6.ATOMIC MODELS

TEACHING TASK

JEE MAINS LEVEL QUESTIONS

1. If two neutrons are added to an element X, then it will get converted to its
A) isotope B) isotone C) isobar D) None of the above

Answer:A

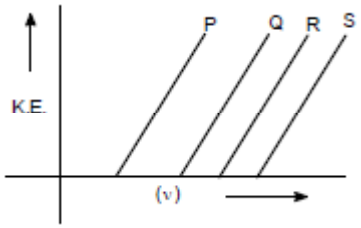
Solution:
Isotopes have the same atomic number (same number of protons) but different number of neutrons.
So, if you add 2 neutrons to the nucleus of X, the proton number remains the same, but the neutron number increases.

2. Two nuclides A and B are isoneutronic. Their mass numbers are 76 and 77 respectively. If atomic number of A is 32, then the atomic number of B will be
A) 33 B) 34 C) 32 D) 30

Answer:A

Solution:Isoneutronic species have the same number of neutrons.
Mass number = Protons + Neutrons
Let's calculate neutrons in A:Neutrons in A=76-32=44
For B to be isoneutronic (i.e., have 44 neutrons), and mass number = 77
Atomic number of B=77-44=33

3.



P, Q, R and S are four elements belonging to the same group of the periodic table. Identify the correct sequence with regard to their atomic number with respect to frequency.
A) P < Q < R < S B) P > Q > R > S
C) P > Q < R < S D) P < Q > R > S

Answer:A

Solution:The atomic number increases as you move down a group. Thus, the correct sequence would be P < Q < R < S.

4. The number of neutrons in dipositive zinc ion with mass number 70 is
A) 34 B) 36 C) 38 D) 40

Answer:D

Solution:Atomic number of Zn = 30""Dipositive ion means loss of 2 electrons (doesn't affect neutrons)""Neutrons = Mass number - Atomic number = 70 - 30 = 40

5. The triad of nuclei that is isotonic is:
A) $^{14}_{6}C$, $^{15}_{7}N$, $^{17}_{9}F$ B) $^{12}_{6}C$, $^{14}_{7}N$, $^{19}_{9}F$C) $^{14}_{6}C$, $^{14}_{7}N$, $^{17}_{9}F$ D) $^{14}_{6}C$, $^{14}_{7}C$, $^{19}_{9}F$

Answer:A

Solution:Isotones $\rightarrow$same number of neutrons
Let's calculate neutrons in each option:
Option A: $^{14}_{6}C$, $^{15}_{7}N$, $^{17}_{9}F$
$^{14}_{6}C$:14 - 6 = 8
$^{15}_{7}N$: 15 - 7 = 8
$^{17}_{9}F$: 17 - 9 = 8
6. Rutherford's experiment, which estabilished the nuclear model of the atom, used a beam of:
A) β-particles, which impinged on a metal foil and got absorbed.
B) γ- rays, which impinged on a metal foil and ejected electrons.
C) helium atoms, which impinged on a metal foil and got scattered.
D) helium nuclei, which impinged on a metal foild and got scattered.
Answer:D
Solution:Rutherford used α-particles (helium nuclei, He^{2+}) directed at a thin gold foil.
Most passed through, but some were scattered, leading to the discovery of the nucleus.
7. The sum of the number of neutrons and protons in the isotope of hydrogen is:
A) 6 B) 5 C) 4 D) 3
Answer:D
Solution:Protium (^1H): 1 proton, 0 neutrons $\rightarrow$ Sum = 1
Deuterium (^2H): 1 proton, 1 neutron $\rightarrow$ Sum = 2
Tritium (^3H): 1 proton, 2 neutrons $\rightarrow$Sum = 3
The question likely refers to tritium (^3H).
8. An atom contains electrons, protons and neutrons. If the mass of each neutrons i s hal ved , and each electron is doub led , then the atomic mass of $^{24}_{12}Mg$
A) Gets doubled
B) Approximately remain same
C) Approximately get reduced by 5%
D) Approximately get reduced by 25%
Answer:D
Solution:Atomic mass ˜ protons + neutrons (electron mass negligible).
Original mass of $^{24}_{12}Mg$
Mg: 12 protons + 12 neutrons ˜ 24 u.
After changes:
Neutron mass halved $\rightarrow$ 12 × 0.5 = 6 u
Electron mass doubled $\rightarrow$ negligible effect
New mass ˜ 12 (protons) + 6 (neutrons) = 18 u
Reduction = (24 - 18)/24 = 25%
9. The e/m ratio of cathode rays is x unit, when hydrogen is filled in the discharge tube. What will be its value when deuterium (D_2) is filled in it?
A) x unit B) x/2 unit C) 2x unit D) x/4 unit
Answer:A
Solution:Cathode rays = electrons
e/m ratio is a property of electrons, not of the gas filled
So filling hydrogen or deuterium doesn't change e/m of cathode rays
10. α –particles are projected towards the following metals, with the same kinetic

energy. Towards which metal, the distance of closest approach is minimum?
A) Cu (Z =29) B) Ag (Z =47) C) Au(Z =79) D) Ca(Z =20)

Answer:C

Solution:Distance of closest approach (r_0) α 1/Z (higher nuclear charge attracts α-particles more strongly).
Gold (Au, Z = 79) has the highest Z, so minimum r0.

JEE ADVANCED LEVEL QUESTIONS

Statement Type

A) Both statement-1 and statement-2 are correct, and statement-2 is the correct explanation of the statement-1.
B) Both statement-1and statement-2 are correct, and statement-2 is the notcorrect explanation of the statement-1.
C) statement-1 is correct, but statement-2 is incorrect.
D) statement-1 is incorrect, but statement-2 is correct.

11. Statement-1: Nuclide $^{30}_{13}$Al is less stable than $^{40}_{20}$Ca .
Statement-2: Nuclides having odd number of protons and neutrons are generally unstable.

Answer:A

Solution:$^{30}_{13}$Al :Protons = 13 (odd), Neutrons = 30 - 13 = 17 (odd) $\rightarrow$odd-odd
$^{40}_{20}$Ca:Protons = 20 (even), Neutrons = 20 (even) $\rightarrow$even-even
Even-even nuclei are generally more stable than odd-odd.

12. Statement-1: The frequency of ultraviolet radiation is greater than the frequency of infrared radiation
Statement-2: The velocity of ultraviolet radiation is greater than the velocity of infrared radiation.

Answer:C

Solution:Statement-1: The frequency of ultraviolet (UV) radiation is greater than infrared (IR) $\rightarrow$ Correct
UV has shorter wavelength than IR, hence higher frequency
Statement-2: The velocity of UV radiation is greater than IR radiation $\rightarrow$ Incorrect
In a vacuum (or same medium), all electromagnetic waves travel with the same speed c

Comprehension Type

Comprehension - I:

Atomic number of an element is characterised by Mosely's law & is given as $\sqrt{\vartheta} = a(z-b)$, where f^{o} is frequency of ϑ-rays, a & b are constants.

13. Which of the following represents Mosley's law

$A)\sqrt{\vartheta}\alpha\frac{1}{Z}\sqrt{\vartheta}\alpha\frac{1}{Z}$

$B)\sqrt{\lambda}\alpha Z$

$C)\sqrt{\frac{\lambda_1}{\lambda_2}}=\frac{Z_2}{Z_1}$

$D)\sqrt{\lambda}\alpha\frac{1}{Z}$

Answer:D

Solution:Moseley's Law relates the frequency (or square root of frequency) of characteristic X-rays emitted by elements to their atomic number Z:

$\sqrt{\vartheta}\alpha(Z-b)$

$\sqrt{\vartheta}\alpha Z$

$\sqrt{\lambda}\alpha\frac{1}{Z}$

14. In the graph between $\sqrt{\vartheta}\alpha Z$ (Moseley's equation), if a straight line is at angle of 45^0 with intercept 1 on $\sqrt{\vartheta}$ axis. Then constant 'a' is

A)1/2 B) 1 C) $\sqrt{2}$ D) $\sqrt{3}$

Answer:B

Solution:Slope m=tanθ

$\theta=45^0$, m=tan45^0=1

Intercept on $\sqrt{\vartheta}$-axis is 1 ---> Equation of the line: $\sqrt{\vartheta}$=Z+c

intercept c=1

Comprehension - II:

Electron, proton & neutron are said to be fundamental particles the charge of fundamental particles calculated by mullikan oil drop experiment.

15. An oil drop has -6.39x 10^{-19} coulomb change. The number of electrons in this oil drop is

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

Answer:A

Solution:

The charge of one electron (e) = -1.6×10^{-19} C.

Given charge on oil drop = -6.39x10^{-19} C.

Number of electrons $=\frac{TotalCh\arg e}{Ch\arg eofElectron}=\frac{6.39\times10^{-19}}{1.6\times10^{-19}}\approx4$

Integer Type

16. The no . of electrons in 8 gm of O^{-2} ion is xx10^{24} then x is _____

Answer:3

Solution:Atomic number of O = 8 $\rightarrow$ Normally 8 electrons
O^{2-} has 2 extra electrons $\rightarrow$ 10 electrons per ion
Molar mass of O = 16 g/mol
Moles in 8g = 8/16 =0.5 mol
No. of ions = $0.5\times6.022\times10^{23}$
Total electrons =$0.5\times6.022\times10^{23}$x10=3 x 10^{24}
x=3

17. How many grams of nitrogen (N^{14}) contains same number of neutrons as 6 gm of C^{12}

Answer:6

Solution:C^{12}: 6 neutrons per atom
Moles in 6 g = 6/12=0.5 mol
Total atoms = $0.5\times6.022\times10^{23}$
Neutrons =$0.5\times6.022\times10^{23}$x6
Now, each N^{14} atom has 7 neutrons
So required number of N^{14} atoms =

$$\frac{6 neutrons per C}{7 Per N}\times 0.5 mol=\frac{6}{7}\times0.5=\frac{3}{7}mol$$

$$Mass=\frac{3}{7}\times14=6g$$

18. Though Moseley's equation $\sqrt{\vartheta}$ on y-axis & z on x-axis, if a straight line is at angle of 45^0 and y intercept equal to 1 & is obtained when the frequency is 25 sec^{-1} then, atomic number of the element is

Answer:4

Solution:A graph is plotted with $\sqrt{\vartheta}$ (square root of frequency) on the y-axis and atomic number Z on the x-axis
The line makes an angle of 45° $\rightarrow$ slope = tan45°=1
y-intercept = 1
Frequency ϑ =$25s^{-1}$

Since slope = 1 and intercept = 1, the equation of the straight line is: $\sqrt{\vartheta}\alpha Z+1$

$$\sqrt{\vartheta}\alpha\sqrt{25}=5$$

$$5=Z+1\rightarrow Z=5-1=4$$

19. The atomic mass of an element is 19. The second shell of its atom contains 7 electrons. The number of neutrons in its nucleus is 2x. The value of x is _____

Answer:5

Solution:Atomic massA=19.
Second shell has 7 electrons:
Configuration:
2,7 $\rightarrow$ Total electrons = 9

Z=9.
Neutrons ,N=A-Z=19-9=10.
Given N=2x: 2x=10$\rightarrow$x=5
20. Sum of the number of neutrons and protons in an isotope of hydrogen (Deuterium) is _____
Answer:2
Solution:$_1D^2$(Deuterium) Protons = 1
Neutrons = 1
Sum = 1+1=2.
21. The mass number of an anion, X^{3-}, is 14. If there are ten electrons in the anion, the number of neutrons in the nucleus of atom, X_2 of the element will be
Answer:7
Solution:Anion has 3 extra electrons $\rightarrow$ neutral atom has 10-3=7 protons
So atomic number = 7$\rightarrow$ Neutrons = 14 - 7 = 7

LEARNERS TASK

CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1. Among the following which is not isoelectronic with others
A) HF B) H_2O C) NH_3 D) CO
Answer:D
Solution:Count total electrons:
HF: 1 (H) + 9 (F) = 10
H_2O: 2 (H) + 8 (O) = 10
NH_3: 3 (H) + 7 (N) = 10
CO: 6 (C) + 8 (O) = 14
2. Set of iso electronic ions among the following is
A) Na^+, Cl^-, O^{-2} B) K^+, Ca^{+2}, F^- C) Cl^-, K^+, S^{-2} D) H^+, Be^{+2}, Na+
Answer:C
Solution:Isoelectronic ions have the same number of electrons.
Count electrons:
Option C:
Cl^-: 17 + 1 = 18
K^+: 19 - 1 = 18
S^{2-}: 16 + 2 = 18
3. The total number of protons in one molecule of nitrogen dioxide
A)23 B)46 C)69 D)92
Answer:A
Solution:NO_2 has 1 N (7 protons) + 2 O (8 protons each).
Total protons = 7 + (2 × 8) = 23 per molecule.
4. Number of neutrons in heavy hydrogen atom is
A)0 B)1 C)2 D)3
Answer:B
Solution:Deuterium (^2H) has 1 proton and 1 neutron.
5. The nucleus of helium contains
A) Four protons B)Four neutrons

C)Two neutrons and two protons D) Four protons and two electrons

Answer:C

Solution:Helium nucleus ($_2He^4$) has 2 protons and 2 neutrons. Electrons are outside the nucleus.

6. An atom has 26 electrons and its atomic weight is 56. The number of neutrons in the nucleus of the atom will be

A)26 B)30 C)36 D)56

Answer:B

Solution:Electrons = Protons = 26 (atomic number).

Neutrons = Mass number - Protons = 56 - 26 = 30.

7. The atomic number of an element represents

A) Number of neutrons in the nucleus B)Number of protons in the nucleus

C) Atomic weight of element D)Valency of element

Answer:B

Solution:Atomic number = Protons in the nucleus.

8. The mass of an atom is constituted mainly by

A)Neutron and neutrino B)Neutron and electron

C)Neutron and proton D)Proton and electron

Answer:C

Solution:Mass comes from protons and neutrons (electrons are negligible).

9. An element with mass number 120 contains 40% more neutrons as compared to protons. Then element is

A) Mn^{120} B) Sn^{120} C) Fe^{56} D) None of these

Answer:B

Solution:Let protons = p, neutrons = 1.4p (40% more).

Mass number = $p+1.4p=2.4p=120$.

$p=50 \rightarrow$ Sn (Tin) has atomic number 50.

10. The average atomic mass of Boron is 10.2 whose isotopes are in 4 : 1 abundance. The isotopic mass of isotopes are

A) 10 & 11 B) 9 & 11 C) 11 & 10 D) 11 & 9

Answer:A

Solution:Let masses be x (80%) and y (20%).

$0.8x+0.2y=10.2$.

Option A: $0.8\times10+0.2\times11=8+2.2=10.2$.

JEE MAIN LEVEL QUESTIONS

1. The molecular weight of an oxide of nitrogen is 30. What should be the number of electrons in it ?

A) 15 B) 30 C) 45 D) 20

Answer:A

Solution:The oxide is NO (Nitric oxide, MW = 14 + 16 = 30).

Electrons in NO: 7 (N) + 8 (O) = 15.

2. A dipositive ion has 16 protons. What should be the number of electrons in its tetrapositive ion.

A)16 B) 14 C) 12 D) 10

Answer:C

Solution:Dipositive ion: 16 protons, 14 electrons (lost 2 electrons).

Tetrapositive ion: Loses 2 more electrons $\rightarrow$ 12 electrons.

3. Rutherford's alpha particle scattering experiment eventually led to the conclusion that:

A) mass and energy are related.

B) electrons occupy space around the nucleus'

C) neutrons are buried deep in the nucleus

D) the point of impact with matter can be precisely determined.

Answer:B

Solution:Rutherford concluded that electrons orbit a tiny, dense nucleus.

4. Rutherford's scattering experiment is related to the size of the

A) nucleus B) atoms C) electron D) neutron

Answer:A

Solution:The experiment estimated the size of the nucleus.

5. Among $_{10}A^{20}$ $_{11}B^{21}$ $_{11}C^{22}$ and $_{12}D^{22}$ the isobar combination is

A) A & B B) B & C C) C & D D) A & D

Answer:C

Solution:Isobars have the same mass number but different atomic numbers. $_{11}C^{22}$ and $_{12}D^{22}$ both have mass number 22.

6. The wrong statement among the following is

A) Nitrogen atom, nitride ion have same atomic number

B) Aluminium atom and its ion have same mass number

C) Iron atom, ferrous ion have same electron configuration

D) Nuclear charge is same in both chlorine atom, chloride ion

Answer:C

Solution:Fe atom: [Ar] $3d^6$ $4s^2$

Fe^{2+} ion: [Ar] $3d^6$ (loses 2 electrons).

7. An ion with mass number 56 contains 3 units of positive charge and 30.4% more neutrons than electrons. Assign the symbol to this ion

A) $^{55}_{26}Fe^{3+}$ B) $^{57}_{26}Fe^{3+}$ C) $^{59}_{26}Fe^{3+}$ D) $^{56}_{26}Fe^{3+}$

Answer:D

Solution:Let electrons = x, neutrons = 1.304x.

For Fe^{3+}: Electrons = 23 (26 - 3), neutrons = 30 (56 - 26).

Check: 1.304×23˜30.

8. Two isotopes of Boron are found in the nature with atomic weights 10.01(I) and 11.01(II). The atomic weight of natural Boron is 10.81. The percentage of (I) and (II) isotopes in it are respectively-

A) 20 and 80 B) 10 and 90 C) 15 and 75 D) 30 and 70

Answer:A

Solution:Let % of I = x, II = 100-x.

Equation: 10.01x+11.01(100-x)=10.81×100.

Solve: x=20%, 100-x=80%

9. An isotope of zirconium has 25% more neutrons as campared with protons. Atomic mass number of isotope is

A) 40 B) 50 C) 10 D) 90

Answer:D

Solution:Zirconium (Zr) has atomic number 40 (protons = 40).

Neutrons = 1.25×40=50.
Mass number = 40 + 50 = 90.
10. The abundance of Ne^{20}, Ne^{21} & Ne^{22} are 0.98, 0.015 & 0.005 respectively the average atomic mass of Neon is
A) 20 B) 20.025 C) 20.25 D) 21.25
Answer:B
Solution:Average mass = (20×0.98)+(21×0.015)+(22×0.005).
Calculation: 19.6+0.315+0.11=20.025.

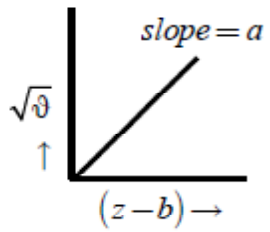
JEE ADVANCED LEVEL QUESTIONS

Multiple Correct Answer Type

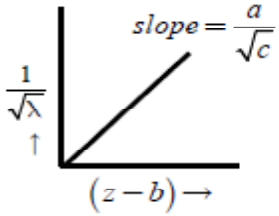
11. An isostone of $^{76}_{32}Ge$ is/are:
A) $^{77}_{32}Ge$ B) $^{77}_{33}As$ C) $^{77}_{34}Se$ D) $^{78}_{34}Se$
Answer:B,D
Solution:$^{76}_{32}Ge$ No.of neutrons=76-32=44
A) $^{77}_{32}Ge$,No.of neutrons=77-32=45
B) $^{77}_{33}As$,No.of neutrons=77-33=44
C) $^{77}_{34}Se$,No.of neutrons=77-34=43
D) $^{78}_{34}Se$,No.of neutrons=78-34=44
12. Many elements have non-integral masses because:
A) they have isotopes
B) their isotopes have non-integral masses
C) their isotopes have different masses
D) the constituents, neutrons, protons and electrons, combine to give fractional masses
Answer:C
Solution:Non-integral atomic masses arise due to weighted averages of isotopes with different masses (Option C).
Isotopes themselves have nearly integral masses, but their natural abundance leads to non-integral averages.
13. When α - particles are sent through a thin metal foil, most them go straight through the foil because:
A) α - particles are much heavier than electrons
B) α - particles are positively charged
C) most part of the atom is empty space
D) α - particle move with high velocity.
Answer:C
Solution:Rutherford's experiment showed that most a-particles passed through because atoms are mostly empty space.
Deflections occurred only when a-particles came close to the dense nucleus

14. Which of the following graphs repre
sents Moseley's Law

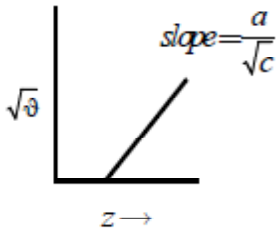
A)



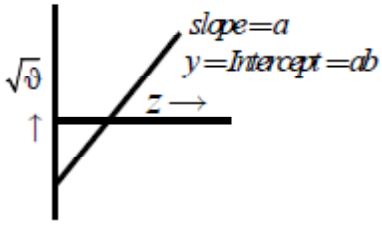
B)



C)



D)



Answer:A

Solution: $\sqrt{\vartheta} = a(Z-b)$

This is a straight-line equation: $y = mx + c \rightarrow \sqrt{\vartheta} = a(Z-b)$

x-axis: $(Z-b)$,y-axis: $\sqrt{\vartheta}$,Slope = a

No y-intercept (if x-axis is Z-b, the line passes through origin)

15. Atomic number (z) of an element is

A) equal to charge of atom

B) equal to total charge of all electrons present in an ion of element

C) equal to charge of nucleus

D) equal to number of neutrons present in nucleus

Answer:C

Solution:The nucleus contains protons (+1 charge each).

So, total positive charge of nucleus = Z × (+1)

Atomic number = nuclear charge

Comprehension - II:

Electron, proton & neutron are said to be fundamental particles the charge of fundamental particles calculated by mullikan oil drop experiment.

16. The total number of fundamental particle in $^{17}_{8}O$

A) 8 B) 17 C) 16 D) 25

Answer:D

Solution:Protons (atomic number) = 8

Neutrons = 17 - 8 = 9

Electrons = 8 (since it's a neutral atom)

Total = Protons + Neutrons + Electrons=8+9+8= 25

17. The isotope doesnot consists of neutron

A) $_1H^2$ B) $_1H^1$ C) $_2He^4$ D) None of these.

Answer:B

Solution:Only protium ($_1H^1$) has no neutron

Integer Type

18. The no . of electrons in 8 gm of O^{-2} ion is xx10^{24} then x is _____

Answer:3

Solution:Atomic number of O = 8 $\rightarrow$ Normally 8 electrons

O^{2-} has 2 extra electrons $\rightarrow$ 10 electrons per ion

Molar mass of O = 16 g/mol

Moles in 8g = 8/16 =0.5 mol

No. of ions = $0.5\times6.022\times10^{23}$

Total electrons =$0.5\times6.022\times10^{23}$x10=3 x 10^{24}

x=3

Matrix Matching type

19.

Column-I	Column-II
A) Thomson atomic model	P) Protons or electrons in Neutral atom
B) Rutherford's atomic model	Q) Protons + Neutrons Collectively
C) Atomic Number	R) Existence of Nucleus
D) Mass Number	S) No existence of orbitals

Answer:A-S,B-R,C-P,D-Q

Solution:

A) Thomson atomic model	S) No existence of orbitals
B) Rutherford's atomic model	R) Existence of Nucleus
C) Atomic Number	P) Protons or electrons in Neutral atom
D) Mass Number	Q) Protons + Neutrons Collectively

20.

Column-I	Column-II
A) Isosters	P) $^{19}_{9}F$,$_{11}Na^{23}$
B) Isodiaphers	Q) $^{14}_{6}C$, $^{14}_{7}N$
C) Isotones	R) C_6H_6 & $B_3N_3H_6$
D) Isobars	S) $^{23}_{11}Na$, $^{24}_{12}Mg$

Answer:A-R,B-P,C-S,D-Q

Solution:

A) Isosters	R) C_6H_6 & $B_3N_3H_6$
B) Isodiaphers	P) $^{19}_{9}F$,$_{11}Na^{23}$
C) Isotones	S) $^{23}_{11}Na$, $^{24}_{12}Mg$
D) Isobars	Q) $^{14}_{6}C$, $^{14}_{7}N$

KEY

				TEACHING TASK					
			JEE MAINS LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
A	A	A	D	A	D	D	D	A	C
			JEE ADVANCED LEVEL QUESTIONS						
11	12	13	14	15	16	17	18	19	20
A	C	D	B	A	3	6	4	5	2
21									
7									
				LEARNERS TASK					
				CUQ'S					
1	2	3	4	5	6	7	8	9	10
D	C	A	B	C	B	B	C	B	A
			JEE MAIN LEVEL QUESTIONS						
1	2	3	4	5	6	7	8	9	10
A	C	B	A	C	C	D	A	D	B
			JEE ADVANCED LEVEL QUESTIONS						
11	12	13	14	15	16	17	18	19	
B,D	C	C	A	C	D	B	3	A-S,B-R,C-P,D-Q	
20									
A-R,B-P,C-S,D-Q									