f: 500 Hz

36 In the circuit shown, if the current is 20 A, then:

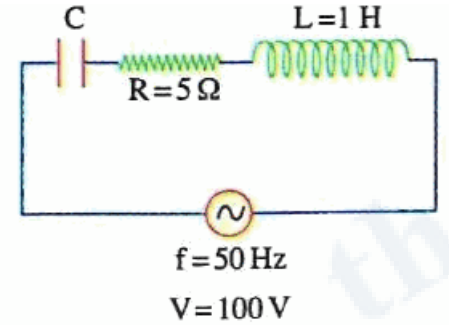
(1) the capacitance C of the capacitor is .....



(A) 10^{-5} μF (B) 5 F (C) 10^{-5} F (D) 98596 F

37 In the circuit shown, if the current is 20 A, then:

(2) the voltage across the coil is .....



(A) 0 (B) 50 V (C) 100 V (D) 6285.7 V

38 A resonant circuit consisting of a 30 μF capacitor and an inductor of self-inductance L_1 receives a wave of frequency 750 kHz. If the coil is replaced by another of self-inductance (L_2), five times that of the first coil, and the capacitance is increased by 32 μF, then: (given: the speed of electromagnetic waves = 3×10^8 m/s)

(1) the frequency of the wave that can be received equals .....

(A) 7.3×10^4 Hz (B) 2.33×10^5 Hz (C) 4.8×10^5 Hz (D) 24.1×10^5 Hz

39 A resonant circuit consisting of a 30 μF capacitor and an inductor of self-inductance L_1 receives a wave of frequency 750 kHz. If the coil is replaced by another of self-inductance (L_2), five times that of the first coil, and the capacitance is increased by 32 μF, then: (given: the speed of electromagnetic waves = 3×10^8 m/s)

(2) the wavelength of the wave that can be received equals .....

(A) 6.99×10^{13} m (B) 2.25×10^{13} m (C) 1.29×10^3 m (D) 4×10^2 m

40 A resonant circuit consisting of a 30 μF capacitor and an inductor of self-inductance L_1 receives a wave of frequency 750 kHz. If the coil is replaced by another of self-inductance (L_2), five times that of the first coil, and the capacitance is increased by 32 μF, then: (given: the speed of electromagnetic waves = 3×10^8 m/s)

(3) the self-inductances of the coil in the two cases, L_1 and L_2, are respectively .....

(A) 7.1×10^{-3} H, 3.5×10^{-2} H
(B) 1.12×10^{-3} H, 7.1×10^{-3} H
(C) 1.5×10^{-9} H, 7.5×10^{-9} H
(D) 7.5×10^{-9} H, 1.5×10^{-9} H

41 A receiving circuit consists of a 10 mH inductor, a variable capacitor and a 50 Ω resistor. When it receives radio waves of frequency 980 kHz, a potential difference of 10^{-4} V is produced across the circuit. Then:

(1) the capacitance needed for resonance equals .....

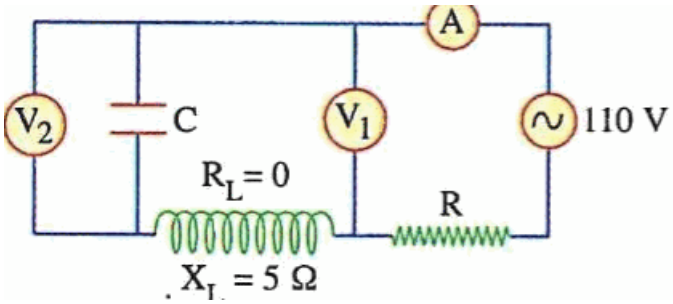
(A) 8.3×10^{-12} F
(B) 2.6×10^{-12} F
(C) 8.4×10^{-5} F
(D) 1.6×10^{-5} F

42 A receiving circuit consists of a 10 mH inductor, a variable capacitor and a 50 Ω resistor. When it receives radio waves of frequency 980 kHz, a potential difference of 10^{-4} V is produced across the circuit. Then:

(2) the current in the circuit at resonance equals .....

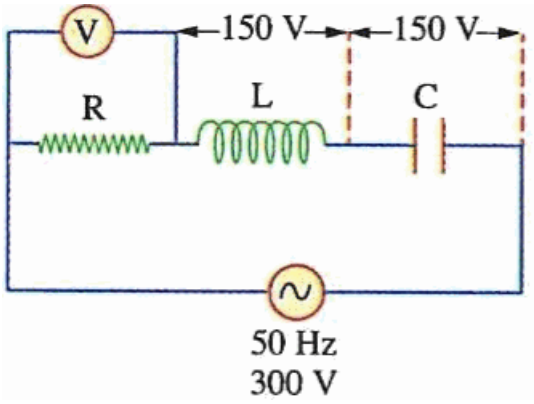
(A) 1.6×10^{-9} A
(B) 2×10^{-7} A
(C) 2×10^{-6} A
(D) 3×10^{-6} A

43 In the AC circuit shown in the figure, if the reading of the hot-wire ammeter is 2 A and the reading of voltmeter V_1 is zero, the value of resistance R and the reading of voltmeter V_2 are respectively .....



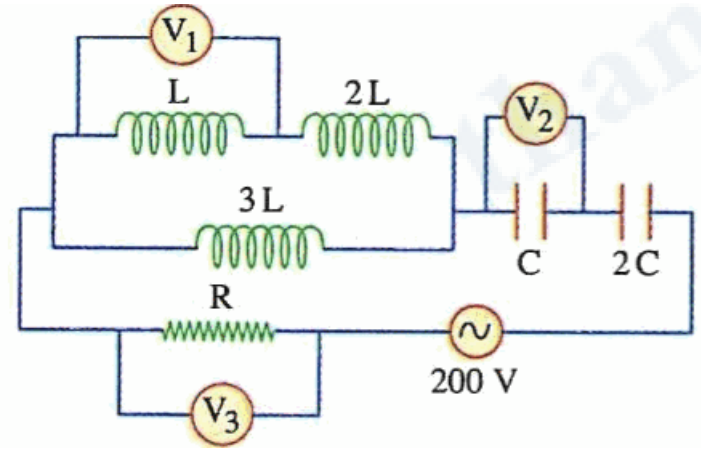
(A) 45 Ω, 5 V
(B) 50 Ω, 8 V
(C) 55 Ω, 10 V
(D) 60 Ω, 20 V

44 In the circuit shown, the reading of the voltmeter is ..... (given: the ohmic resistances of the source and the coil are negligible)



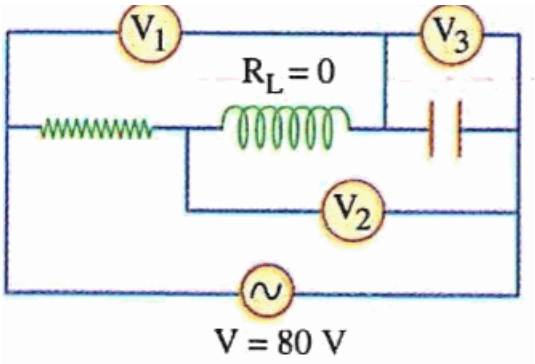
(A) zero (B) 100 V (C) 200 V (D) 300 V

45 In the opposite electric circuit, the inductors have negligible ohmic resistance, and the readings of voltmeters (V_1) and (V_2) are 50 V and 100 V respectively. The reading of voltmeter (V_3) equals .....



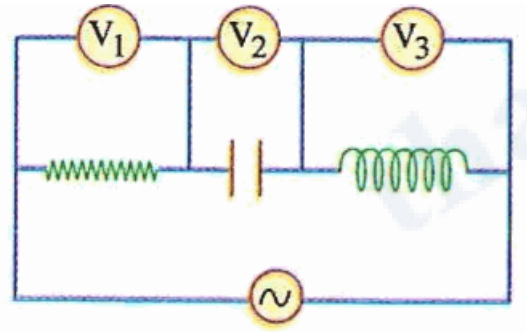
(A) 50 V (B) 100 V (C) 150 V (D) 200 V

46 In the opposite electric circuit, the readings of voltmeters (V_1) and (V_2) are 100 V and 0 V respectively. The reading of voltmeter (V_3) equals .....



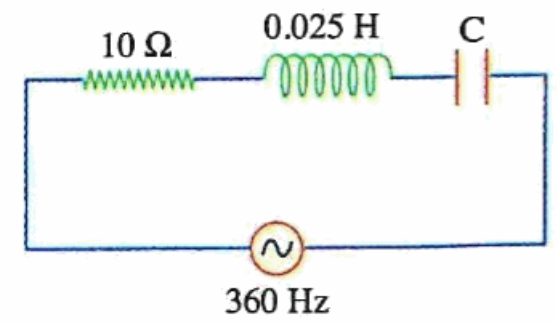
(A) 0 V (B) 60 V (C) 80 V (D) 100 V

47 In the opposite figure, an (RLC) AC circuit is at resonance and the current in it is 1 A. If the readings of voltmeters (V_1), (V_2) and (V_3) are 20 V, 60 V and 100 V respectively, the total ohmic resistance in the circuit equals .....



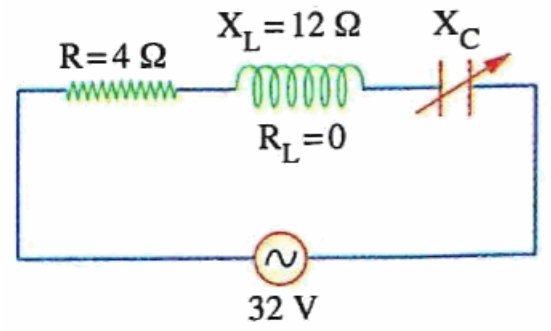
(A) 20 Ω (B) 60 Ω (C) 80 Ω (D) 100 Ω

48 In the opposite electric circuit, for the total voltage and the current to be in phase, the capacitance of the capacitor must be .....



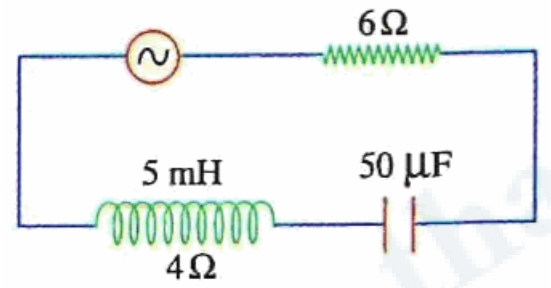
(A) 2.8×10^{-3} F (B) 5.6×10^{-3} F (C) 7.8 μF (D) 3.9 μF

49 The opposite figure shows an RLC circuit containing a variable capacitor. The greatest effective current that can flow in the circuit equals .....



(A) 2 A (B) 4 A (C) 6 A (D) 8 A

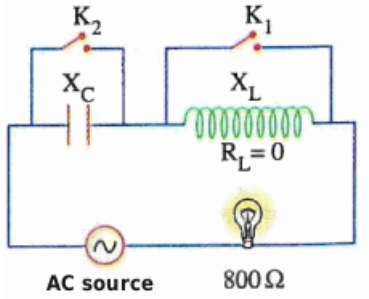
50 The opposite figure shows an AC circuit whose source voltage is given by $(V = 20 \sin \omega t)$, with $\omega = 2000$ rad/s. The maximum current in the circuit equals .....



(A) 2 A (B) 3.3 A (C) $2\sqrt{(5)}$ A (D) $\sqrt{(5)}$ A

51 In the circuit shown in the figure, an AC source has a frequency of 50 Hz and an emf of 220 V, the capacitor has a capacitance of 4 μF and the inductor has a self-inductance of $1225/484$ H. Then:

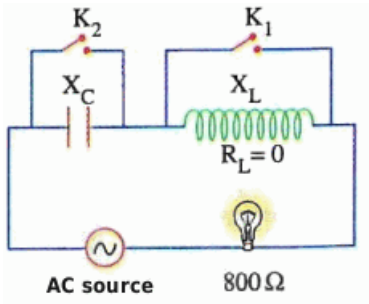
(1) the impedance of the circuit when switches K_1 and K_2 are both open is .....



(A) 800 Ω (B) 765.45 Ω (C) 150.6 Ω (D) 0

52 In the circuit shown in the figure, an AC source has a frequency of 50 Hz and an emf of 220 V, the capacitor has a capacitance of 4 μF and the inductor has a self-inductance of *1225/484* H. Then:

(2) the ratio of the impedance of the circuit with switch K_1 only closed to its impedance with switch K_2 only closed equals .....

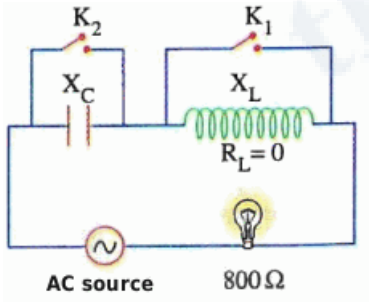


(A) *1/1* (B) *1/2* (C) *2/1* (D) *1/3*

---

53 In the circuit shown in the figure, an AC source has a frequency of 50 Hz and an emf of 220 V, the capacitor has a capacitance of 4 μF and the inductor has a self-inductance of *1225/484* H. Then:

(3) when switches K_1 and K_2 are both closed .....



(A) lamp brightness: increases, impedance: 795.45 Ω

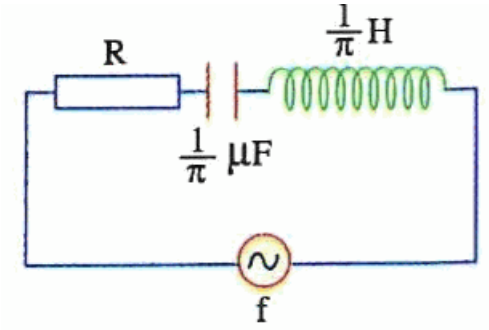
(B) lamp brightness: increases, impedance: 800 Ω

(C) lamp brightness: stays constant, impedance: 795.45 Ω

(D) lamp brightness: stays constant, impedance: 800 Ω

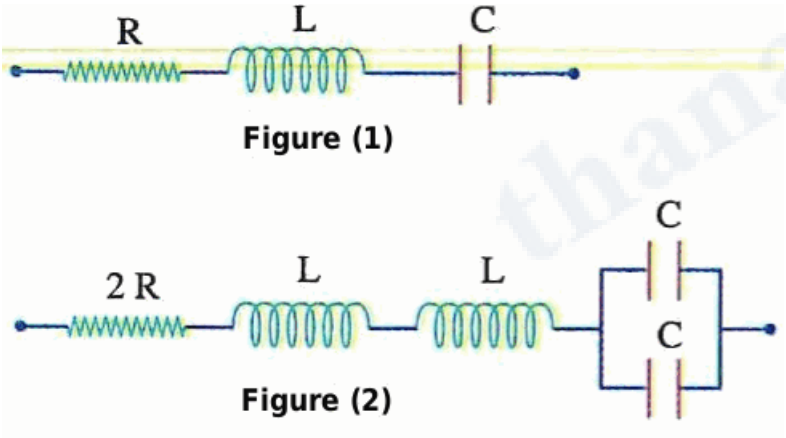
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54 The opposite circuit shows an AC source whose frequency can be changed. If the source has a constant voltage, the voltage across resistor R has its greatest effective value at a frequency of .....



(A) 0 (B) 100 Hz (C) 250 Hz (D) 500 Hz

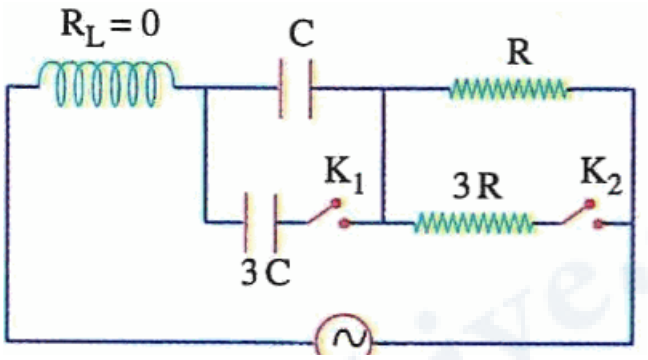
55 Figures (1) and (2) show parts of two AC circuits. If the resonance frequency in figure (1) is 10 kHz, the resonance frequency in figure (2) equals .....



(A) 2.5 kHz (B) 5 kHz (C) 10 kHz (D) 40 kHz

56 In the opposite electric circuit, if the frequency that gives resonance when switches (K_1) and (K_2) are open is (f_o), the frequency that gives resonance after:

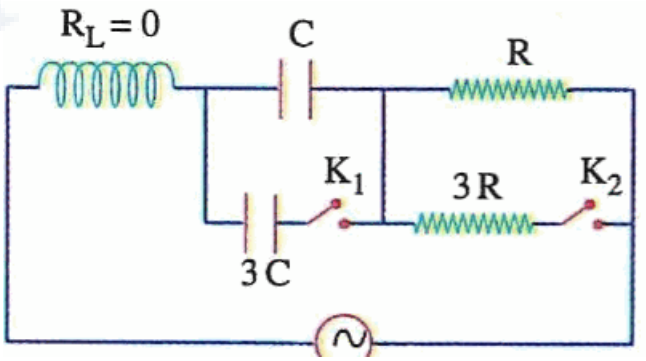
(1) closing switch (K_1) only is .....



(A) $1/4\ f_o$ (B) $1/2\ f_o$ (C) f_o (D) $2\ f_o$

57 In the opposite electric circuit, if the frequency that gives resonance when switches (K_1) and (K_2) are open is (f_o), the frequency that gives resonance after:

(2) closing switch (K_2) only is .....



(A) $1/4\ f_o$ (B) $1/2\ f_o$ (C) f_o (D) $2\ f_o$

---

58 A radio transmitting circuit contains an oscillating circuit made of an inductor of self-inductance $49/121$ mH and a capacitor whose plates have a potential difference of 9 V when one plate carries a charge of 36 mC. Then:

(1) the frequency of the oscillating circuit is .....

(A) 25 Hz (B) 41.67 Hz (C) 62.5 Hz (D) 125 Hz

---

59 A radio transmitting circuit contains an oscillating circuit made of an inductor of self-inductance $49/121$ mH and a capacitor whose plates have a potential difference of 9 V when one plate carries a charge of 36 mC. Then:

(2) the reactances of the coil and the capacitor are respectively .....

(A) $7/22\ \Omega, 22/7\ \Omega$ (B) $22/7\ \Omega, 7/22\ \Omega$ (C) $22/7\ \Omega, 22/7\ \Omega$ (D) $7/22\ \Omega, 7/22\ \Omega$

---

60 A battery of emf 12 V is connected in series with an inductor, and the current in the circuit is 2 A. If the battery is replaced by an AC source of effective voltage 12 V, the effective current in this case is 1.2 A, and when a capacitor is connected in series with the coil in the second circuit, the current returns to its value in the first circuit. Then: (assuming the internal resistances of the two sources are negligible)

(1) the ohmic resistance of the coil equals .....

(A) 4 Ω (B) 6 Ω (C) 8 Ω (D) 10 Ω

---

61 A battery of emf 12 V is connected in series with an inductor, and the current in the circuit is 2 A. If the battery is replaced by an AC source of effective voltage 12 V, the effective current in this case is 1.2 A, and when a capacitor is connected in series with the coil in the second circuit, the current returns to its value in the first circuit. Then: (assuming the internal resistances of the two sources are negligible)

(2) the inductive reactance of the coil equals .....

(A) 4 Ω (B) 6 Ω (C) 8 Ω (D) 10 Ω

---

62 A battery of emf 12 V is connected in series with an inductor, and the current in the circuit is 2 A. If the battery is replaced by an AC source of effective voltage 12 V, the effective current in this case is 1.2 A, and when a capacitor is connected in series with the coil in the second circuit, the current returns to its value in the first circuit. Then: (assuming the internal resistances of the two sources are negligible)

(3) the last circuit, made of the AC source, the coil and the capacitor, ...

(A) has capacitive properties
(B) is at resonance
(C) has inductive properties
(D) has capacitive and inductive properties

---

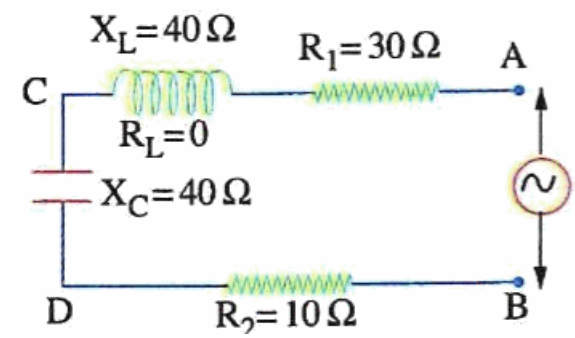
63 An inductor of self-inductance 0.08 H and ohmic resistance 30 Ω is connected to a 10 V AC source of frequency 80 Hz. Which of the following components, connected in series in this circuit, reduces the phase angle between the total voltage and the current to zero without changing the current through the coil?

(A) A capacitor of capacitive reactance 6 Ω
(B) A capacitor of capacitive reactance 8 Ω
(C) A 20.18 Ω resistor and a 100 μF capacitor
(D) A 20.18 Ω resistor and a 49.43 μF capacitor

---

64 In the opposite figure, points A and B are connected to an AC source of emf 200 V and frequency 50 Hz. Then:

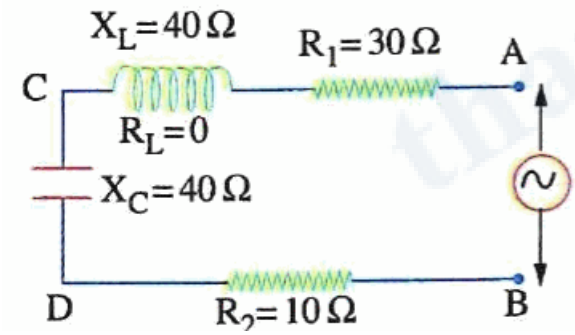
(1) the potential difference between A and C equals .....



(A) 350 V (B) 250 V (C) 140 V (D) 100 V

65 In the opposite figure, points A and B are connected to an AC source of emf 200 V and frequency 50 Hz. Then:

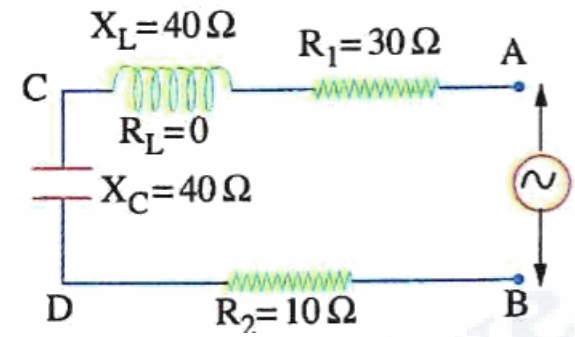
(2) the potential difference between B and C equals .....



(A) 137.44 V (B) 155.2 V (C) 206.16 V (D) 250 V

66 In the opposite figure, points A and B are connected to an AC source of emf 200 V and frequency 50 Hz. Then:

(3) the power consumed in the circuit equals .....



(A) 250 W (B) 600 W (C) 750 W (D) 1000 W

67 An AC source is connected in series in a circuit containing an inductor of negligible resistance, a capacitor and a 100 Ω ohmic resistor, and the maximum possible current flows in the circuit. When the source is replaced by another of the same emf and twice the frequency, the current drops to 0.45 of its value in the first case. The inductive and capacitive reactances in the first case are respectively .....

(A) 79.38 Ω, 79.38 Ω
(B) 79.38 Ω, 132.3 Ω
(C) 132.3 Ω, 132.3 Ω
(D) 132.3 Ω, 79.38 Ω

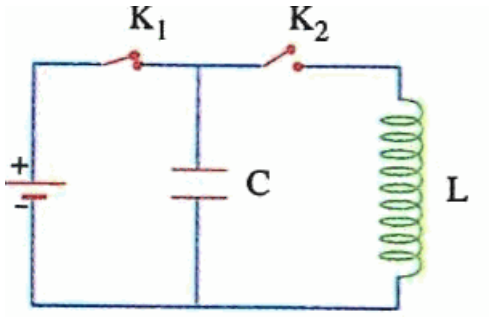
68 An RLC AC circuit is at resonance when its frequency is 60 Hz, and its impedance is then 8 Ω. When its frequency is changed to 80 Hz, the impedance of the circuit becomes 10 Ω. The self-inductance of the coil and the capacitance of the capacitor are .....

(A) self-inductance of the coil: 0.027 H, capacitance: 2.58×10^{-4} F
(B) self-inductance of the coil: 0.015 H, capacitance: 2.58×10^{-4} F
(C) self-inductance of the coil: 0.027 H, capacitance: 4.54×10^{-4} F
(D) self-inductance of the coil: 0.015 H, capacitance: 6.36×10^{-4} F

69 In an oscillating circuit, what change must be made to the self-inductance of the coil to double the frequency of the current in it?

(A) Decreasing it to a quarter
(B) Increasing it to four times
(C) Decreasing it to half
(D) Doubling it

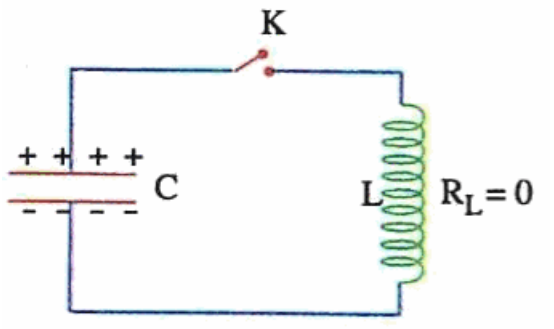
70 In the opposite oscillating circuit, when switch K_1 is opened and then switch K_2 is closed for a while, assuming the ohmic resistance of the coil and the connecting wires is negligible, which of the following happens in the coil?



(A) A direct current flows in it
(B) A unidirectional current flows in it
(C) An alternating current flows in it
(D) No electric current flows in it

71 The opposite figure shows an oscillating circuit made of a 25.3 μF capacitor and a 0.4 H inductor. How many times during one second from the moment switch K is closed is:

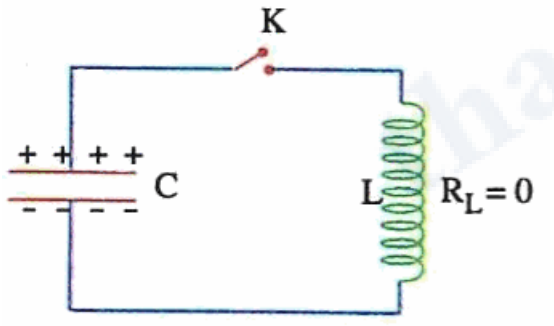
(1) the capacitor completely discharged?



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

72 The opposite figure shows an oscillating circuit made of a 25.3 μF capacitor and a 0.4 H inductor. How many times during one second from the moment switch K is closed is:

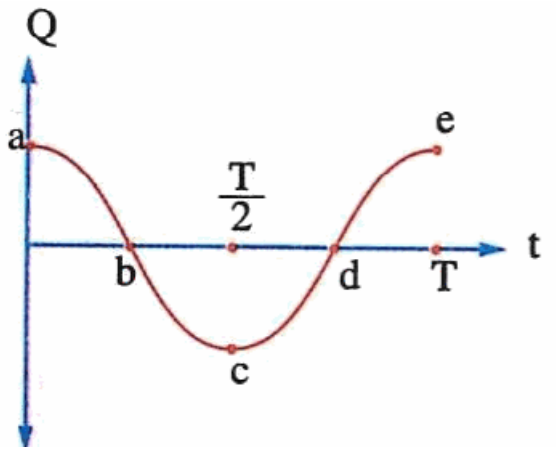
(2) the magnetic energy in the coil equal to the electric energy in the capacitor?



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

73 The opposite graph shows the relation between the charge (Q) on the plates of the capacitor in an oscillating circuit and time (t). At which two of the points shown on the graph:

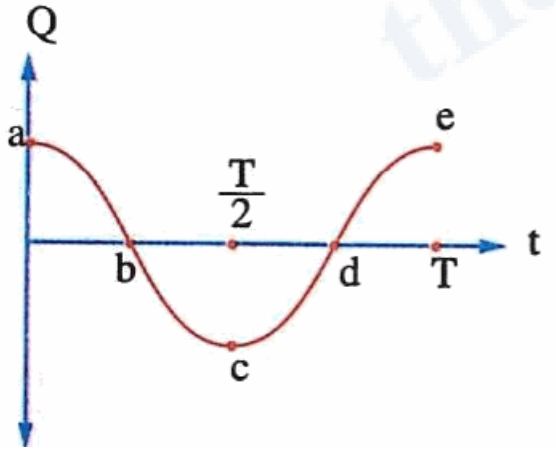
(1) is the current in the circuit greatest?



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

74 The opposite graph shows the relation between the charge (Q) on the plates of the capacitor in an oscillating circuit and time (t). At which two of the points shown on the graph:

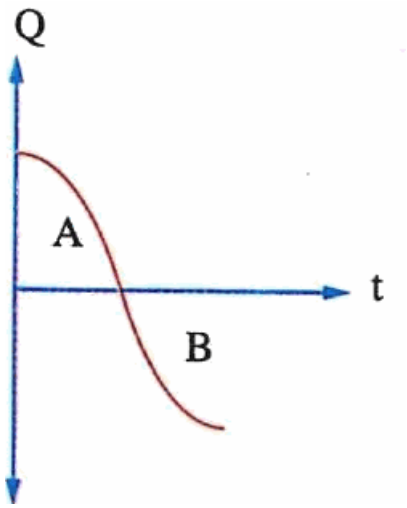
(2) is the capacitor charged with the same charge and the same polarity?



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

75 The opposite graph shows half a cycle of the charge stored on the capacitor in an oscillating circuit from the moment the switch of the circuit is closed. In which of the two stages (A) and (B):

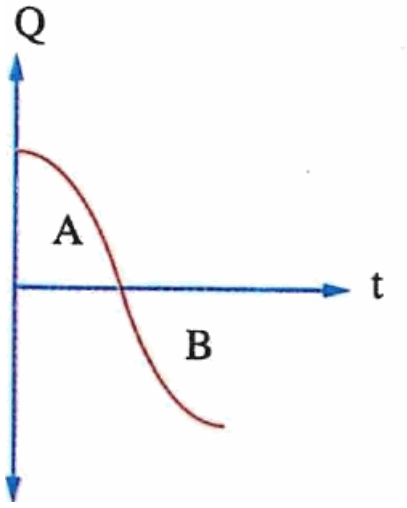
(1) does the potential difference across the capacitor increase?



(A) Stage (A) (B) Stage (B) (C) Both stages (D) Neither stage

76 The opposite graph shows half a cycle of the charge stored on the capacitor in an oscillating circuit from the moment the switch of the circuit is closed. In which of the two stages (A) and (B):

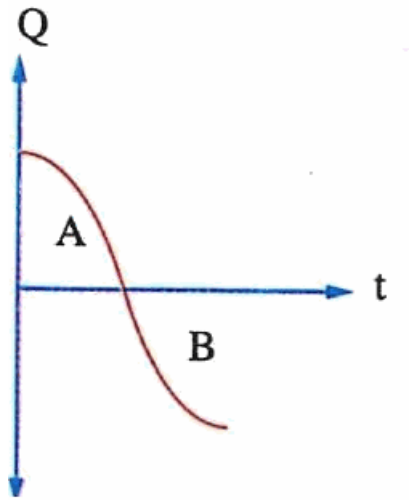
(2) is a forward induced emf produced in the coil?



(A) Stage (A) (B) Stage (B) (C) Both stages (D) Neither stage

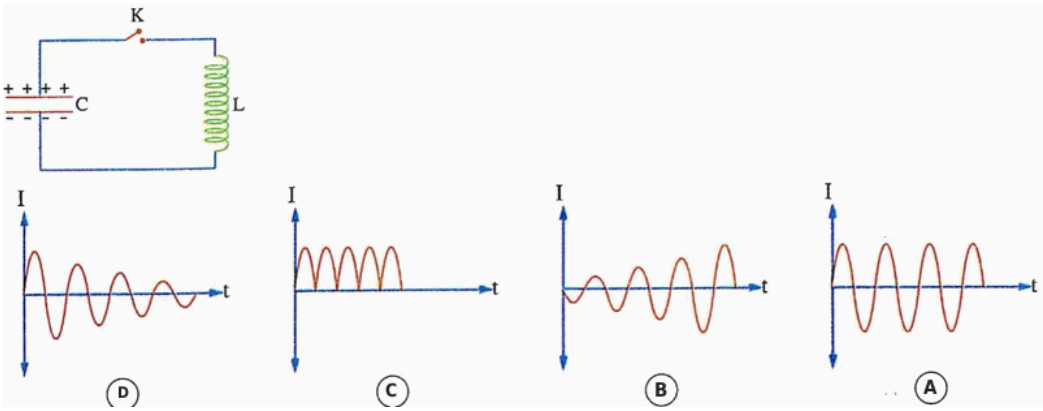
77 The opposite graph shows half a cycle of the charge stored on the capacitor in an oscillating circuit from the moment the switch of the circuit is closed. In which of the two stages (A) and (B):

(3) does the energy stored in the coil increase?

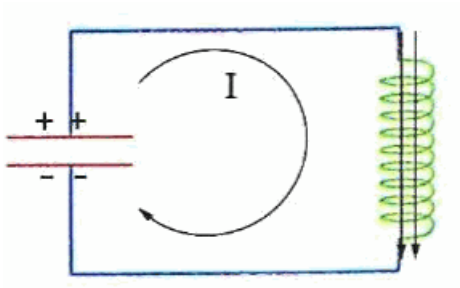


(A) Stage (A) (B) Stage (B) (C) Both stages (D) Neither stage

78 The electric circuit shown has a charged capacitor C connected to an inductor L of ohmic resistance R through an open switch K. The current in the coil after closing switch (K) is shown by graph .....



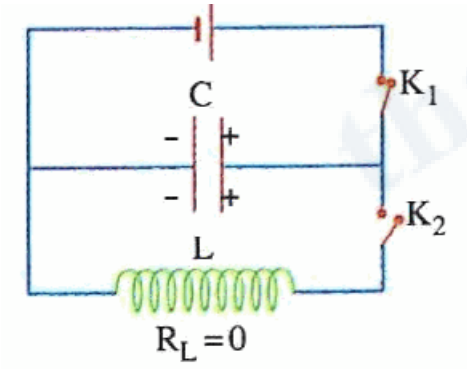
79 The figure shown represents the direction of the current in an oscillating circuit at a certain moment. What happens to the value of the current (I) in the moments after that moment, during a quarter of the periodic time of the current?



(A) It increases
(B) It increases then decreases
(C) It decreases
(D) It decreases then increases

---

80 In the opposite electric circuit, a coil of self-inductance 0.25 mH and a 1 μF capacitor carrying a charge Q. If switch K_1 is opened, the capacitor discharges completely for the first time after closing switch K_2 within a time of .....

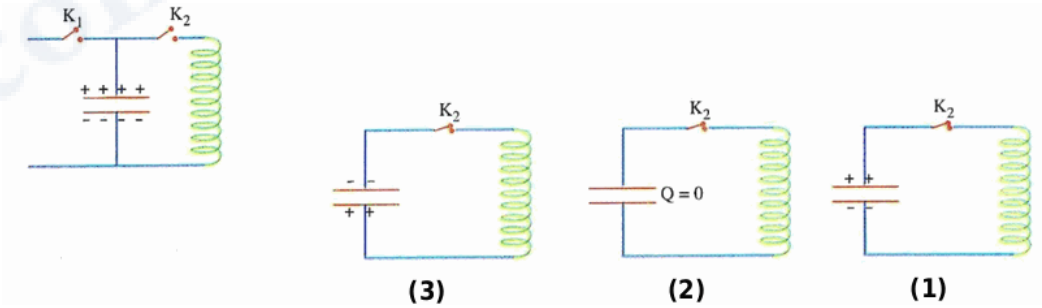


(A) 10 μs
(B) 20 μs
(C) 25 μs
(D) 100 μs

---

81 The opposite figure shows an oscillating circuit with a charged capacitor, and the following figures show three moments of the circuit during half a cycle of the current since switch K_2 was closed. Which of these figures shows:

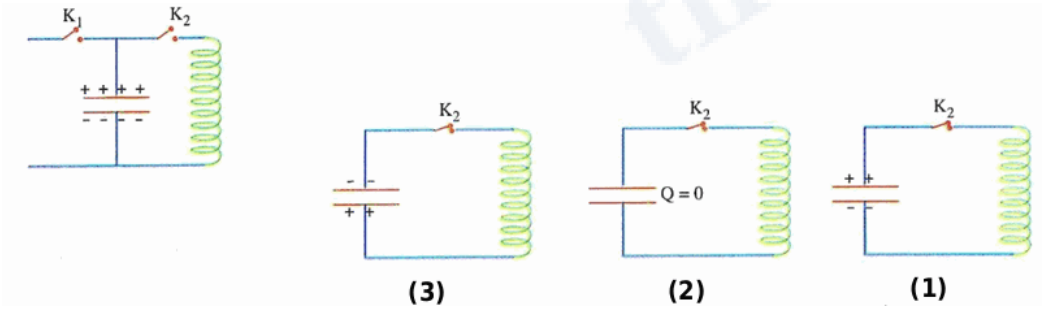
(1) the conversion of energy from electric energy into magnetic energy in the coil?



(A) Figure (1) only
(B) Figure (2) only
(C) Figure (3) only
(D) Figures (1) and (3) together

82 The opposite figure shows an oscillating circuit with a charged capacitor, and the following figures show three moments of the circuit during half a cycle of the current since switch K_2 was closed. Which of these figures shows:

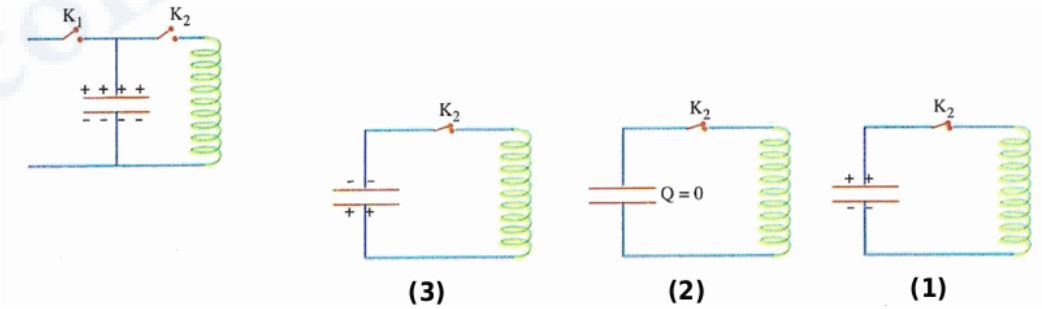
(2) the conversion of energy from magnetic energy into electric energy in the capacitor?



(A) Figure (1) only
(B) Figure (2) only
(C) Figure (3) only
(D) Figures (1) and (3) together

83 The opposite figure shows an oscillating circuit with a charged capacitor, and the following figures show three moments of the circuit during half a cycle of the current since switch K_2 was closed. Which of these figures shows:

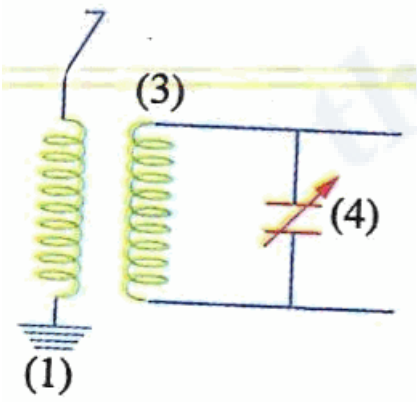
(3) the charging of the capacitor?



(A) Figure (1) only
(B) Figure (2) only
(C) Figure (3) only
(D) Figures (1) and (3) together

---

84 The opposite figure shows a radio receiving circuit. Through which of the components shown can we control the radio station whose signal is picked up?



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

---

85 A radio tuning (resonant) circuit receives a radio station of frequency f. What change must be made to the tuning circuit so that it receives a radio wave of frequency 2 f?

(A) Doubling the self-inductance of the coil and doubling the capacitance of the capacitor
(B) Doubling the self-inductance of the coil and halving the capacitance of the capacitor
(C) Halving the self-inductance of the coil and doubling the capacitance of the capacitor
(D) Halving the self-inductance of the coil and halving the capacitance of the capacitor

---

86 The ratio of the impedance of a receiving circuit when it receives a radio signal of frequency f to its impedance when it receives another radio signal of frequency 4 f is .....

(A) 0.25 (B) 0.5 (C) 1 (D) 4

Essay questions — 14 questions

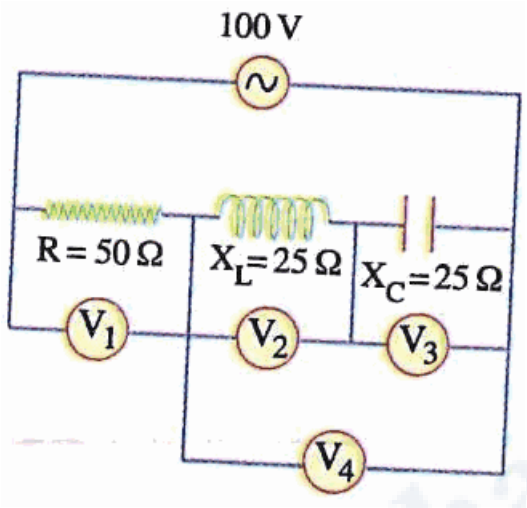
1 Using the electric circuit shown and the given data, calculate:

(1) the ratio of the readings of the two voltmeters (V_1/V_2).

(2) the ratio of the readings of the two voltmeters (V_2/V_3).

(3) the reading of voltmeter (V_4).

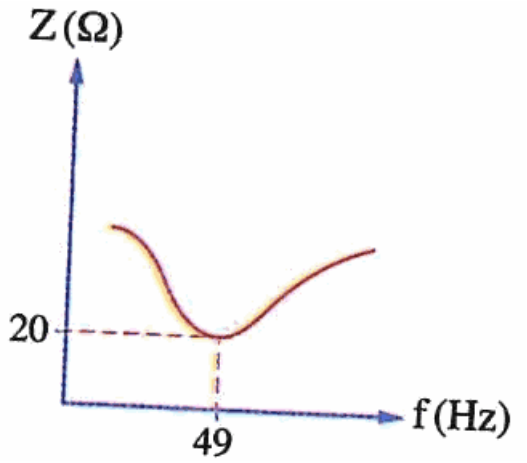
(4) the ratio $(V_1/(V_{source}))$, where V_{source} is the voltage of the source.



2 The opposite graph shows the relation between the impedance of an RLC circuit and the frequency of the AC source. If the capacitance of the capacitor in the circuit is $1.05 \times 10^{-4}\ F$, find:

(1) the ohmic resistance in the circuit.

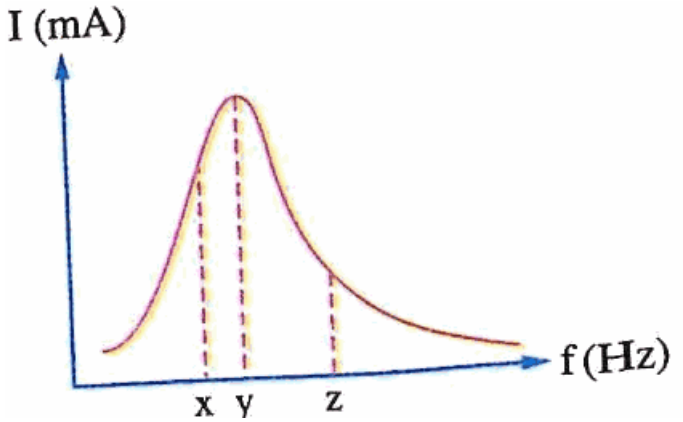
(2) the self-inductance of the coil.



3 The opposite graph shows the relation between the current (I) in an RLC AC circuit and the frequency of the current (f). Explain at which of the frequencies x, y and z shown on the graph:

(1) the inductive reactance of the inductor is less than the capacitive reactance of the capacitor.

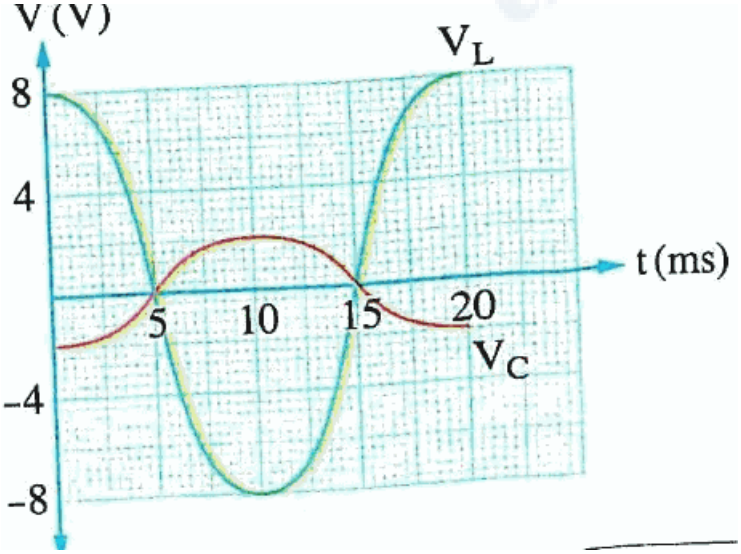
(2) the phase angle between the total voltage and the current in the circuit is zero.



4 The opposite graph shows the sine curves of the alternating voltage across an inductor V_L and a capacitor V_C in an RLC circuit:

(1) Explain why this circuit is not at resonance.

(2) Calculate the frequency that puts the circuit at resonance.



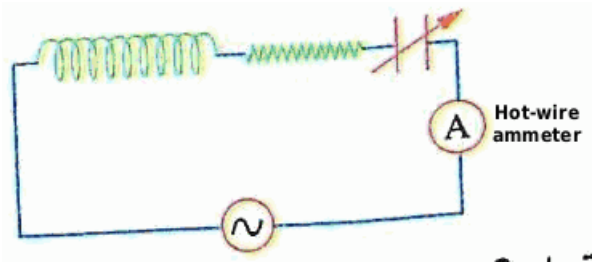
5 In the figure shown, if the circuit is at resonance, what happens to the reading of the hot-wire ammeter when each of the following is increased:

(1) the capacitance of the capacitor?

(2) the value of resistance R?

(3) the frequency of the source, its voltage being constant?

(4) the voltage of the source, the frequency of the current being constant?



6 When the ends of a solenoid were connected to a DC source of emf 12 V and negligible internal resistance, a current of 1 A flowed in the circuit. When this source was replaced by an AC source whose effective voltage equals the voltage of the DC source, with negligible internal resistance and a frequency of 50 Hz, a current of 0.6 A flowed in the circuit. When a capacitor was connected in series with the coil in this circuit, the current returned to 1 A. Calculate:

(1) the self-inductance of the coil.

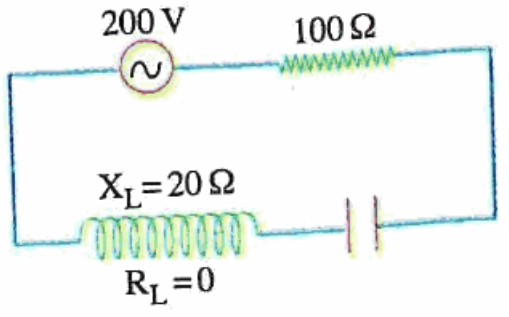
(2) the capacitance of the capacitor.

(3) the phase angle between the current and the total voltage in the last AC circuit.

7 In the circuit shown, if the circuit is at resonance and the maximum charge (Q_{max}) stored on the capacitor is 200 μC, calculate:

(1) the capacitance of the capacitor.

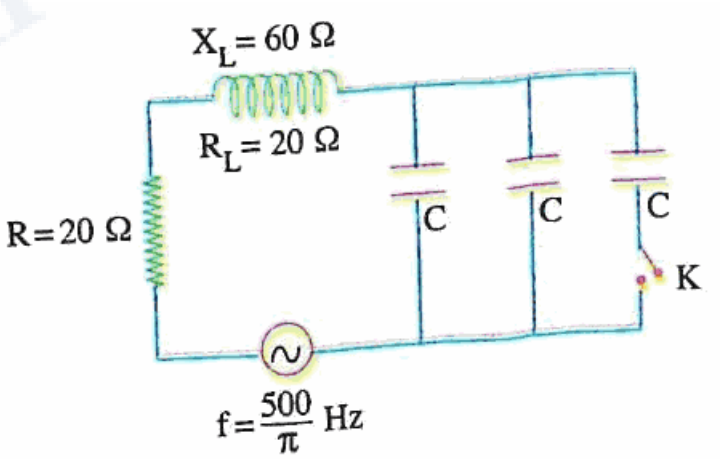
(2) the resonance frequency.



8 If the opposite AC circuit is at resonance with switch K open, calculate:

(1) the capacitance of capacitor C

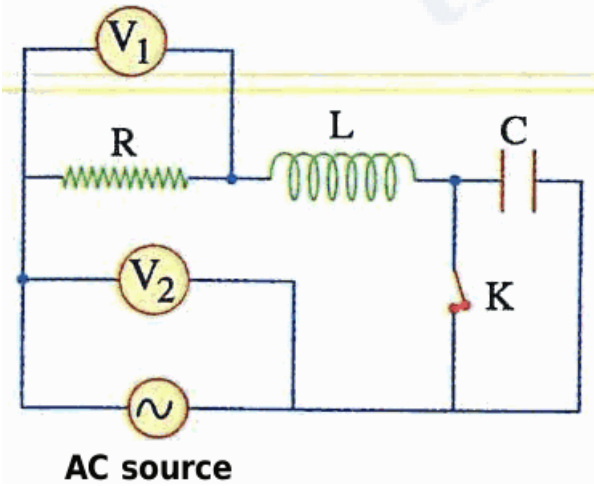
(2) the phase angle between the total voltage and the current when switch K is closed



9 In the AC circuit shown in the figure:

(1) Given that the ohmic resistance of coil L is negligible, deduce the potential difference across it in terms of the readings of the two voltmeters V_1 and V_2

(2) It was found that when switch K is opened, the readings of the two voltmeters V_1 and V_2 become equal. How do you explain this?

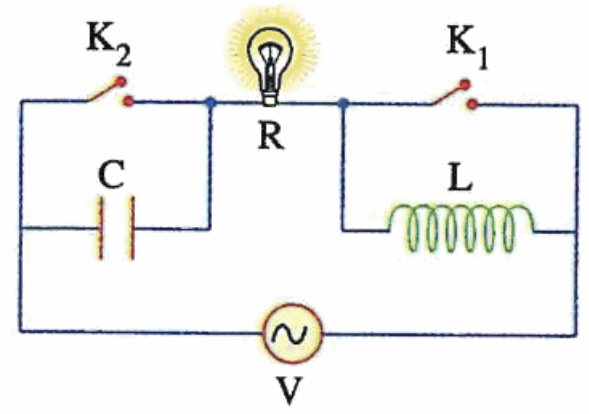


10 The RLC circuit shown in the figure is at resonance. Explain what happens to the brightness of the lamp in each of the following cases:

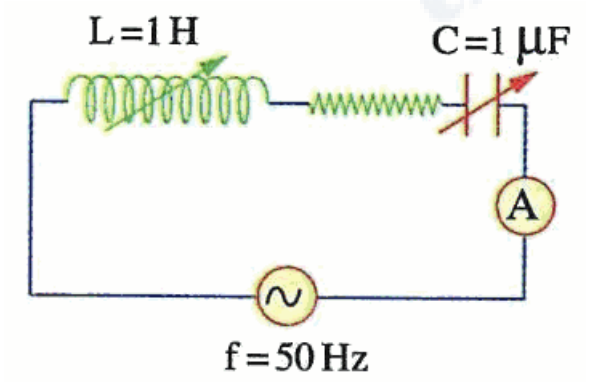
(1) closing switch K_1 only.

(2) closing switch K_2 only.

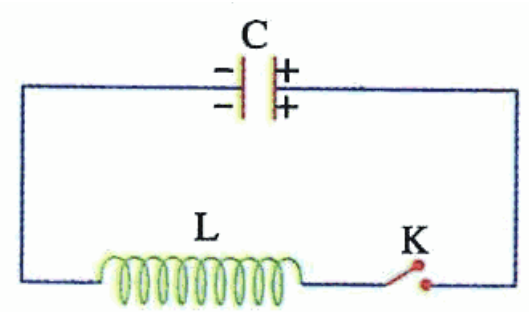
(3) closing switches K_1 and K_2 together.



11 The opposite figure shows an AC circuit containing a dynamo whose coil rotates at a frequency of 50 Hz, an inductor of self-inductance 1 H, a 1 μF capacitor and a hot-wire ammeter. Suggest three different ways to increase the reading of the hot-wire ammeter to the greatest possible value without changing the ohmic resistance of the circuit.



12 The opposite figure shows a capacitor C whose plates carry a charge Q, connected to an inductor L of negligible ohmic resistance through a switch K. Explain why the plates of the capacitor exchange their charges some time after switch K is closed.

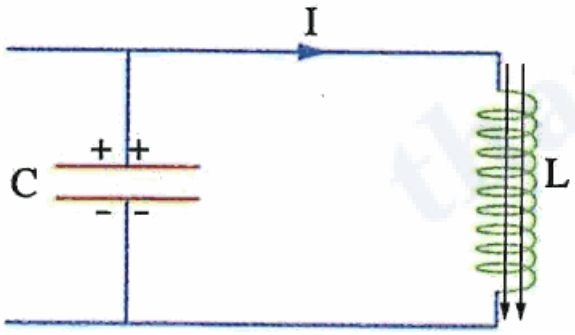


13 The opposite figure shows an oscillating circuit at a certain moment. At that moment:

(1) Is the capacitor charging or discharging?

(2) Is the magnetic energy in the coil increasing or decreasing? Explain your answer.

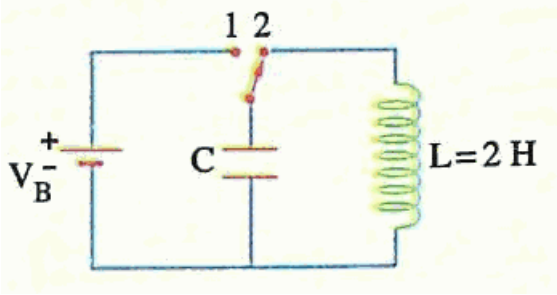
(3) Explain why the charging and discharging of the capacitor do not go on forever.



14 Explain how a radio receiver can pick up a certain radio wave and not the others.

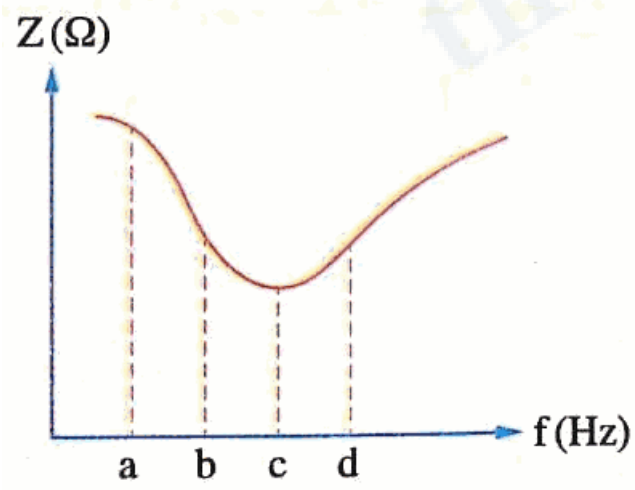
Past exam questions — 30 questions

1 In the oscillating circuit shown in the figure, if the self-inductance of the coil is (L = 2 H), the capacitance (C) needed to get a current of frequency 80 Hz is ..... (π = 3.14) (Trial exam / June 2021, Sample exam 2025)



(A) 1.98 μF (B) $1.98 \times 10^{-6}\ \mu F$ (C) $1.58 \times 10^{-4}\ \mu F$ (D) 1.58 μF

2 An AC circuit has an inductor of negligible ohmic resistance, a variable capacitor and an ohmic resistor, all connected in series. Using the opposite graph, the voltage of the source equals the potential difference across the ohmic resistor at the frequency ..... (Trial exam / June 2021)

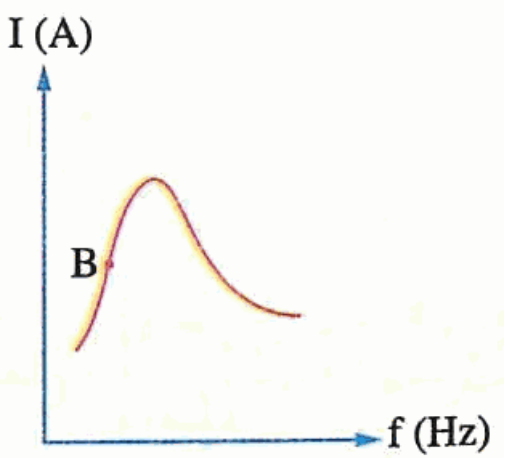


(A) c only (B) b and d (C) a only (D) a and c

3 In an oscillating circuit, what change must be made to the self-inductance of the coil to double the frequency of the current in it? (1st session 2021)

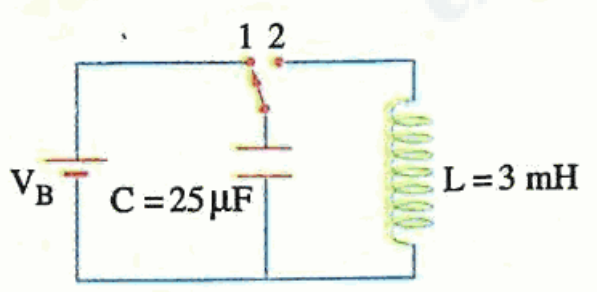
(A) Decreasing it to a quarter (B) Increasing it to four times
(C) Decreasing it to half (D) Doubling it

4 An AC circuit has an inductor, a capacitor and an ohmic resistor connected in series with a source of constant effective emf and variable frequency. Using the opposite graph, the ratio of the source voltage to the potential difference across the ohmic resistor at point B is ..... (1st session 2021)



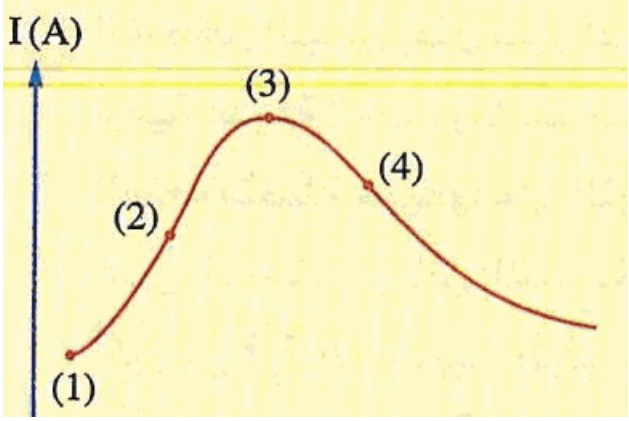
(A) equal to one (B) less than one (C) equal to zero (D) greater than one

5 The figure shows an oscillating circuit containing a capacitor of capacitance (C) and a coil of self-inductance (L). The frequency of the current in it when the switch is moved from position (1) to position (2) equals ..... (π = 3.14) (2nd session 2021)



(A) 0.58 hertz (B) 0.0183 hertz (C) 58.14 hertz (D) 581.4 hertz

6 An AC circuit has an inductor of negligible ohmic resistance, a variable capacitor and an ohmic resistor connected together in series. Using the opposite graph, the net of the inductive reactance of the coil and the capacitive reactance of the capacitor is zero at point ..... (2nd session 2021)

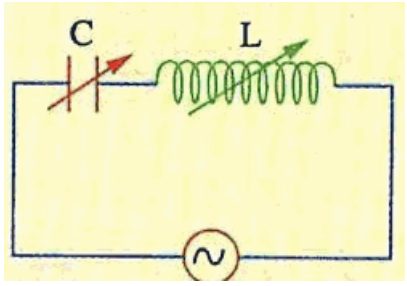


(A) 1 (B) 2 (C) 3 (D) 4

7 Resonant circuit x has an inductor of self-inductance 0.2 H and a capacitor of capacitance 0.2 μF, and resonant circuit y has a coil of self-inductance 0.4 H and a capacitor of capacitance 0.1 μF. The ratio of (the frequency of resonant circuit (x)) to (the frequency of resonant circuit (y)) is ..... (1st session 2022)

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

8 The figure shows a resonant circuit made of a variable capacitor and an inductor with ohmic resistance connected in series. If the capacitance of the capacitor is doubled and the circuit is to be kept at resonance, the ratio of the inductive reactance in the first case to its value in the second case $((X_L)_1)/((X_L)_2)$ equals ..... (2nd session 2022)

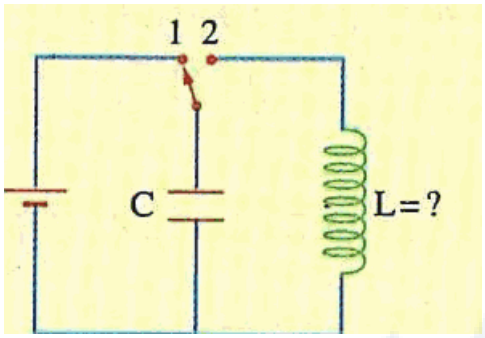


(A) *1/2* (B) *1/4* (C) *4/1* (D) *2/1*

9 A resonant circuit of frequency 2×10^{14} Hz has a capacitor of capacitance (C) and a coil of self-inductance (L). When the capacitance is increased to (9C) and the self-inductance of the coil is decreased to $(L/9)$, the resonance frequency of the circuit ..... (Trial exam 2023)

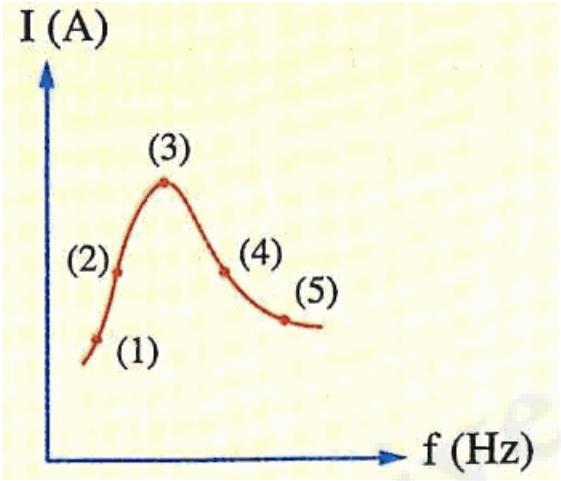
(A) increases to three times its value
(B) stays the same
(C) increases to nine times its value
(D) decreases to a third of its value

10 The figure shows an oscillating circuit containing a capacitor of capacitance C = 200 μF. When the switch is moved from position (1) to position (2), what is the self-inductance of the coil (L) so that a current of frequency 100 hertz flows through it? (given: π = 3.14) (1st session 2023)



(A) 12.68 henry
(B) 0.0127 henry
(C) 78.75 henry
(D) 1.267×10^{-8} henry

11 The graph shows how the current (I) changes with the frequency (f) in an AC circuit containing a non-inductive ohmic resistor, an inductor of negligible ohmic resistance and a variable capacitor, all connected in series. The two points on the curve at which the potential difference across the capacitor plates is greater than the potential difference across the coil are ..... (1st session 2023)



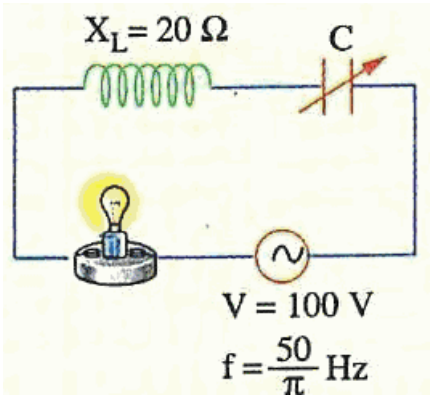
(A) points (2), (3)
(B) points (4), (5)
(C) points (1), (2)
(D) points (2), (4)

12 An oscillating circuit consists of a coil of self-inductance 1 H and a capacitor of capacitance 3.5 μF. The frequency of the current in the oscillating circuit is ..... (given: π = 3.14) (2nd session 2023)

(A) 45.495 kilohertz (B) 85.1 hertz (C) 0.085 hertz (D) 13.55 hertz

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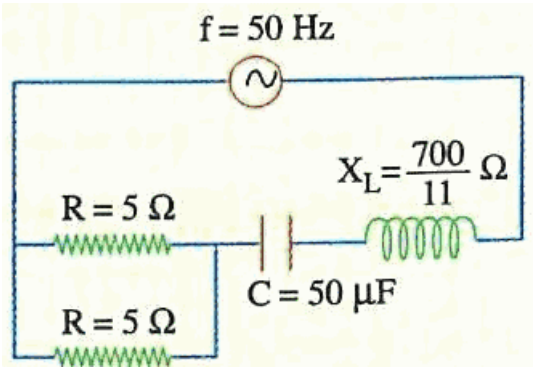
13 From the circuit shown in the figure, the capacitance (C) at which the brightness of the lamp is greatest equals ..... farad (2nd session 2023)



(A) 2.5×10^{-4} (B) 10×10^{-4} (C) 5×10^{-4} (D) 15×10^{-4}

---

14 The figure shows an RLC AC circuit. The total voltage in the circuit ..... ($\pi = 22/7$) (2nd session 2023)



(A) lags behind the current by 90° (B) leads the current by 45°

(C) lags behind the current by 45° (D) and the current are in the same phase

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15 In an oscillating circuit, what change happens to the frequency of the current in the circuit when both the self-inductance of its coil and the capacitance of its capacitor are doubled? (1st session 2024)

(A) It increases to four times (B) It decreases to a quarter

(C) It decreases to half (D) It doubles

16 An oscillating circuit contains a capacitor and a coil of self-inductance *1/5* H. To double the frequency of the circuit, another coil can be connected in parallel with the first coil, with a self-inductance equal to ..... (2nd session 2024)

(A) *1/25* H (B) *1/15* H (C) *3/20* H (D) *1/5* H

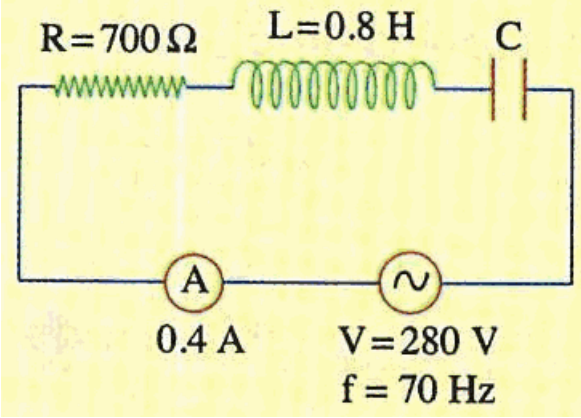
17 An AC circuit at resonance contains an ohmic resistor (R), an inductor of inductive reactance $(X_L)_1$ with no ohmic resistance, and a capacitor of capacitive reactance $(X_C)_1$. When the capacitor is replaced by another of capacitive reactance $(X_C)_2$, the inductive reactance of the inductor had to be doubled to keep the resonance. The ratio $((X_C)_1/(X_C)_2)$ equals ..... (2nd session 2024)

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

18 In an RLC circuit, which of the following has a role in determining the resonance frequency of the circuit? (Sample exam 2025)

(A) The total ohmic resistance of the circuit
(B) The maximum value of the alternating voltage applied to the circuit
(C) The total capacitance and the total inductance of the circuit
(D) The total impedance of the circuit

19 In the electric circuit shown in the figure, neglecting the ohmic resistance of the hot-wire ammeter, the capacitance of the capacitor is ..... (Sample exam 2025)



(A) 4.24 μF (B) 5.68 μF (C) 6.46 μF (D) 8.72 μF

20 In an RLC circuit whose components are connected in series, if $(V_R = V_L = V_C = V_{source})$, then when the inductor is removed from the circuit, the potential difference across resistor R becomes ..... (Sample exam 2025)

(A) $\sqrt{(2)}\ V_{source}$
(B) $(V_{source})/(\sqrt{(2)})$
(C) V_{source}
(D) $(V_{source})/2$

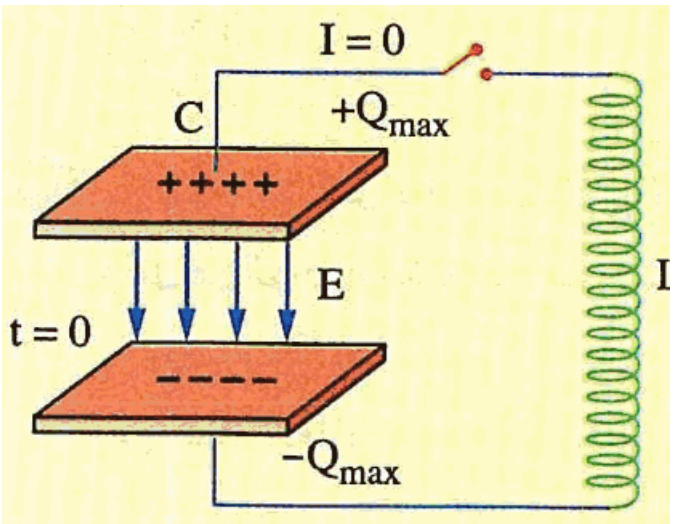
21 A radio contains a receiving circuit with a variable capacitor for picking up different radio stations, and an inductor. If the self-inductance of the coil used in the tuning circuit is 1 mH and the required frequency range is from 540 kHz to 1600 kHz, the approximate range of the required capacitance should be ..... (Sample exam 2025)

(A) from 10 pF to 87 pF
(B) from 100 pF to 870 pF
(C) from 1 nF to 8.7 nF
(D) from 10 nF to 87 nF

22 The electromagnetic waves produced by an oscillating circuit are damped because of ..... (Sample exam 2025)

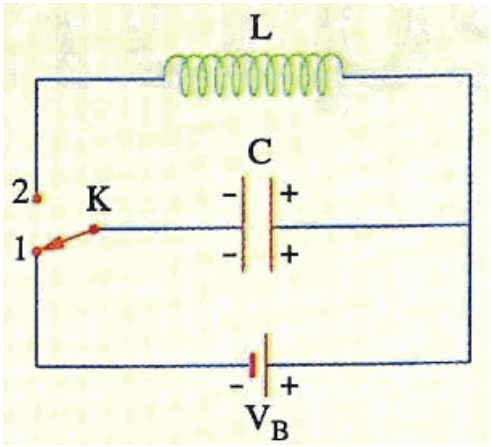
(A) the ohmic resistance of the circuit
(B) the inductive reactance of the coil
(C) the capacitive reactance of the capacitor
(D) the total reactance of the circuit

23 In the figure in front of you, when the switch is closed, during a quarter cycle of the current, the coil produces ..... emf (Sample exam 2025)



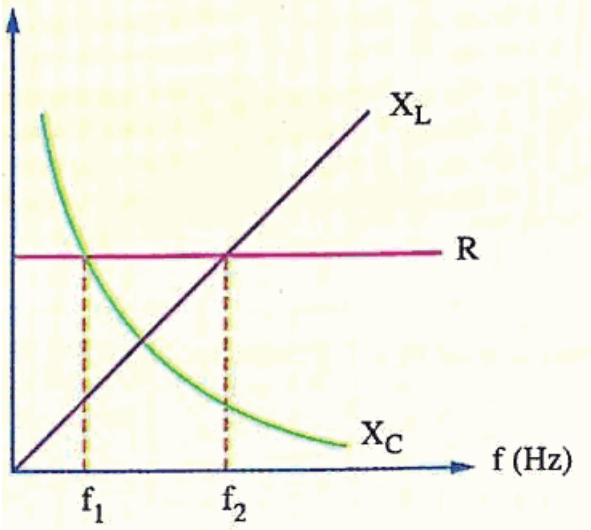
(A) a reverse induced
(B) a constant
(C) an increasing with time
(D) a forward induced

24 The figure shows an oscillating circuit containing a coil of self-inductance (L) and a capacitor of capacitance (C), each of whose plates carries a charge (q). Starting from the moment switch (K) reaches position (2), what is the shortest time that passes until each plate of the capacitor is charged with an opposite charge of magnitude (q)? (given: the periodic time is the reciprocal of the frequency) (1st session 2025)



(A) $\pi\sqrt{(LC)}$ (B) $2\pi\sqrt{(LC)}$ (C) $1/(2\pi\sqrt{(LC)})$ (D) πLC

25 The graph shows the effect of changing the frequency of an AC source in an (LCR) circuit on its inductive reactance, capacitive reactance and ohmic resistance. What is the phase difference between the total voltage and the current in the circuit at each of the two frequencies f_1 and f_2? (1st session 2025)



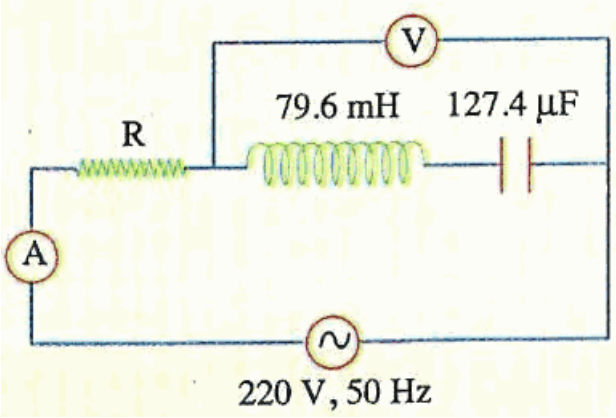
(A) At f_1: the total voltage and the current are in the same phase; at f_2: the total voltage and the current are in the same phase

(B) At f_1: the total voltage leads the current by an angle (θ_1); at f_2: the total voltage lags behind the current by an angle (θ_2)

(C) At f_1: the total voltage lags behind the current by an angle (θ_1); at f_2: the total voltage leads the current by an angle (θ_2)

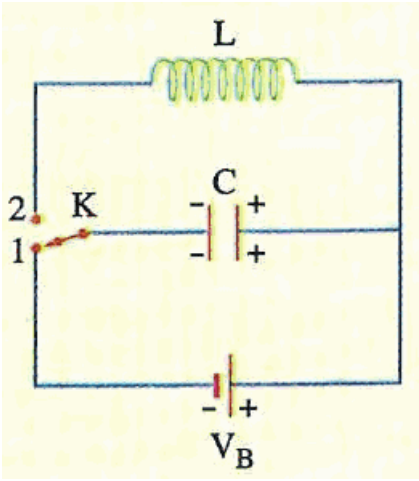
(D) At f_1: the total voltage leads the current by an angle (θ_1); at f_2: the total voltage leads the current by an angle (θ_2)

26 The figure shows an (LCR) circuit containing an AC source (220 V, 50 Hz), a capacitor of capacitance 127.4 μF and a coil of self-inductance 79.6 mH with negligible ohmic resistance, all connected in series. If the ohmic resistance in the circuit is 44 Ω, the readings of the voltmeter and the ammeter are ..... ($\pi = 3.14$) (1st session 2025)



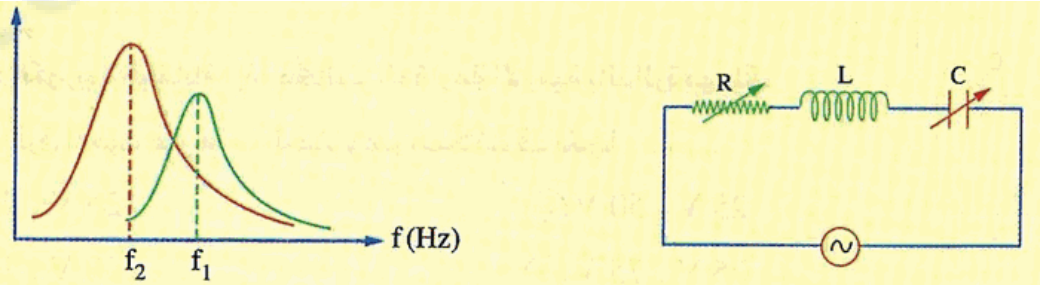
(A) 150 V, 2 A (B) 150 V, 6 A (C) 0 V, 5 A (D) 0 V, 4 A

27 The figure shows an oscillating circuit containing a coil of self-inductance (L) and a capacitor of capacitance (C), each of whose plates carries a charge (q). Starting from the moment switch (K) touches position (2), what is the shortest time that passes until all the electric energy in the capacitor is converted into magnetic energy in the coil? (given: the periodic time is the reciprocal of the frequency) (2nd session 2025)



(A) πLC (B) $\pi\sqrt{(LC)}$ (C) $2\pi\sqrt{(LC)}$ (D) $(\pi)/2\sqrt{(LC)}$

28 An (LCR) AC circuit contains an AC source, an inductor (L), a variable capacitor (C) and a variable ohmic resistor (R) as in the figure, and the graph shows the relation between the effective current (I) and the frequency (f). If the circuit is at resonance at frequency (f_1), what change is needed in the capacitance and the ohmic resistance so that the circuit reaches another resonance at frequency (f_2), as shown by the curve on the graph? (2nd session 2025)



(A) capacitance: increase, ohmic resistance: increase

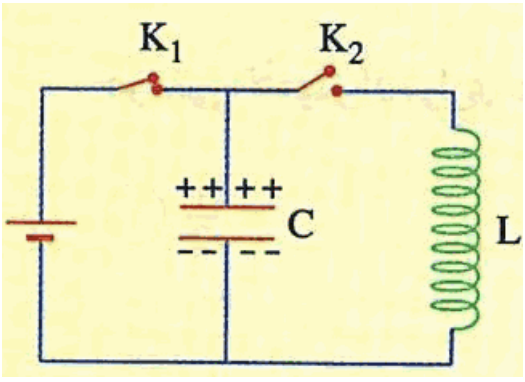
(B) capacitance: increase, ohmic resistance: decrease

(C) capacitance: decrease, ohmic resistance: increase

(D) capacitance: decrease, ohmic resistance: decrease

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29 The figure shows an oscillating circuit with a capacitor of capacitance $25/(\pi)\ \mu F$ and an inductor of self-inductance $1/(\pi)$ H. If switch (K_1) is opened and switch (K_2) is closed, then after 5 ms from the moment switch (K_2) is closed, capacitor (C) becomes ..... (assuming no energy loss) (Sample exam 2026)



(A) uncharged

(B) partly charged

(C) fully charged with the opposite charge

(D) fully charged with the same charge

---

30 Two oscillating circuits (X) and (Y) have identical coils and identical capacitors. The resistance of the wires of circuit (X) is (R_X) and that of circuit (Y) is (R_Y). If the charge on the capacitor plates in circuit (X) dies away faster than in circuit (Y), the choice that correctly expresses the relation between the two resistances (R_X) and (R_Y) is ..... (Sample exam 2026)

(A) $R_X > R_Y$
(B) $R_X = R_Y$
(C) $R_X < R_Y$
(D) The answer cannot be determined

Answer key and solutions

Multiple choice questions

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

1 **Answer (A)**

At resonance $X_L = X_C$, so they cancel each other.

$Z = \sqrt{(R^2 + (X_L - X_C)^2)} = R$, which is the smallest value of the impedance (a minimum).

2 **Answer (B)**

At resonance $V_L = V_C$ and they are opposite, so they cancel, leaving only V_R in the direction of the current.

V_L leads the current by $90°$ (up) and V_C lags behind it by $90°$ (down).

The two vectors are equal in length in figure (B) only.

3 **Answer (A)**

The current increases with frequency up to a maximum (resonance) and then decreases.

This happens only when a coil and a capacitor are both present: the circuit contains an inductor, a capacitor and a resistor.

4 **Answer (A)**

Removing the iron core decreases L, so X_L decreases and the resonance condition $X_L = X_C$ is no longer met.

So the impedance increases, the current decreases and the ammeter reading decreases.

5 **Answer (A)**

The ohmic resistance is a property of the wire and does not depend on the frequency of the source, so it stays constant.

6 **Answer (B)**

Increasing the frequency makes $X_L > X_C$, so the resonance is lost.

$Z = \sqrt{(R^2 + (X_L - X_C)^2)}$ increases, so the current and the ammeter reading decrease.

7 **Answer (B)**

Resonance frequency $f_r = 1/(2\pi\sqrt{(LC)})$

So it is determined by the self-inductance of the coil and the capacitance of the capacitor.

8 **Answer (D)**

At resonance $\omega L = 1/(\omega C)$

$LC = 1/(\omega^2)$, i.e. the reciprocal of the square of the angular frequency.

9 **Answer (D)**

$f_r = 1/(2\pi\sqrt{(LC)})$, so to decrease the resonance frequency we must increase L or C

Spreading the turns apart or cutting off part of the coil decreases L, and removing the capacitor removes the resonance.

Connecting an external capacitor in parallel increases the total capacitance, so the resonance frequency decreases.

10 **Answer (B)**

Moving the slider towards a increases the number of coil turns included in the circuit.

So L increases and the resonance frequency $f_r = 1/(2\pi\sqrt{(LC)})$ decreases.

11 **Answer (A)**

$f_r \propto 1/(\sqrt{(LC)})$ and the new product is $L'C' = 1/8L \times 2C = 1/4LC$

$(f_r')/f_r = \sqrt{(LC/(L'C'))} = \sqrt{(4)} = 2$, so it is doubled.

12 **Answer (C)**

The two capacitors are in parallel, so the total capacitance is $C_1 + C_2$ and the total reactance is $X_C = ((X_C)_1 (X_C)_2)/((X_C)_1 + (X_C)_2)$

At resonance $X_L = X_C$

13 **Answer (B)**

At a frequency below the resonance frequency, $X_C = 1/(2\pi fC)$ is larger and $X_L = 2\pi fL$ is smaller.

So $X_L < X_C$ and the circuit has capacitive properties.

14 **Answer (B)**

Two coils in parallel: $R/2$, and two capacitors in parallel: $R/2$

$X_L = X_C$, so the circuit is at resonance and its properties are ohmic.

15 **Answer (D)**

The consumed power $P = I^2R$ is greatest at resonance, where $X_L = X_C$

The voltmeter is across the coil and the capacitor together: $V = |V_L - V_C| = 0$

16 **Answer (C)**

At resonance $V_L = V_C$ and they are opposite, so their sum is zero.

Voltmeter V_4 is across the coil and the capacitor together, so it reads zero, while V_1 and V_3 measure V_L and V_C separately.

17 **Answer (C)**

The circuit is at resonance, so $Z = R$

$P = (V_{rms}^2)/R = ((12/\sqrt{(2)})^2)/10 = 7.2$ W

18 **Answer (B)**

In (a) the voltage leads the current, so it is a coil; in (b) it lags, so it is a capacitor.

The two lamps are identical and their powers are equal, so the currents are equal, i.e. $Z_a = Z_b$, so $X_L = X_C$

When K_3 is closed the circuit is at resonance, $Z = R$, so the current increases and the power of lamp (z) increases.

19 **Answer (C)**

(a) is a coil and (b) is a capacitor, and the powers of the two lamps are equal, so $X_L = X_C$

When K_3 is closed the circuit is at resonance, so the total voltage and the current are in the same phase.

20 **Answer (B)**

$Z = R$ means $X_L = X_C$, i.e. resonance.

$L = 1/(4\pi^2 f^2 C) = 1/(4\pi^2 \times 50^2 \times 6 \times 10^{-6}) \approx 1.69$ H

21 **Answer (B)**

$f^2 = 1/(4\pi^2 C) \times 1/L$, so the slope $= 1/(4\pi^2 C)$

Slope $= 6000/2.5 = 2400$

$C = 1/(4\pi^2 \times 2400) \approx 1.05 \times 10^{-5}$ F

22 **Answer (A)**

The voltage across the resistor equals that across the coil when $R = X_L$

This is at frequency A, where the X_L curve crosses the R line.

23 **Answer (A)**

The properties are capacitive when $X_C > X_L$

This is at frequencies below the resonance frequency B, so we choose A.

24 **Answer (A)**

Frequency B is where X_L and X_C cross, i.e. resonance $X_L = X_C$

$Z = \sqrt{(R^2 + (X_L - X_C)^2)} = R$

25 **Answer (D)**

At resonance the impedance is the smallest, $Z = R$

From the graph $R = 10\ \Omega$

26 **Answer (A)**

Resonance is at $f_r = 50$ Hz, where Z is the smallest.

$L = 1/(4\pi^2 f_r^2 C) = 1/(4\pi^2 \times 50^2 \times (10^{-3})/(\pi^2)) = 0.1$ H

27 **Answer (B)**

At resonance $Z = R = 50\ \Omega$ (the resistance of the coil), so $I = V/R = 35/50 = 0.7$ A

$X_L = X_C = 2\pi f L = 2\pi \times 50 \times 0.1 \approx 31.4\ \Omega$

$V_C = I X_C = 0.7 \times 31.4 \approx 22$ V

The coil has resistance: $Z_{coil} = \sqrt{(R^2 + X_L^2)} = \sqrt{(50^2 + 31.4^2)} \approx 59.05\ \Omega$

$V_{coil} = I Z_{coil} = 0.7 \times 59.05 \approx 41.34$ V

28 **Answer (C)**

$L = 1/(4\pi^2 f_r^2 C) = 1/(4\pi^2 \times 60^2 \times 2.58 \times 10^{-4}) \approx 0.027$ H $= 27$ mH

29 **Answer (A)**

$I_{max} = V/R$ and the voltage is constant, so the greater resistance gives a lower peak.
The peak of circuit (1) is lower, so its resistance is greater.

30 **Answer (A)**

The capacitances are equal and $f_r = 1/(2\pi\sqrt{(LC)})$, so a lower frequency means a greater L
The resonance frequency of circuit (1) is lower, so its inductance is greater.

31 **Answer (A)**

$\varphi = tan^{-1}(X_L - X_C)/R$, which is zero at resonance b, so it is the smallest there.
The angle increases as the frequency moves away from the resonance frequency, and a is farther than c, so it is the greatest.

32 **Answer (B)**

$f_r \propto 1/(\sqrt{(C)})$, and doubling C divides f_r by $\sqrt{(2)}$
$f_r' = 50/(\sqrt{(2)}) = 25\sqrt{(2)}$ Hz

33 **Answer (B)**

At resonance $I = 2$ A and $X_L = X_C$, so $V_L = V_C$
$X_C = 1/(2\pi f C) = 1/(2\pi \times 500 \times (10^{-6})/(\pi)) = 1000\ \Omega$
$V_L = I X_L = 2 \times 1000 = 2000$ V $= 2$ kV

34 **Answer (C)**

$V = I_{max}R = 2 \times 50 = 100$ V
$X_C = 1/(2\pi \times 250 \times (10^{-6})/(\pi)) = 2000\ \Omega$, and at resonance $X_L = X_C = 1000\ \Omega$, so at 250 Hz $X_L = 500\ \Omega$
$Z = \sqrt{(50^2 + (500 - 2000)^2)} \approx 1500.8\ \Omega$, so $I = 100/1500.8 \approx 0.0666$ A
$V_C = I X_C = 0.0666 \times 2000 \approx 133$ V

35 **Answer (D)**

Resonance condition: $f = 1/(2\pi\sqrt{(LC)})$
Choice (D), taking $\pi = 22/7$: $f = 1/(2 \times 22/7 \times \sqrt{(7/22 \times 10^{-6} \times 7/22)}) = 1/(2 \times 10^{-3}) = 500$ Hz

36 **Answer (C)**

$Z = V/I = 100/20 = 5\ \Omega = R$, so the circuit is at resonance.
$C = 1/(4\pi^2 f^2 L) = 1/(4\pi^2 \times 50^2 \times 1) \approx 10^{-5}$ F

37 **Answer (D)**

$X_L = 2\pi f L = 2 \times 22/7 \times 50 \times 1 \approx 314.3\ \Omega$

$V_L = I X_L = 20 \times 314.3 \approx 6285.7$ V

38 **Answer (B)**

$C_2 = 30 + 32 = 62\ \mu F$ and $L_2 = 5L_1$

$f_2/f_1 = \sqrt{(L_1C_1/L_2C_2)} = \sqrt{(30/(5 \times 62))} \approx 0.311$

$f_2 = 750 \times 10^3 \times 0.311 \approx 2.33 \times 10^5$ Hz

39 **Answer (C)**

$\lambda = c/f_2 = (3 \times 10^8)/(2.33 \times 10^5) \approx 1.29 \times 10^3$ m

40 **Answer (C)**

$L_1 = 1/(4\pi^2 f_1^2 C_1) = 1/(4\pi^2 \times (750 \times 10^3)^2 \times 30 \times 10^{-6}) \approx 1.5 \times 10^{-9}$ H

$L_2 = 5L_1 = 7.5 \times 10^{-9}$ H

41 **Answer (B)**

$C = 1/(4\pi^2 f^2 L) = 1/(4\pi^2 \times (980 \times 10^3)^2 \times 10 \times 10^{-3}) \approx 2.6 \times 10^{-12}$ F

42 **Answer (C)**

At resonance $Z = R = 50\ \Omega$

$I = V/R = (10^{-4})/50 = 2 \times 10^{-6}$ A

43 **Answer (C)**

Voltmeter V_1 is across the coil and the capacitor together and reads zero, so $X_C = X_L = 5\ \Omega$ (resonance)

$V_2 = I X_C = 2 \times 5 = 10$ V

$Z = R$, so $R = V/I = 110/2 = 55\ \Omega$

44 **Answer (D)**

$V_L = V_C = 150$ V and they are opposite, so the circuit is at resonance.

So the whole source voltage is across the resistor: $V_R = 300$ V

45 **Answer (D)**

V_1 is across L only, which is one third of the branch $(L + 2L)$, so the voltage across all the coils $= 3 \times 50 = 150$ V

The two capacitors are in series and the voltage is inversely proportional to the capacitance: $V_{2C} = 100/2 = 50$ V, so the voltage across the capacitors $= 100 + 50 = 150$ V

$V_L = V_C$, so the circuit is at resonance and $V_3 = V_R = 200$ V

46 **Answer (B)**

V_2 is across the coil and the capacitor together and reads zero, so $V_R = 80$ V

V_1 is across the resistor and the coil: $V_1^2 = V_R^2 + V_L^2$, so $V_L = \sqrt{(100^2 - 80^2)} = 60$ V

At resonance $V_C = V_L$, so $V_3 = 60$ V

47 **Answer (D)**

At resonance $V_C = V_L = 60$ V, and voltmeter V_3 measures the voltage of the coil with its resistance $= 100$ V

Voltage across the coil's resistance $= \sqrt{(100^2 - 60^2)} = 80$ V

$R_{total} = (20 + 80)/1 = 100\ \Omega$

48 **Answer (C)**

The voltage and the current in phase means resonance.

$C = 1/(4\pi^2 f^2 L) = 1/(4\pi^2 \times 360^2 \times 0.025) \approx 7.8 \times 10^{-6}$ F $= 7.8\ \mu F$

49 **Answer (D)**

The greatest current is at resonance, where $X_L = X_C$ and $Z = R$

$I = V/R = 32/4 = 8$ A

50 **Answer (A)**

$X_L = \omega L = 2000 \times 5 \times 10^{-3} = 10\ \Omega$

$X_C = 1/(\omega C) = 1/(2000 \times 50 \times 10^{-6}) = 10\ \Omega$, so the circuit is at resonance.

$Z = R_{total} = 6 + 4 = 10\ \Omega$

$I_{max} = (V_{max})/Z = 20/10 = 2$ A

51 **Answer (A)**

Open switches short nothing, so the lamp, the coil and the capacitor are in series.

$X_L = 2\pi f L = 2 \times 22/7 \times 50 \times 1225/484 \approx 795.45\ \Omega$

$X_C = 1/(2\pi f C) = 1/(2 \times 22/7 \times 50 \times 4 \times 10^{-6}) \approx 795.45\ \Omega$

$X_L = X_C$, resonance, so $Z = R = 800\ \Omega$

52 **Answer (A)**

Closing K_1 short-circuits the coil, leaving R and C; closing K_2 short-circuits the capacitor, leaving R and L

$X_L = X_C$, so the two impedances are equal, $Z = \sqrt{(800^2 + 795.45^2)}$, and the ratio $= 1$

53 **Answer (D)**

Closing both switches short-circuits the coil and the capacitor, leaving only R: $Z = 800\ \Omega$

Before that the circuit was at resonance, $Z = R = 800\ \Omega$, so the current did not change and the lamp brightness stays constant.

54 **Answer (D)**

The voltage across R is greatest at resonance.

$f_r = 1/(2\pi\sqrt{(LC)}) = 1/(2\pi\sqrt{(1/(\pi) \times (10^{-6})/(\pi))}) = 1/(2 \times 10^{-3}) = 500$ Hz

55 **Answer (B)**

Figure (2): the two coils are in series, $L' = 2L$, and the two capacitors are in parallel, $C' = 2C$

$L'C' = 4LC$, so $f_r' = f_r/(\sqrt{(4)}) = 10/2 = 5$ kHz

56 **Answer (B)**

Closing K_1 connects capacitor $3C$ in parallel with C, so $C' = 4C$

$f_r' = f_0/(\sqrt{(4)}) = 1/2f_0$

57 **Answer (C)**

$f_r = 1/(2\pi\sqrt{(LC)})$ does not depend on the resistance.

Closing K_2 only adds a resistance, so the frequency stays f_0

58 **Answer (D)**

$C = Q/V = (36 \times 10^{-3})/9 = 4 \times 10^{-3}$ F

$f = 1/(2\pi\sqrt{(LC)}) = 1/(2 \times 22/7 \times \sqrt{(196/121)} \times 10^{-3}) = 125$ Hz

59 **Answer (D)**

At resonance $X_L = X_C$

$X_L = 2\pi f L = 2 \times 22/7 \times 125 \times 49/121 \times 10^{-3} = 7/22\ \Omega$

So the reactance of each of the coil and the capacitor is $7/22\ \Omega$

60 **Answer (B)**

The battery is a DC source, so there is no reactance and the coil is only a resistance.

$R = V/I = 12/2 = 6\ \Omega$

61 **Answer (C)**

$Z = V/I = 12/1.2 = 10\ \Omega$

$X_L = \sqrt{(Z^2 - R^2)} = \sqrt{(10^2 - 6^2)} = 8\ \Omega$

62 **Answer (B)**

The current returned to 2 A, i.e. $Z = 12/2 = 6\ \Omega = R$

So $X_C = X_L$ and the circuit is at resonance.

63 **Answer (D)**

$X_L = 2\pi f L = 2\pi \times 80 \times 0.08 \approx 40.21\ \Omega$ and $Z = \sqrt{(30^2 + 40.21^2)} \approx 50.17\ \Omega$

Zero phase means resonance, and an unchanged current means an unchanged Z, so $R_{total} = 50.17\ \Omega$, i.e. we add $20.17 \approx 20.18\ \Omega$

$X_C = X_L$, so $C = 1/(2\pi f X_C) = 1/(2\pi \times 80 \times 40.21) \approx 49.43\ \mu F$

64 **Answer (B)**

$X_L = X_C$, so the circuit is at resonance, $Z = R_1 + R_2 = 40\ \Omega$

$I = V/Z = 200/40 = 5$ A

Between A and C are resistor R_1 and the coil: $Z_{AC} = \sqrt{(30^2 + 40^2)} = 50\ \Omega$

$V_{AC} = I Z_{AC} = 5 \times 50 = 250$ V

65 **Answer (C)**

Resonance, so $I = 200/40 = 5$ A

Between B and C are resistor R_2 and the capacitor: $Z_{BC} = \sqrt{(10^2 + 40^2)} \approx 41.23\ \Omega$

$V_{BC} = I Z_{BC} = 5 \times 41.23 \approx 206.16$ V

66 **Answer (D)**

Resonance, so $I = 200/40 = 5$ A

$P = I^2 R = 5^2 \times 40 = 1000$ W

67 **Answer (C)**

In the first case there is resonance: $I_1 = V/R$, then $I_2 = 0.45\, I_1$, so $Z_2 = R/0.45 \approx 222.2\ \Omega$

$|X_L - X_C| = \sqrt{(Z_2^2 - R^2)} = \sqrt{(222.2^2 - 100^2)} \approx 198.4\ \Omega$

Doubling the frequency: $X_L' = 2X_L$ and $X_C' = X_C/2 = X_L/2$, so the difference $= 3/2X_L = 198.4$

$X_L = X_C = 132.3\ \Omega$

68 **Answer (A)**

At resonance $X_L = X_C = X$ at 60 Hz

At 80 Hz: $X_L' = 80/60X = 4/3X$ and $X_C' = 3/4X$

$Z = \sqrt{(R^2 + (X_L' - X_C')^2)}$, so $X_L' - X_C' = \sqrt{(10^2 - 8^2)} = 6\ \Omega$, i.e. $7/12X = 6$, so $X \approx 10.29\ \Omega$

$L = X/(2\pi \times 60) \approx 0.027$ H and $C = 1/(2\pi \times 60 \times X) \approx 2.58 \times 10^{-4}$ F

69 **Answer (A)**

$f \propto 1/(\sqrt{(L)})$, so to double the frequency $\sqrt{(L)}$ must become half its value

i.e. L is decreased to a quarter.

70 **Answer (C)**

When K_1 is opened and K_2 closed, the charged capacitor discharges through the coil.

So energy is exchanged between the electric field of the capacitor and the magnetic field of the coil and the current oscillates, so an alternating current flows in the coil.

71 **Answer (B)**

$f = 1/(2\pi\sqrt{(LC)}) = 1/(2\pi\sqrt{(0.4 \times 25.3 \times 10^{-6})}) \approx 50$ Hz

The capacitor is completely discharged twice in each cycle: $2 \times 50 = 100$ times

72 **Answer (D)**

$f \approx 50$ Hz from $f = 1/(2\pi\sqrt{(LC)})$

The two energies are equal four times in each cycle: $4 \times 50 = 200$ times

73 **Answer (B)**

The current is greatest when the capacitor is discharged, $Q = 0$

These are points b and d.

74 **Answer (A)**

The same charge and the same polarity means the same point in the cycle.

These are a and e (the start and the end of the cycle).

75 **Answer (B)**

$V = Q/C$, so the voltage of the capacitor is proportional to Q

In stage B the capacitor is charged with the opposite polarity, so Q increases and the potential difference increases.

76 **Answer (B)**

The emf of the coil opposes the change in current; it is forward (in the direction of the current) when the current decreases.

In stage B the capacitor is being charged, so the current decreases.

77 **Answer (A)**

The energy of the coil $1/2LI^2$ increases as the current increases.

The current increases in stage A while the capacitor discharges.

78 **Answer (D)**

The resistance R turns part of the energy into heat in each oscillation.

So the current gradually decreases (damped oscillation).

79 **Answer (B)**

The current leaves the positive plate towards the coil, so the capacitor is discharging and the current increases until the charge is zero.

Then the capacitor is charged with the opposite polarity, so the current decreases; so during the quarter cycle it increases then decreases.

80 **Answer (C)**

$T = 2\pi\sqrt{(LC)} = 2\pi\sqrt{(0.25 \times 10^{-3} \times 10^{-6})} \approx 100\ \mu s$

The capacitor is completely discharged for the first time after $T/4 = 25\ \mu s$

81 **Answer (A)**

Figure (1): the capacitor is charged and discharges through the coil, so electric energy turns into magnetic energy.

Figure (2): $Q = 0$ and all the energy is magnetic.

82 **Answer (C)**

After the charge becomes zero, the capacitor is charged with the opposite polarity (figure 3) from the magnetic energy of the coil.

So the magnetic energy turns into electric energy.

83 **Answer (C)**

Figure (1) is discharging and figure (2) is $Q = 0$

Charging with the opposite polarity happens in figure (3).

84 **Answer (D)**

The station is selected by tuning the frequency of the circuit to the frequency of the station (resonance).

This is done by changing the capacitance of the variable capacitor (4).

85 **Answer (D)**

$f_r \propto 1/(\sqrt{(LC)})$, and to double the frequency the product LC must drop to a quarter

i.e. halving L and halving C

86 **Answer (C)**

Receiving each signal means tuning the circuit to the frequency of that signal (resonance).

So $Z = R$ in both cases and the ratio $= 1$

Essay questions

1 **Model answer**

(1) $V_1/V_2 = IR/IX_L = R/X_L = 50/25 = 2/1$

(2) $V_2/V_3 = IX_L/IX_C = 25/25 = 1/1$

(3) $X_L = X_C$, so the circuit is at resonance: $V_4 = 0$

(4) The circuit is at resonance: $V_{source} = V_R$, so $V_1/(V_{source}) = 1/1$

2 **Model answer**

(1) At the resonance frequency (49 Hz): $R = Z = 20\ \Omega$

(2) $L = 1/(4\pi^2 f^2 C) = 1/(4 \times (22/7)^2 \times 49^2 \times 1.05 \times 10^{-4}) = 0.1\ H$

3 **Model answer**

(1) At frequency x: the inductive reactance is directly proportional to the frequency and the capacitive reactance is inversely proportional to it, so at low frequencies (below the resonance frequency) $X_C > X_L$

(2) At frequency y (the resonance frequency), because at this frequency the inductive reactance of the coil equals the capacitive reactance of the capacitor, and since $(\tan\theta = (X_L - X_C)/R)$, $(\theta = 0^\circ)$.

4 **Model answer**

(1) Because $X_L \neq X_C$, so $V_L \neq V_C$

(2) $f = 1/T = 1/(20 \times 10^{-3}) = 50\ Hz$

$V_L/V_C = 2\pi f L \times 2\pi f C = 8/2 \Rightarrow LC = 1/(\pi^2 f^2)$

$f_0^2 = 1/(4\pi^2 LC) = (f^2)/4 = 625$, $f_0 = 25\ Hz$

5 **Model answer**

(1) The reading of the hot-wire ammeter decreases, because the circuit is no longer at resonance.

(2) The reading of the hot-wire ammeter decreases, because the ohmic resistance of the circuit increases.

(3) The reading of the hot-wire ammeter decreases, because the circuit is no longer at resonance.

(4) The reading of the hot-wire ammeter increases, because since the capacitance, the self-inductance and the frequency do not change, the circuit stays at resonance, and when the voltage increases the current increases according to $(I = V/R)$.

6 **Model answer**

(1) With the DC source: $R_L = 12/1 = 12\ \Omega$

With the AC source: $Z = 12/0.6 = 20\ \Omega$, $X_L = \sqrt{(20^2 - 12^2)} = 16\ \Omega$

$16 = 2 \times 22/7 \times 50 \times L \Rightarrow L = 0.051\ H$

(2) When the capacitor is connected, the circuit is at resonance: $X_C = X_L = 16\ \Omega$

$C = 7/(2 \times 22 \times 50 \times 16) = 1.99 \times 10^{-4}\ F$

(3) $\theta = 0^\circ$

7 **Model answer**

(1) $I_{eff} = 200/100 = 2\ A$, $(V_C)_{eff} = (V_L)_{eff} = 2 \times 20 = 40\ V$

$(V_C)_{max} = 40\sqrt{(2)}\ V$, $C = (Q_{max})/((V_C)_{max}) = (200 \times 10^{-6})/(40\sqrt{(2)}) = 3.54 \times 10^{-6}\ F$

(2) $f = 1/(2\pi X_C C) = 1/(2\pi \times 20 \times 3.54 \times 10^{-6}) = 2247.05\ Hz$

8 **Model answer**

(1) The circuit is at resonance: $X_L = X_C' = 60\ \Omega$, where the equivalent capacitance is 2C

$60 = 1/(2\pi \times 500/(\pi) \times 2C) \Rightarrow C = 8.33\ \mu F$

(2) After closing K the capacitance becomes 3C: $X_C = 1/(2\pi \times 500/(\pi) \times 3 \times 8.33 \times 10^{-6}) = 40\ \Omega$

$\tan\theta = (X_L - X_C)/(R + R_L) = (60 - 40)/(20 + 20) = 0.5$, $\theta = 26.57^\circ$

9 **Model answer**

(1) $V_2 = \sqrt{(V_1^2 + V_L^2)}$, so $V_L = \sqrt{(V_2^2 - V_1^2)}$

(2) $V_1 = V_2$, so $V_R = V_{source}$, i.e. the circuit is at resonance, which happens when $(X_L = X_C)$.

10 **Model answer**

(1) The brightness of the lamp decreases because the current in the circuit decreases: when switch K_1 is closed the circuit leaves resonance, so the impedance of the circuit increases and becomes $(Z = \sqrt{(R^2 + X_C^2)})$.

(2) The brightness of the lamp decreases because the current in the circuit decreases: when switch K_2 is closed the circuit leaves resonance, so the impedance of the circuit increases and becomes $(Z = \sqrt{(R^2 + X_L^2)})$.

(3) The brightness of the lamp is not affected, because the impedance of the circuit in this case equals its impedance at resonance (Z = R).

11 **Model answer**

For the reading of the hot-wire ammeter to reach the greatest possible value without changing the ohmic resistance, the circuit must be at resonance $(X_L = X_C)$, by one of the following ways:

(1) Changing the rotation frequency of the dynamo coil with C and L constant: $f = 1/(2\pi\sqrt{(1 \times 1 \times 10^{-6})}) = 159.09\ Hz$

(2) Changing the capacitance of the capacitor with L and f constant: $C = 1/(4\pi^2 \times 50^2 \times 1) = 10.12 \times 10^{-6}\ F = 10.12\ \mu F$

(3) Changing the self-inductance of the coil with C and f constant: $L = 1/(4\pi^2 \times 50^2 \times 10^{-6}) = 10.12\ H$

12 **Model answer**

When switch K is closed, the capacitor starts to discharge through the inductor, causing an electric current, and the current through the coil produces a magnetic field.

After the capacitor is completely discharged, the magnetic field of the coil starts to decrease as the current through it dies away, so a forward emf is induced by self-induction which pushes more charges, so the plates of the capacitor are charged with the opposite charge.

13 **Model answer**

(1) The capacitor is discharging.

(2) The magnetic energy stored in the coil increases, because while the capacitor discharges, the electric energy stored in it turns into magnetic energy stored in the coil.

(3) Because of the resistance of the coil and the wires, part of the electric energy turns into heat energy, causing a gradual loss of electric energy, so the alternating current in the circuit gradually decreases and the maximum potential difference between the plates of the capacitor gradually decreases until it becomes zero and the charging and discharging stop.

14 **Model answer**

By changing the capacitance of the capacitor or the self-inductance of the coil connected in the circuit until the frequency of the circuit equals the frequency of the radio wave to be picked up.

Past exam questions

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

1 **Answer (A)**

$f = 1/(2\pi\sqrt{(LC)}) \Rightarrow C = 1/(4\pi^2 f^2 L)$

$C = 1/(4 \times 3.14^2 \times 80^2 \times 2) = 1.98 \times 10^{-6}\ F = 1.98\ \mu F$

2 **Answer (A)**

The source voltage equals V_R only at resonance ($X_L = X_C$ and $Z = R$), i.e. at the smallest impedance: frequency c

3 **Answer (A)**

$f \propto 1/(\sqrt{(L)})$, so to double the frequency L is decreased to a quarter.

4 **Answer (D)**

Point B is not at resonance, so $Z > R$

$V/V_R = Z/R > 1$

5 **Answer (D)**

$f = 1/(2\pi\sqrt{(LC)}) = 1/(2 \times 3.14\sqrt{(3 \times 10^{-3} \times 25 \times 10^{-6})}) = 581.4\ Hz$

6 **Answer (C)**

The net X_L - X_C is zero at resonance, where the current is greatest: point 3

7 **Answer (C)**

$f \propto 1/(\sqrt{(LC)})$

$L_x C_x = 0.2 \times 0.2 = 0.04$ and $L_y C_y = 0.4 \times 0.1 = 0.04$

$f_x/f_y = 1$

8 **Answer (D)**

Doubling C halves X_C, and to keep resonance $(X_L = X_C)$ X_L is halved.

$((X_L)_1)/((X_L)_2) = 2/1$

9 **Answer (B)**

$9C \times L/9 = LC$, so the resonance frequency stays the same.

10 **Answer (B)**

$L = 1/(4\pi^2 f^2 C) = 1/(4 \times 3.14^2 \times 100^2 \times 200 \times 10^{-6}) = 0.0127\ H$

11 **Answer (C)**

$V_C > V_L$ when $X_C > X_L$, i.e. at frequencies below the resonance frequency: points (1) and (2).

12 **Answer (B)**

$f = 1/(2\pi\sqrt{(1 \times 3.5 \times 10^{-6})}) = 85.1\ Hz$

13 **Answer (C)**

The greatest brightness is at resonance: $X_C = X_L = 20\ \Omega$

$\omega = 2\pi \times 50/(\pi) = 100\ rad/s$

$C = 1/(\omega X_C) = 1/(100 \times 20) = 5 \times 10^{-4}\ F$

14 **Answer (D)**

$\omega = 2 \times 22/7 \times 50 = 2200/7$

$X_C = 1/(\omega C) = 7/(2200 \times 50 \times 10^{-6}) = 700/11\ \Omega = X_L$

The circuit is at resonance, so the total voltage and the current are in the same phase.

15 **Answer (C)**

$f \propto 1/(\sqrt{(LC)})$; doubling L and C makes LC four times as large, so the frequency is halved.

16 **Answer (B)**

To double the frequency the total L drops to a quarter: $1/20\ H$

$(1/5\ L')/(1/5 + L') = 1/20 \Rightarrow L' = 1/15\ H$

17 **Answer (D)**

At resonance $X_C = X_L$, so when X_L is doubled, X_C is doubled

$((X_C)_1)/((X_C)_2) = 1/2$

18 **Answer (C)**

$f_0 = 1/(2\pi\sqrt{(LC)})$, so the resonance frequency is determined by the total capacitance and the total inductance.

19 **Answer (C)**

$Z = 280/0.4 = 700\ \Omega = R$, so the circuit is at resonance.

$C = 1/(4\pi^2 f^2 L) = 1/(4\pi^2 \times 70^2 \times 0.8) = 6.46\ \mu F$

20 **Answer (B)**

$V_R = V$, so the circuit is at resonance and $R = X_L = X_C$

After removing the coil: $Z = \sqrt{(R^2 + X_C{}^2)} = \sqrt{(2)}R$

$V_R = IR = V/(\sqrt{(2)})$

21 **Answer (A)**

$C = 1/(4\pi^2 f^2 L)$

At 540 kHz: $C = 1/(4\pi^2 \times (540 \times 10^3)^2 \times 10^{-3}) = 87\ pF$

At 1600 kHz: $C = 10\ pF$

22 **Answer (A)**

The ohmic resistance of the circuit turns part of the energy into heat, so the waves are damped.

23 **Answer (A)**

When the switch is closed the capacitor starts to discharge and the current in the coil increases, so a reverse induced emf is produced in it.

24 **Answer (A)**

Each plate is charged with an opposite charge after half a cycle:

$T/2 = 1/2 \times 2\pi\sqrt{(LC)} = \pi\sqrt{(LC)}$

25 **Answer (C)**

At f_1: $X_C > X_L$, so the total voltage lags behind the current.

At f_2: $X_L > X_C$, so the total voltage leads the current.

26 **Answer (C)**

$X_L = 2 \times 3.14 \times 50 \times 79.6 \times 10^{-3} = 25\ \Omega$

$X_C = 1/(2 \times 3.14 \times 50 \times 127.4 \times 10^{-6}) = 25\ \Omega$

The circuit is at resonance: the voltmeter across the coil and the capacitor reads 0

$I = 220/44 = 5\ A$

27 **Answer (D)**

All the electric energy turns into magnetic energy after a quarter cycle:

$T/4 = (2\pi\sqrt{(LC)})/4 = (\pi)/2\sqrt{(LC)}$

28 **Answer (B)**

$f_2 < f_1$, so the capacitance must be increased $(f \propto 1/(\sqrt{(C)}))$.

The current at the f_2 resonance is greater, so the ohmic resistance must be decreased $(I = V/R)$.

29 **Answer (C)**

$T = 2\pi\sqrt{(LC)} = 2\pi\sqrt{(1/(\pi) \times 25/(\pi) \times 10^{-6})} = 10\ ms$

After 5 ms (half a cycle) the capacitor is fully charged with the opposite charge.

30 **Answer (A)**

The greater the resistance, the more energy is lost as heat, so the charge dies away faster: $R_X > R_Y$