13 - ELECTROSTATICS

(Answers at the end of all questions)

1) Two point charges + 8q and - 2q are located at x = 0 and x = L respectively. The location of a point on the x axis at which the net electric field due to these two point charges is zero is

(a) L / 4 (b) 2 L (c) 4 L (d) 8 L [AIEEE 2005]

2) Two thin wire rings each having a radius R are placed at a distance d apart with their axes coinciding. The charges on the two rings are + q and - q. The potential difference between the centres of the two rings is

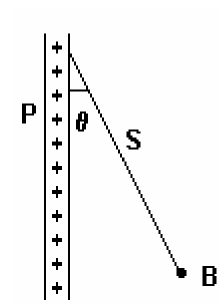
(a) $\frac{q}{2\pi\varepsilon_0} \; \frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}}$ (b) $\frac{qR}{4\pi\varepsilon_0 d^2}$ (c) $\frac{q}{4\pi\varepsilon_0} \; \frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}}$ (d) zero

[AIEEE 2005]

3) A parallel plate capacitor is made by stacking n equally spaced plates connected alternatively. If the capacitance between any two adjacent plates is 'C', then the resultant capacitance is

(a) (n + 1)C (b) (n - 1)C (c) nC (d) C [AIEEE 2005]

4) A charged ball B hangs from a silk thread S, which makes an angle θ with a large conducting sheet P, as shown in the figure. The surface charge density σ of the sheet is proportional to



(a) cot θ
(b) cos θ
(c) tan θ
(d) sin θ [AIEEE 2005]

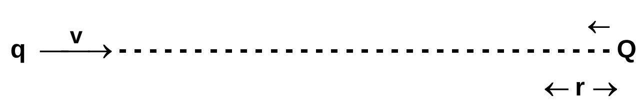
5) A fully charged capacitor has a capacitance 'C'. It is discharged through a small coil of resistance wire embedded in a thermally insulated block of specific heat capacity 's' and mass 'm'. If the temperature of the block is raised by 'ΔT', the potential difference 'V' across the capacitance is

(a) $\frac{m C \Delta T}{s}$ (b) $\sqrt{\frac{2 m C \Delta T}{s}}$ (c) $\sqrt{\frac{2 m s \Delta T}{C}}$ (d) $\frac{m s \Delta T}{C}$ [AIEEE 2005]

6) Two spherical conductors B and C having equal radii and carrying equal charges in them repel each other with a force F when kept apart at some distance. A third spherical conductor having same radius as that of B but uncharged, is brought in contact with B, then brought in contact with C and finally removed away from both. The new force of repulsion between B and C is

(a) F / 4 (b) 3 F / 4 (c) F / 8 (d) 3 F / 8 [AIEEE 2004]

7) A charged particle q is shot towards another charged particle Q, which is fixed, with a speed v. It approaches Q upto a closest distance r and then returns. If q was given a speed 2v, the closest distance of approach would be



(a) r (b) 2r (c) r / 2 (d) r / 4 [AIEEE 2004]

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(Answers at the end of all questions)

8) Four charges equal to -Q are placed at the four corners of the square and a charge q is at its centre. If the system is in equilibrium, the value of q is

(a) $-\frac{Q}{4}(1+2\sqrt{2})$ (b) $\frac{Q}{4}(1+2\sqrt{2})$ (c) $-\frac{Q}{2}(1+2\sqrt{2})$ (d) $\frac{Q}{2}(1+2\sqrt{2})$

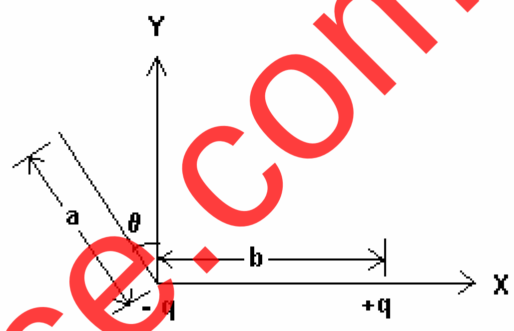
[AIEEE 2004]

9) Three charges $-q_1$, $+q_2$ and $-q_3$ are placed as shown in the figure. The x-component of the force on $-q_1$ is proportional to

(a) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\sin\theta$ (b) $\frac{q_2}{b^2} - \frac{q_3}{a^2}\cos\theta$

(c) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta$ (d) $\frac{q_2}{b^2} + \frac{q_3}{a^2}\sin\theta$

[AIEEE 2003]



10) A thin spherical conducting shell of radius R has charge q. Another charge Q is placed at the centre of the shell. The electrostatic potential at a point P at a distance R / 2 from the centre of the shell is

(a) $\frac{2Q}{4\pi\varepsilon_\circ R}$ (b) $\frac{(q+Q)^2}{4\pi\varepsilon_\circ R}$ (c) $\frac{2Q}{4\pi\varepsilon_\circ R} - \frac{2q}{4\pi\varepsilon_\circ R}$ (d) $\frac{2Q}{4\pi\varepsilon_\circ R} + \frac{q}{4\pi\varepsilon_\circ R}$

[AIEEE 2003]

11) If electric flux entering and leaving an enclosed surface is Φ_1 and Φ_2 respectively, the electric charge inside the enclosed surface will be

(a) $(\Phi_1 + \Phi_2)\,\varepsilon_0$ (b) $(\Phi_2 - \Phi_1)\,\varepsilon_0$ (c) $(\Phi_1 + \Phi_2)/\varepsilon_0$ (d) $(\Phi_2 - \Phi_1)/\varepsilon_0$

[AIEEE 2003]

12) The work done in placing a charge of 8×10^{-18} coulomb on a condenser of capacity 100 μF is

(a) 32×10^{-32} J (b) 16×10^{-32} J (c) 8×10^{-26} J (d) 4×10^{-10} J [AIEEE 2003]

13) A sheet of aluminium foil of negligible thickness is introduced between the plates of a capacitor. The capacitance of the capacitor

(a) increases (b) decreases (c) becomes infinite (d) remains unchanged

[AIEEE 2003]

14) A charge q is placed at the centre of a cube, the magnitude of flux through one of its face will be

(a) q/ε_0 (b) $q/3\varepsilon_0$ (c) $q/6\varepsilon_0$ (d) $6q/\varepsilon_0$ [AIEEE 2003]

15) A charged capacitor is discharged by using a wire and equation of decreasing charge in wire is $q = 0.1\,e^{-3t}$ coulomb. The current in the wire at t = 2 sec will be

(a) $0.1/e^6$ (b) $0.3/e^6$ (c) $0.5/e^6$ (d) $0.7/e^8$ [AIEEE 2002]

16) If n capacitors each of capacitance C are connected in series with a battery of V volt, then the energy stored in all the capacitors will be

(a) nCV^2 (b) $nCV^2/4$ (c) $nCV^2/2$ (d) $CV^2/2n$ [AIEEE 2002]

(Answers at the end of all questions)

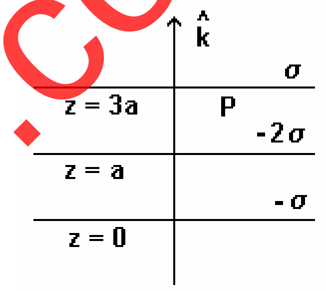
17) A conducting sphere of radius 10 cm is charged with 10 μC. Another uncharged sphere of radius 20 cm is allowed to touch it for some time. If both the spheres are separated, then surface density of the charges on the spheres will be in the ratio of

(a) 1 : 4 (b) 4 : 1 (c) 1 : 2 (d) 2:1 [AIEEE 2002]

18) Sixty four equal charged drops are combined to form a big drop. If the potential on each drop is 10 volt, then the potential of the big drop will be

(a) 10 V (b) 40 V (c) 160 V (d) 640 V [AIEEE 2002]

19) Three large charged sheets are having surface charge density as shown in the figure. The sheets are placed parallel to XY plane. Then electric field at point P will be

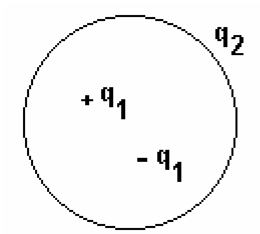


(a) $-\dfrac{4\sigma}{\varepsilon_0}\hat{k}$ (b) $\dfrac{4\sigma}{\varepsilon_0}\hat{k}$

(c) $\dfrac{2\sigma}{\varepsilon_0}\hat{k}$ (d) $-\dfrac{2\sigma}{\varepsilon_0}\hat{k}$

[IIT 2005]

20) Consider the charge configuration and a spherical Gaussian surface as shown in the figure. When calculating the flux of the electric field over the spherical surface, the electric field will be due to

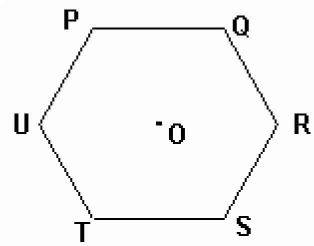


(a) q_2 (b) only the positive charges

(c) all the charges (d) $+q_1$ and $-q_1$

[IIT 2004]

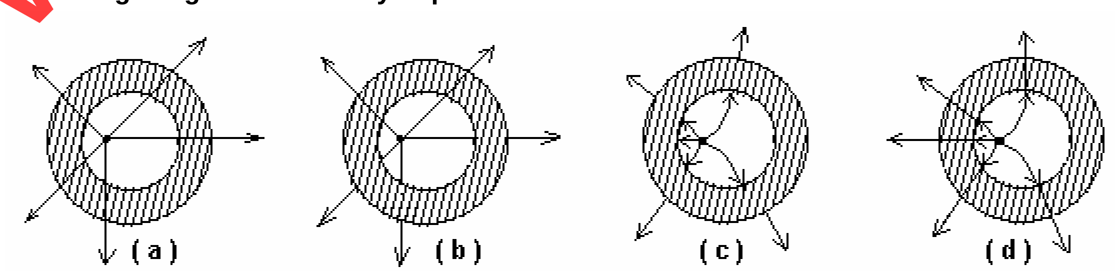
21) Six charges, three positive and three negative, of equal magnitude are to be placed at the vertices of a regular hexagon such that the electric field at O is double the electric field when only one positive charge of the same magnitude is placed at R. Which of the following arrangement of charges is possible for P, Q, R, S, T and U respectively ?



(a) +, -, +, -, -, + (b) +, -, +, -, +, -

(c) +, +, -, +, -, - (d) -, +, +, -, +, - [IIT 2004]

22) A metallic shell has a point charge ' q ' kept inside its cavity. Which one of the following diagrams correctly represents the electric lines of forces ?



[IIT 2003]

(Answers at the end of all questions)

23) Two equal point charges are fixed at $x = -a$ and $x = +a$ on the X-axis. Another point charge Q is placed at the origin. The change in the electrical potential energy of Q, when it is displaced by a small distance x along the X-axis, is approximately proportional to

(a) x (b) x^2 (c) x^3 (d) $1/x$ [IIT 2002]

24) Two identical capacitors, have the same capacitance C. One of them is charged to potential V_1 and the other to V_2. The negative ends of the capacitors are also connected together. When the positive ends are also connected the decrease in energy of the combined system is

(a) $\frac{1}{4}C(V_1^2 - V_2^2)$ (b) $\frac{1}{4}C(V_1^2 + V_2^2)$

(c) $\frac{1}{4}C(V_1 - V_2)^2$ (d) $\frac{1}{4}C(V_1 + V_2)^2$ [IIT 2002]

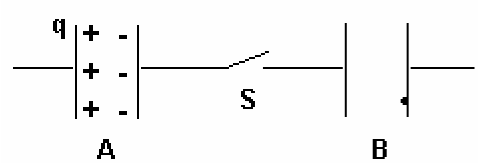
25) Three positive charges of equal value q are placed at the vertices of an equilateral triangle. The resulting lines should be sketched as in

[IIT 2001]

26) Consider the situation shown in the figure. The capacitor A has a charge q on it whereas B is uncharged. The charge appearing on the capacitor B a long time after the switch is closed is

(a) zero (b) q / 2 (c) q (d) 2q

[IIT 2001]



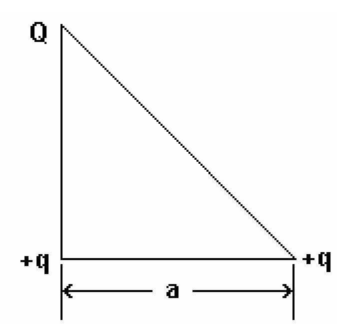
27) I uniform electric field pointing in positive X-direction exists in a region. Let A be the origin, B be the point on the X-axis at x = +1 cm and C be the point on the Y-axis at Y = + 1 cm. Then the potentials at A, B and C satisfy

(a) $V_A < V_B$ (b) $V_A > V_B$ (c) $V_A < V_C$ (d) $V_A > V_C$ [IIT 2001]

28) Three charges Q, + q and + q are placed at the vertices of a right-angled isosceles triangle as shown in the figure. The net electrostatic energy of the configuration is zero if Q is equal to

(a) $-\frac{q}{1 + \sqrt{2}}$ (b) $-\frac{2q}{2 + \sqrt{2}}$ (c) $-2q$ (d) $+q$

[IIT 2000]



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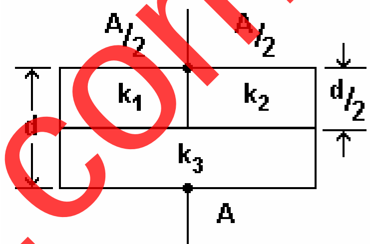
(Answers at the end of all questions)

29) A parallel plate capacitor of area A, plate separation d and capacitance C is fitted with three different dielectric constants k_1, k_2 and k_3 as shown in the figure. If a single dielectric material is to be used to have the same capacitance C in this capacitor, then its dielectric constant k is given by



(a) $\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{2k_3}$

(b) $\frac{1}{k} = \frac{1}{k_1 + k_2} + \frac{1}{2k_3}$

(c) $k = \frac{k_1 k_2}{k_1 + k_2} + 2k_3$

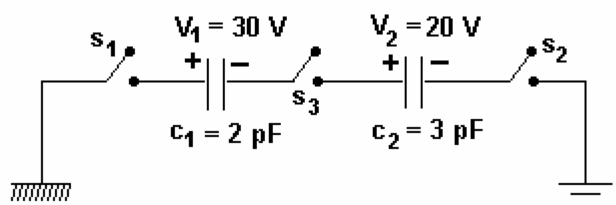
(d) $k = \frac{k_1 k_3}{k_1 + k_2} + \frac{k_2 k_3}{k_2 + k_3}$ [IIT 2000]

30) Two identical metal plates are given positive charges Q_1 and Q_2 ($< Q_1$) respectively. If they are now brought close together to form a parallel plate capacitor with capacitance C, the potential difference between them is

(a) $(Q_1 + Q_2) / 2C$ (b) $(Q_1 + Q_2) / C$

(c) $(Q_1 - Q_2) / C$ (d) $(Q_1 - Q_2) / 2C$ [IIT 1999]

31) For the circuit shown, which of the following statements is true ?



(a) With s_1 closed, $V_1 = 15$ V, $V_2 = 20$ V

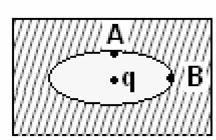
(b) With s_3 closed, $V_1 = V_2 = 25$ V

(c) With s_1 and s_2 closed, $V_1 = V_2 = 0$

(d) With s_1 and s_3 closed, $V_1 = 30$ V, $V_2 = 20$ V

[IIT 1999]

32) An elliptical cavity is carved within a perfect conductor. A positive charge q is placed at the centre of the cavity. The points A and B are on the cavity surface as shown in the figure. Then



(a) electric field near A in the cavity = electric field near B in the cavity

(b) charge density at A = charge density at A

(c) potential at A = potential at B

(d) total electric field flux through the surface f the cavity is q / ε_o [IIT 1999]

33) A dielectric slab of thickness d is inserted in a parallel plate capacitor whose negative plate is at x = 0 and positive plate is at x = 3d. The slab is equidistant from the plates. The capacitor is given some charge. As x goes from 0 to 3d,

(a) the magnitude of the electric field remains the same

(b) the direction of the electric field remains the same

(c) the electric potential increases continuously

(d) the electric potential increases at first, then decreases and again increases

[IIT 1998]

34) A charge $+q$ is fixed at each of the points $x = x_0$, $x = 3x_0$, $x = 5x_0$, ... , ∞ on X-axis and a charge of $-q$ is fixed at each of the points $x = 2x_0$, $x = 4x_0$, $x = 6x_0$, ... , ∞. Here, x_0 is a positive constant. Take the electric potential at a point due to a charge Q at a distance r from it to be $\dfrac{Q}{4\pi\varepsilon_0 r}$. Then the potential at the origin due to the above system of charges is

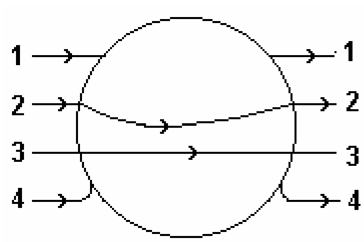
(a) 0 (b) $\dfrac{q}{8\pi\varepsilon_0 x_0 \ln 2}$ (c) ∞ (d) $\dfrac{q \ln 2}{4\pi\varepsilon_0 x_0}$ [IIT 1998]

35) A non-conducting solid sphere of radius R is uniformly charged. The magnitude of the electric field due to the sphere at a distance r from its centre
(a) increases as r increases for $r < R$
(b) decreases as r increases for $0 < r < \infty$
(c) decreases as r increases for $R < r < \infty$
(d) is discontinuous ar $r = R$ [IIT 1998]

36) A positively charged thin metal ring of radius R is fixed in the xy plane with its centre at the origin O. A negatively charged particle P is released from rest at the point $(0, 0, z_o)$ where $z_o > 0$. Then the motion of P is
(a) periodic for all values of z_o satisfying $0 < z_o < \infty$
(b) simple harmonic for all values of z_o satisfying $0 < z_o \le R$
(c) approximately simple harmonic provided $z_o << R$
(d) such that P crosses O and continues to move along the negiative z-axis towards $z = -\infty$ [IIT 1998]

37) The magnitude of electric field $\vec{E}$ in the annular region of a charged cylindrical capacitor
(a) is the same throughout
(b) is higher near the outer cylinder than near the inner cylinder
(c) varies as $1/r$ where r is the distance from the axis
(d) varies as $1/r^2$ where r is the distance from the axis [IIT 1996]

38) A metallic solid sphere is placed in a uniform electric field. The lines of force follow the path(s) shown in the figure as in



(a) 1 (b) 2 (c) 3 (d) 4 [IIT 1996]

39) Two identical thin rings, each of radius R metres, are coaxially placed a distance R metres apart. If Q_1 and Q_2 coulomb are respectively the charges uniformly spread on the two rings, the work done in moving the charge q from the centre of one ring to that of the other is

(a) zero (b) $q(Q_1 - Q_2)(\sqrt{2} - 1)/(\sqrt{2} \cdot 4\pi\varepsilon_0 R)$
(c) $q\sqrt{2}(Q_1 + Q_2)/(4\pi\varepsilon_0 R)$ (d) $q(Q_1 + Q_2)(\sqrt{2} + 1)(\sqrt{2} \cdot 4\pi\varepsilon_0 R)$ [IIT 1992]

(Answers at the end of all questions)

40) A parallel plate capacitor of plate area A and plate separation d is charged to potential difference V and then the battery is disconnected. A slab of dielectric constant k is then inserted between the plates of the capacitor so as to fill the space between the plates. If Q, E and W denote respectively the magnitude of charge on each plate, the electric field between the plates (after the slab is inserted) and work done on the system, in question, in the process of inserting the slab, then

(a) $Q = \frac{\varepsilon_0 AV}{d}$ (b) $Q = \frac{\varepsilon_0 kAV}{d}$ (c) $E = \frac{V}{kd}$ (d) $W = \frac{\varepsilon_0 kAV^2}{2d}\left(1 - \frac{1}{k}\right)$

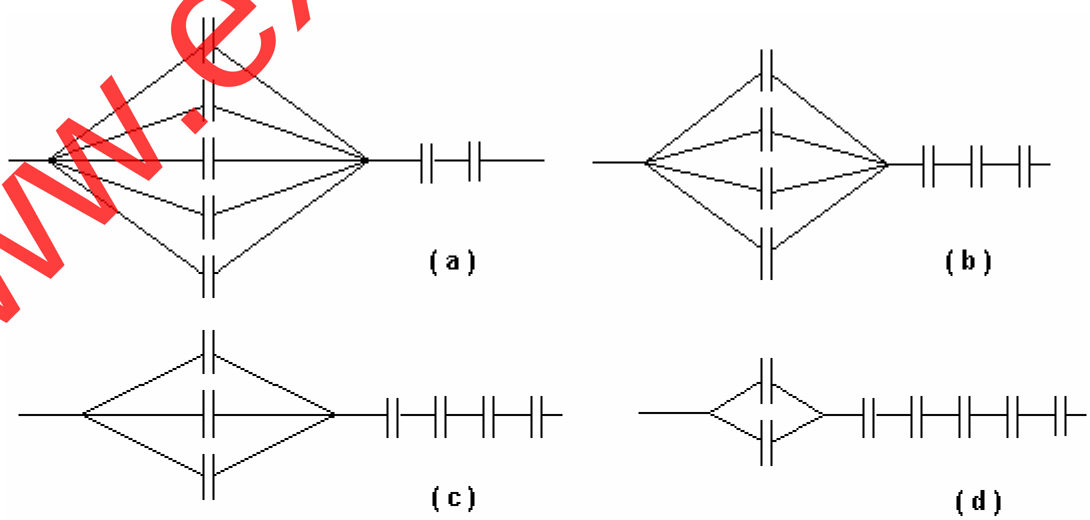
[IIT 1991]

41) A solid conducting sphere having a charge Q is surrounded by an uncharged concentric conducting hollow spherical shell. Let the potential difference between the surface of the solid sphere and that of the outer surface of the hollow be V. If the shell is now given a charge of - 3Q, the new potential difference between the same two surfaces is (a) V (b) 2 V (c) 4 V (d) - 2 V [IIT 1989]

42) Capacitor C_1 of capacitance 1 μF and capacitor C_2 of capacitance 2 μF are separately charged fully by a common battery. The two capacitors are then separately allowed to be discharged through equal resistors at time t = 0. Select the correct alternative (s) from the given.

(a) The currents in each case of the two discharging circuits is zero at t = 0.
(b) The currents in the two discharging circuits at t = 0 are equal but not zero.
(c) The currents in the two discharging circuits at t = 0 are unequal.
(d) Capacitor C_1 loses 50 % of its initial charge sooner than C_2 loses 50 % of its initial charge. [IIT 1989]

43) Seven capacitors each of capacitance 2 μF are to be connected in a configuration to obtain an effective capacitance of (10 / 11) μF. Which of the combination(s) shown in the figure will achieve the desired result ? [IIT 1990]



44) A charge q is placed at the centre of the line joining the two equal charges Q. The system of the three charges will be in equilibrium if q is equal to

(a) - Q / 2 (b) - Q / 4 (c) + Q / 4 (d) + Q / 2 [IIT 1987]

(Answers at the end of all questions)

45) A parallel plate capacitor is charged and the charging battery is then disconnected. If the plates of the capacitors are moved farther apart by means of insulating handles, then
(a) the charge on the capacitor increases
(b) the voltage across the plates increases
(c) the capacitance increases
(d) the electrostatic energy stored in the capacitor increases [IIT 1987]

46) A parallel plate capacitor is connected to a battery. The quantities charge, voltage, electric field and energy associated with this capacitor are given by Q_0, V_0, E_0, and U_0 respectively. A dielectric slab is now introduced to fill the space between the plates with the battery still in connection. The corresponding quantities now given by Q, V, E and U are related to the previous ones as
(a) $Q > Q_0$ (b) $V > V_0$ (c) $E > E_0$ (d) $U > U_0$ [IIT 1985]

47) Two equal negative charges - q are fixed at the points (0, a) and (0, -a) on the y-axis. A positive charge Q is released at rest at the point (2a, 0) on the x-axis. The charge Q will
(a) execute simple harmonic motion about the origin
(b) move to the origin and remain at rest
(c) move to infinity
(d) execute oscillatory but not simple harmonic motion [IIT 1984]

Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
b	d	c	c	c	d	d	b	c	d	b	a	d	c	b	d	d	c	d	c

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
d	c	b	c	c	a	b	b	b	d	d	c,d	b,c	d	a,c	a,c	c	d	b	a,c,d

41	42	43	44	45	46	47
a	b,d	a	b	b,d	a,d	d