DDS ACADEMY

ELECTRO-MAGNETIC INDUCTION — DPP-3 (JEE MAINS)

1. The magnetic flux linked with a coil is given by an equation ϕ (in *webers*) = $8t^2 + 3t + 5$. The induced e.m.f. in the coil at the fourth second will be

(a) 16 *units* (b) 39 *units*

(c) 67 *units* (d) 145 *units*

2. The current flowing in two coaxial coils in the same direction. On increasing the distance between the two, the electric current will

(a) Increase

(b) Decrease

(c) Remain unchanged

(d) The information is incomplete

3. A coil has 2000 turns and area of $70\,cm^2$. The magnetic field perpendicular to the plane of the coil is $0.3\,Wb/m^2$ and takes 0.1*sec* to rotate through 180^o. The value of the induced e.m.f. will be

(a) $8.4\,V$ (b) $84\,V$

(c) $42\,V$ (d) $4.2\,V$

4. A coil of 40 Ω resistance has 100 turns and radius 6 *mm* is connected to ammeter of resistance of 160 *ohms*. Coil is placed perpendicular to the magnetic field. When coil is taken out of the field, 32 μC charge flows through it. The intensity of magnetic field will be

(a) 6.55 T (b) 5.66 T

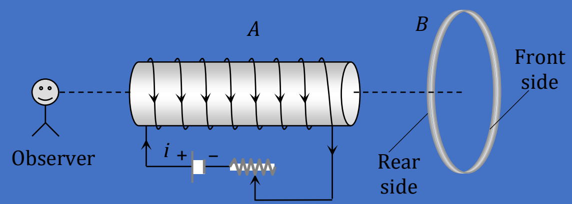
(c) 0.655 T (d) 0.566 T

5. A coil has an area of 0.05 m^2 and it has 800 turns. It is placed perpendicularly in a magnetic field of strength $4 \times 10^{-5}\,Wb/m^2$, it is rotated through 90^o in 0.1 *sec*. The average e.m.f. induced in the coil is

(a) 0.056 V (b) 0.046 V

(c) 0.026 V (d) 0.016 V

6. An aluminium ring B faces an electromagnet A. The current I through A can be altered



(a) Whether I increases or decreases, B will not experience any force

(b) If I decrease, A will repel B

(c) If I increases, A will attract B

(d) If I increases, A will repel B

7. An infinitely long cylinder is kept parallel to an uniform magnetic field B directed along positive *z* axis. The direction of induced current as seen from the *z* axis will be

(a) Clockwise of the +*ve z* axis

(b) Anticlockwise of the +*ve z* axis

(c) Zero No motion

(d) Along the magnetic field

8. Two rails of a railway track insulated from each other and the ground are connected to a milli voltmeter. What is the reading of voltmeter, when a train travels with a speed of 180 *km/hr* along the track. Given that the vertical component of earth's magnetic field is 0.2×10^{-4} *weber* $/m^2$ and the rails are separated by 1 *metre*

(a) 10^{-2} *volt* (b) 10^{-4} *volt*

(c) 10^{-3} *volt* (d) 1 *volt*

9. A metal conductor of length 1*m* rotates vertically about one of its ends at angular velocity 5 *radians per second.* If the horizontal component of earth's magnetic field is $0.2 \times 10^{-4}\,T$, then the e.m.f. developed between the two ends of the conductor is

(a) 5 *mV* (b) $5 \times 10^{-4}\,V$

(c) 50 *mV* (d) 50 μV

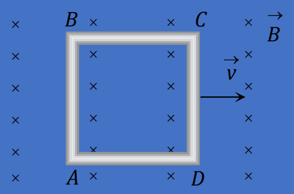
10. A conducting square loop of side *L* and resistance *R* moves in its plane with a uniform velocity *v* perpendicular to one of its sides. A magnetic induction *B* constant in time and space, pointing perpendicular and into the plane of the loop exists everywhere. The current induced in the loop is

(a) $\frac{Blv}{R}$ clockwise

(b) $\frac{Blv}{R}$ anticlockwise

(c) $\frac{2Blv}{R}$ anticlockwise

(d) Zero



11. A metal rod moves at a constant velocity in a direction perpendicular to its length. A constant uniform magnetic field exists in space in a direction perpendicular to the rod as well as its velocity. Select the correct statement(s) from the following

(a) The entire rod is at the same electric potential

(b) There is an electric field in the rod

(c) The electric potential is highest at the centre of the rod and decreases towards its ends

(d) The electric potential is lowest at the centre of the rod and increases towards its ends

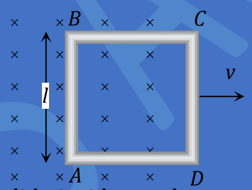
12. A conducting square loop of side *l* and resistance *R* moves in its plane with a uniform velocity *v* perpendicular to one of its sides. A magnetic induction *B* constant in time and space, pointing perpendicular and into the plane at the loop exists everywhere with half the loop outside the field, as shown in figure. The induced e.m.f. is

(a) Zero

(b) *RvB*

(c) *VBl/R*

(d) *VBl*



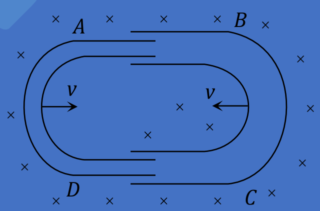
13. One conducting *U* tube can slide inside another as shown in figure, maintaining electrical contacts between the tubes. The magnetic field *B* is perpendicular to the plane of the figure. If each tube moves towards the other at a constant sped *v* then the emf induced in the circuit in terms of *B, l* and *v* where *l* is the width of each tube, will be

(a) Zero

(b) 2 *Blv*

(c) *Blv*

(d) –*Blv*



14. An ideal coil of 10 *henry* is joined in series with a resistance of 5 *ohm* and a battery of 5 *volt.* 2 second after joining, the current flowing in *ampere* in the circuit will be

(a) e^{-1} (b) $(1 - e^{-1})$

(c) $(1 - e)$ (d) e

15. The self inductance of a solenoid of length *L*, area of cross-section *A* and having *N* turns is

(a) $\frac{\mu_0 N^2 A}{L}$ (b) $\frac{\mu_0 NA}{L}$

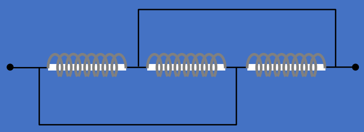
(c) $\mu_0 N^2 LA$ (d) $\mu_0 NAL$

16. The self inductance of a coil is L. Keeping the length and area same, the number of turns in the coil is increased to four times. The self inductance of the coil will now be

(a) $\frac{1}{4} L$ (b) L

(c) $4\,L$ (d) $16\,L$

17. Pure inductance of 3.0 H is connected as shown below. The equivalent inductance of the circuit is



(a) $1\,H$ (b) $2\,H$

(c) $3\,H$ (d) $9\,H$

18. The inductance of a closed-packed coil of 400 turns is 8 mH. A current of 5 mA is passed through it. The magnetic flux through each turn of the coil is

(a) $\frac{1}{4\pi} \mu_0 Wb$ (b) $\frac{1}{2\pi} \mu_0 Wb$

(c) $\frac{1}{3\pi} \mu_0 Wb$ (d) $0.4\,\mu_0 Wb$

19. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon

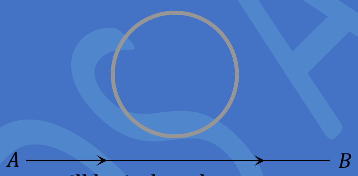
(a) The currents in the two coils

(b) The rates at which currents are changing in the two coils

(c) Relative position and orientation of the two coils

(d) The materials of the wires of the coils

20. An electron moves along the line AB, which lies in the same plane as a circular loop of conducting wires as shown in the diagram. What will be the direction of current induced if any, in the loop



(a) No current will be induced

(b) The current will be clockwise

(c) The current will be anticlockwise

(d) The current will change direction as the electron passes by

21. Two different coils have self-inductance $L_1 = 8\,mH$, $L_2 = 2mH$. The current in one coil is increased at a constant rate. The current in the second coil is also increased at the same rate. At a certain instant of time, the power given to the two coils is the same. At that time the current, the induced voltage and the energy stored in the first coil are i_1, V_1 and W_1 respectively. Corresponding values for the second coil at the same instant are i_2, V_2 and W_2 respectively. Then

(a) $\frac{i_1}{i_2} = \frac{1}{4}$ (b) $\frac{i_1}{i_2} = 4\ 8$

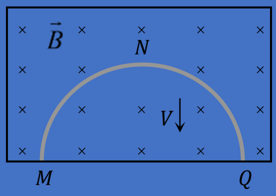
(c) $\frac{W_2}{W_1} = 4$ (d) $\frac{V_2}{V_1} = \frac{1}{4}$

22. An e.m.f. of 15 *volt* is applied in a circuit containing 5 *henry* inductance and 10 *ohm* resistance. The ratio of the currents at time $t = \infty$ and at $t = 1$ *second* is

(a) $\frac{e^{1/2}}{e^{1/2} - 1}$ (b) $\frac{e^2}{e^2 - 1}$

(c) $1 - e^{-1}$ (d) e^{-1}

23. A thin semicircular conducting ring of radius R is falling with its plane vertical in a horizontal magnetic induction B. At the position MNQ, the speed of the ring is V and the potential difference developed across the ring is



(a) Zero

(b) $Bv\pi R^2/2$ and M is at higher potential

(c) πRBV and Q is at higher potential

(d) $2RBV$ and Q is at higher potential

24. A circular loop of radius R carrying current I lies in x-y plane with its centre at origin. The total magnetic flux through x-y plane is

(a) Directly proportional to I

(b) Directly proportional to R

(c) Directly proportional to R^2

(d) Zero

25. Two coils have a mutual inductance 0.005 H. The current changes in the first coil according to equation $I = I_0 \sin \omega t$, where $I_0 = 10\,A$ and $\omega = 100\,\pi$ *radian/sec*. The maximum value of e.m.f. in the second coil is

(a) 2π (b) 5π

(c) π (d) 4π

26. A wire of length 1 m is moving at a speed of $2ms^{-1}$ perpendicular to its length and a homogeneous magnetic field of 0.5 T. The ends of the wire are joined to a circuit of resistance 6 Ω. The rate at which work is being done to keep the wire moving at constant speed is

(a) $\frac{1}{12}W$ (b) $\frac{1}{6}W$

(c) $\frac{1}{3}W$ (d) $1W$

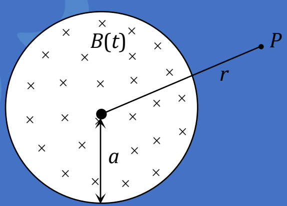
27. A uniform but time-varying magnetic field $B(t)$ exists in a circular region of radius a and is directed into the plane of the paper, as shown. The magnitude of the induced electric field at point P at a distance r from the centre of the circular region

(a) Is zero

(b) Decreases as $\frac{1}{r}$

(c) Increases as r

(d) Decreases as $\frac{1}{r^2}$

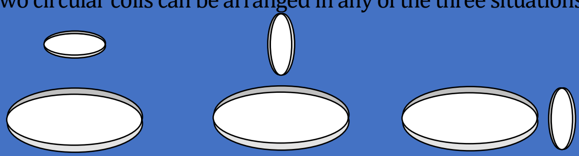


28. A coil of wire having finite inductance and resistance has a conducting ring placed coaxially within it. The coil is connected to a battery at time $t = 0$, so that a time-dependent current $I_1(t)$ starts flowing through the coil. If $I_2(t)$ is the current induced in the ring. and $B(t)$ is the magnetic field at the axis of the coil due to $I_1(t)$, then as a function of time ($t > 0$), the product $I_2(t)\,B(t)$

(a) Increases with time (b) Decreases with time

(c) Does not vary with time (d) Passes through a maximum

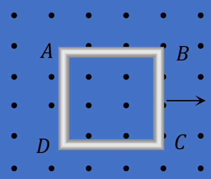
29. Two circular coils can be arranged in any of the three situations shown in the figure. Their mutual inductance will be



(A) (B) (C)

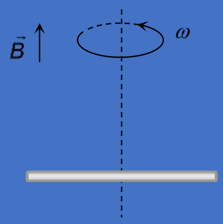
(a) Maximum in situation (A) (b) Maximum in situation (B)
(c) Maximum in situation (C) (d) The same in all situations

30. A metallic square loop *ABCD* is moving in its own plane with velocity *v* in a uniform magnetic field perpendicular to its plane as shown in the figure. An electric field is induced



(a) In *AD*, but not in *BC*
(b) In *BC*, but not in *AD*
(c) Neither in *AD* nor in *BC*
(d) In both *AD* and *BC*

31. A conducting rod of length $2l$ is rotating with constant angular speed ω about its perpendicular bisector. A uniform magnetic field $\vec{B}$ exists parallel to the axis of rotation. The e.m.f. induced between two ends of the rod is

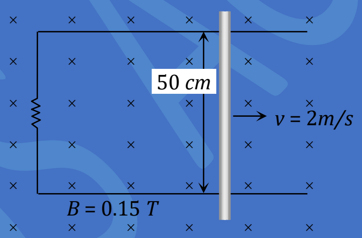


(a) $B\omega l^2$
(b) $\frac{1}{2}B\omega l^2$
(c) $\frac{1}{8}B\omega l^2$
(d) Zero

32. A coil of inductance 8.4 *mH* and resistance 6 Ω is connected to a 12 *V* battery. The current in the coil is 1.0 *A* at approximately the time

(a) 500 *sec* (b) 20 *sec*
(c) 35 *milli sec* (d) 1 *milli sec*

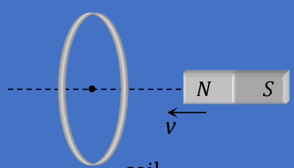
33. As shown in the figure a metal rod makes contact and complete the circuit. The circuit is perpendicular to the magnetic field with $B = 0.15\ tesla$. If the resistance is $3\,\Omega$, force needed to move the rod as indicated with a constant speed of $2m/sec$ is



(a) $3.75 \times 10^{-3}\ N$
(b) $3.75 \times 10^{-2}\ N$
(c) $3.75 \times 10^{2}\ N$
(d) $3.75 \times 10^{-4}\ N$

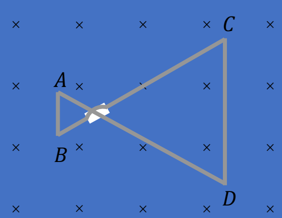
34. In the following figure, the magnet is moved towards the coil with a speed *v* and induced *emf* is *e*. If magnet and coil recede away from one another each moving with speed *v*, the induced *emf* in the coil will be

(a) *e*
(b) 2*e*
(c) *e*/2
(d) 4*e*



coil

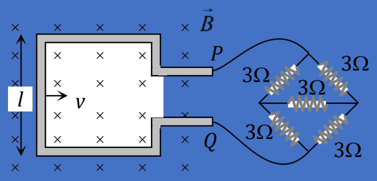
35. A conducting wire frame is placed in a magnetic field which is directed into the paper. The magnetic field is increasing at a constant rate. The directions of induced current in wires *AB* and *CD* are



(a) *B* to *A* and *D* to *C* (b) *A* to *B* and *C* to *D*

(c) A to B and D to C (d) B to A and C to D

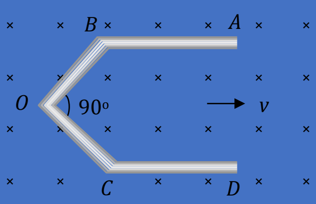
36. A square metallic wire loop of side 0.1 m and resistance of 1Ω is moved with a constant velocity in a magnetic field of 2 wb/m^2 as shown in figure. The magnetic field is perpendicular to the plane of the loop, loop is connected to a network of resistances. What should be the velocity of loop so as to have a steady current of $1 mA$ in loop



(a) 1 cm/sec (b) 2 cm/sec

(c) 3 cm/sec (d) 4 cm/sec

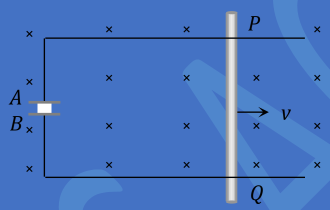
37. A conductor $ABOCD$ moves along its bisector with a velocity of 1 m/s through a perpendicular magnetic field of 1 wb/m^2, as shown in fig. If all the four sides are of $1m$ length each, then the induced emf between points A and D is



(a) 0 (b) 1.41 $volt$

(c) 0.71 $volt$ (d) None of the above

38. A conducting rod PQ of length L = 1.0 m is moving with a uniform speed v = 2 m/s in a uniform magnetic field $B = 4.0\,T$ directed into the paper. A capacitor of capacity C = 10 μF is connected as shown in figure. Then



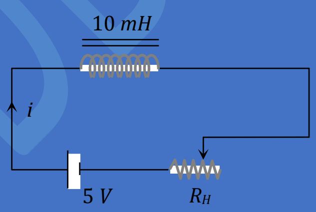
(a) $q_A = +80\ \mu C$ and $q_B = -80\ \mu C$

(b) $q_A = -80\ \mu C$ and $q_B = +80\ \mu C$

(c) $q_A = 0 = q_B$

(d) Charge stored in the capacitor increases exponentially with time

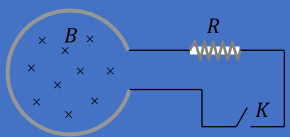
39. The resistance in the following circuit is increased at a particular instant. At this instant the value of resistance is 10Ω. The current in the circuit will be now



(a) $i = 0.5\ A$ (b) $i > 0.5\ A$

(c) $i < 0.5\ A$ (d) $i = 0$

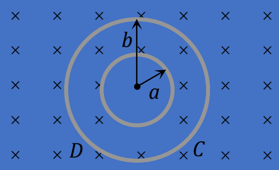
40. Shown in the figure is a circular loop of radius r and resistance R. A variable magnetic field of induction $B = B_0 e^{-t}$ is established inside the coil. If the key (K) is closed, the electrical power developed right after closing the switch is equal to



(a) $\frac{B_0^2 \pi r^2}{R}$ (b) $\frac{B_0 10 r^3}{R}$

(c) $\frac{B_0^2 \pi^2 r^4 R}{5}$ (d) $\frac{B_0^2 \pi^2 r^4}{R}$

41. Plane figures made of thin wires of resistance R = 50 *milli ohm/metre* are located in a uniform magnetic field perpendicular into the plane of the figures and which decrease at the rate dB/dt = 0.1 $m\ T/s$. Then currents in the inner and outer boundary are. (The inner radius a = 10 cm and outer radius b = 20 cm)



(a) $10^{-4}\ A$ (Clockwise), $2 \times 10^{-4}\ A$ (Clockwise)

(b) $10^{-4}\ A$ (Anticlockwise), $2 \times 10^{-4}\ A$ (Clockwise)

(c) $2 \times 10^{-4}\ A$ (clockwise), $10^{-4}\ A$ (Anticlockwise)

(d) $2 \times 10^{-4}\ A$ (Anticlockwise), $10^{-4}\ A$ (Anticlockwise)

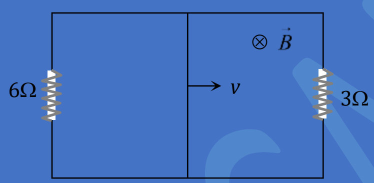
42. A rectangular loop with a sliding connector of length l = 1.0 m is situated in a uniform magnetic field B = 2T perpendicular to the plane of loop. Resistance of connector is r = 2Ω. Two resistance of 6Ω and 3Ω are connected as shown in figure. The external force required to keep the connector moving with a constant velocity v = 2m/s is

(a) 6 N

(b) 4 N

(c) 2 N

(d) 1 N



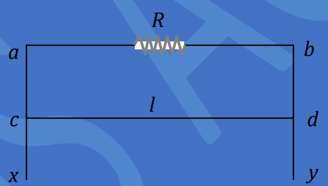
43. A wire cd of length l and mass m is sliding without friction on conducting rails ax and by as shown. The vertical rails are connected to each other with a resistance R between a and b. A uniform magnetic field B is applied perpendicular to the plane $abcd$ such that cd moves with a constant velocity of

(a) $\frac{mgR}{Bl}$

(b) $\frac{mgR}{B^2 l^2}$

(c) $\frac{mgR}{B^3 l^3}$

(d) $\frac{mgR}{B^2 l}$



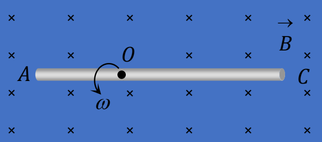
44. A conducting rod AC of length 4l is rotated about a point O in a uniform magnetic field $\vec{B}$ directed into the paper. AO = l and OC = 3l. Then

(a) $V_A - V_O = \frac{B\omega l^2}{2}$

(b) $V_O - V_C = \frac{7}{2} B\omega l^2$

(c) $V_A - V_C = 4B\omega l^2$

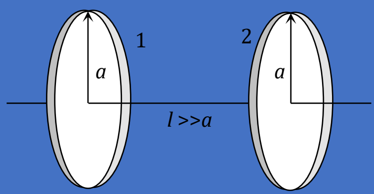
(d) $V_C - V_O = \frac{9}{2} B\omega l^2$



45. What is the mutual inductance of a two-loop system as shown with centre separation l

(a) $\frac{\mu_0 \pi a^4}{8 l^3}$

(b) $\frac{\mu_0 \pi a^4}{4 l^3}$

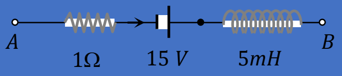


(c) $\dfrac{\mu_0 \pi a^4}{6l^3}$

(d) $\dfrac{\mu_0 \pi a^4}{2l^3}$

46. The network shown in the figure is a part of a complete circuit. If at a certain instant the current i is 5 A and is decreasing at the rate of $10^3 A/s$ then $V_A - V_B$ is

(a) 5 V
(b) 10 V
(c) 15 V
(d) 20 V



47. The current in a LR circuit builds up to $\dfrac{3}{4}$ *th* of its steady state value in $4s$. The time constant of this circuit is

(a) $\dfrac{1}{\ln 2}s$ (b) $\dfrac{2}{\ln 2}s$

(c) $\dfrac{3}{\ln 2}s$ (d) $\dfrac{4}{\ln 2}s$

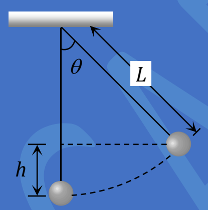
48. A simple pendulum with bob of mass m and conducting wire of length L swings under gravity through an angle 2θ. The earth's magnetic field component in the direction perpendicular to swing is B. Maximum potential difference induced across the pendulum is

(a) $2BL\sin\left(\dfrac{\theta}{2}\right)(gL)^{1/2}$

(b) $BL\sin\left(\dfrac{\theta}{2}\right)(gL)$

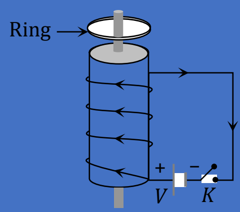
(c) $BL\sin\left(\dfrac{\theta}{2}\right)(gL)^{3/2}$

(d) $BL\sin\left(\dfrac{\theta}{2}\right)(gL)^2$

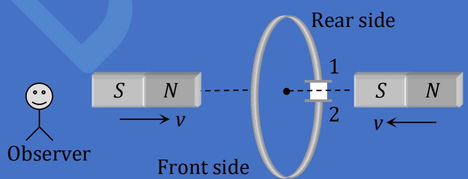


49. A conducting ring is placed around the core of an electromagnet as shown in fig. When key K is pressed, the ring

(a) Remain stationary
(b) Is attracted towards the electromagnet
(c) Jumps out of the core
(d) None of the above



50. The north and south poles of two identical magnets approach a coil, containing a condenser, with equal speeds from opposite sides. Then



(a) Plate 1 will be negative and plate 2 positive
(b) Plate 1 will be positive and plate 2 negative
(c) Both the plates will be positive
(d) Both the plates will be negative

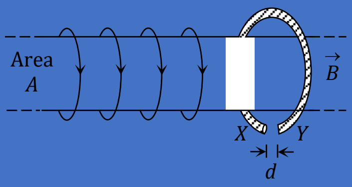
51. A highly conducting ring of radius R is perpendicular to and concentric with the axis of a long solenoid as shown in fig. The ring has a narrow gap of width d in its circumference. The solenoid has cross sectional area A and a uniform internal field of magnitude B_0. Now beginning at $t = 0$, the solenoid current is steadily increased to so that the field magnitude at any time t is given by $B(t) = B_0 + \alpha t$ where $\alpha > 0$. Assuming that no charge can flow across the gap, the end of ring which has excess of positive charge and the magnitude of induced e.m.f. in the ring are respectively

(a) $X, A\alpha$

(b) $X\ \pi R^2\alpha$

(c) $Y, \pi A^2\alpha$

(d) $Y, \pi R^2\alpha$



ANSWER KEY

1. C	**2. A**	**3. B**	**4. D**	**5. D**	**6. D**	**7. C**	**8. C**
9. D	**10. D**	**11. B**	**12. D**	**13. B**	**14. B**	**15. A**	**16. D**
17. A	**18. A**	**19. C**	**20. D**	**21. A,C,D**	**22. B**	**23. D**	**24. D**
25. B	**26. B**	**27. B**	**28. D**	**29. A**	**30. D**	**31. D**	**32. D**
33. A	**34. B**	**35. A**	**36. B**	**37. B**	**38. A**	**39. B**	**40. D**
41. C	**42. A**	**43. C**	**44. B**	**45. C**	**46. D**	**47. C**	**48. B**
49. A	**50. B**	**51. A**					