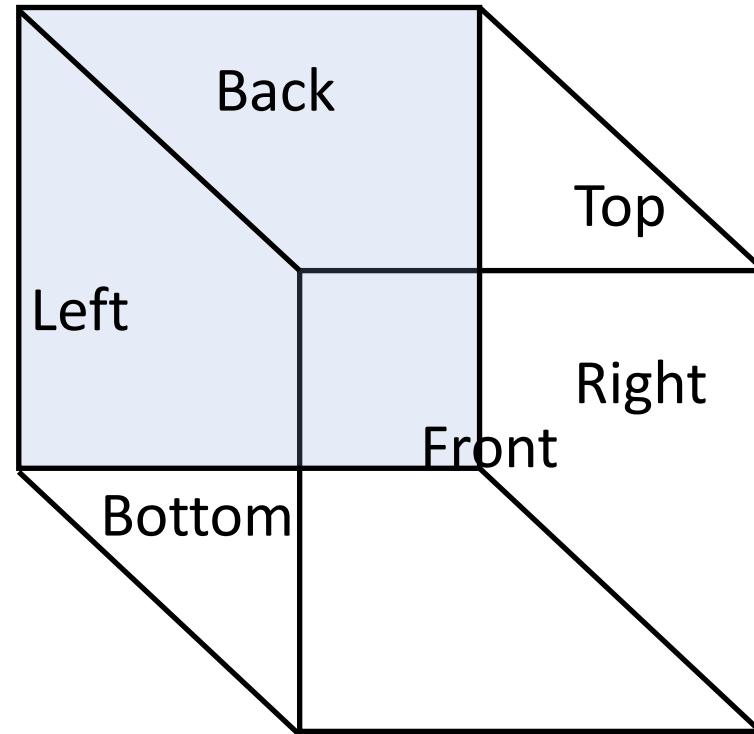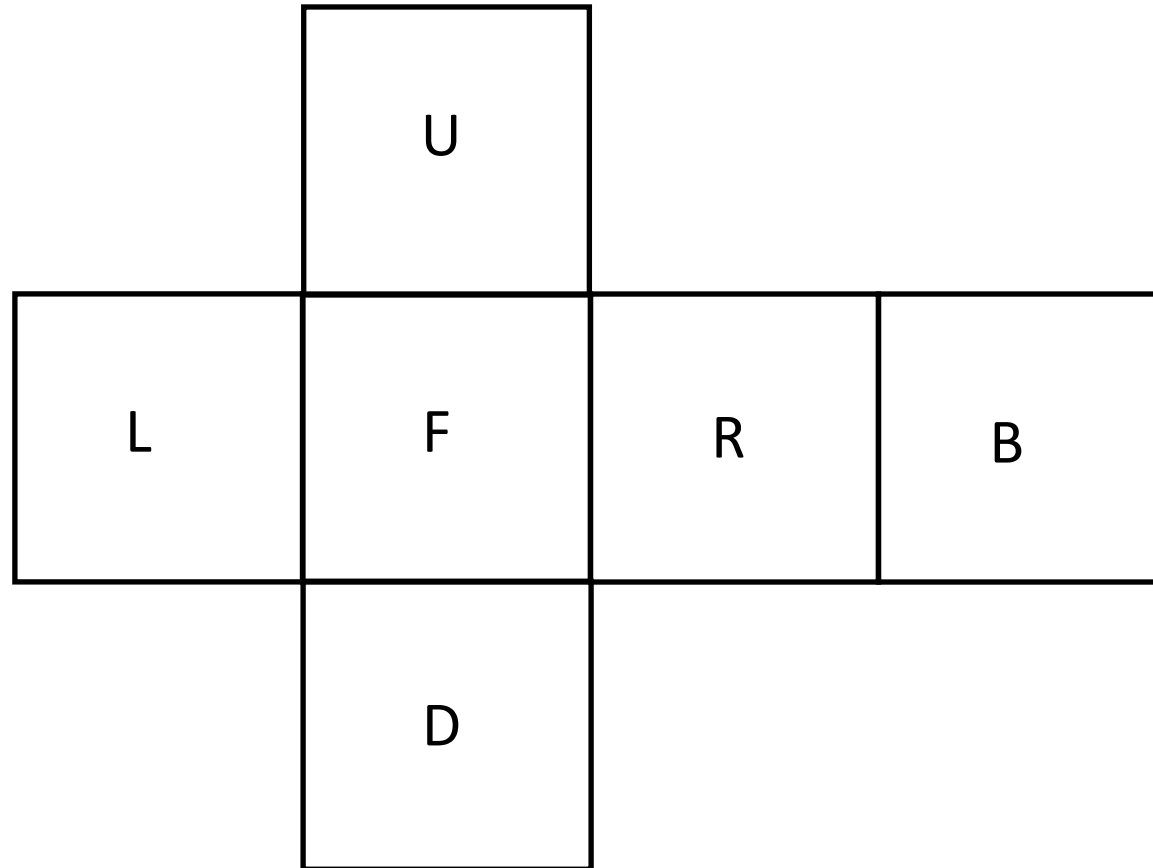# Cube

Rubik cube labels

Legend
- Front (F)
- Back (B)
- Up (U)
- Down (D)
- Left (L)
- Right (R)
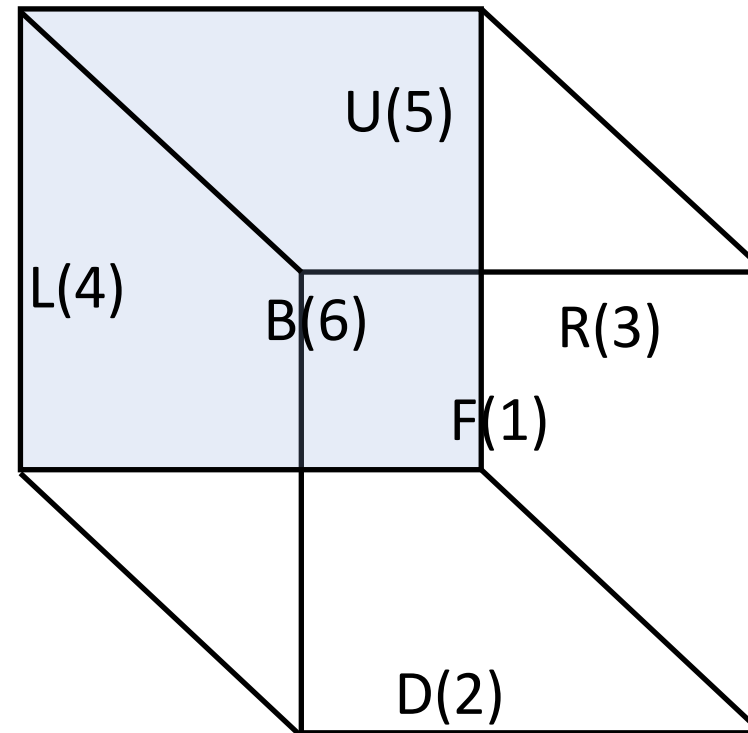
Cube

Legend
- Front (F)
- Back (B)
- Up (U)
- Down (D)
- Left (L)
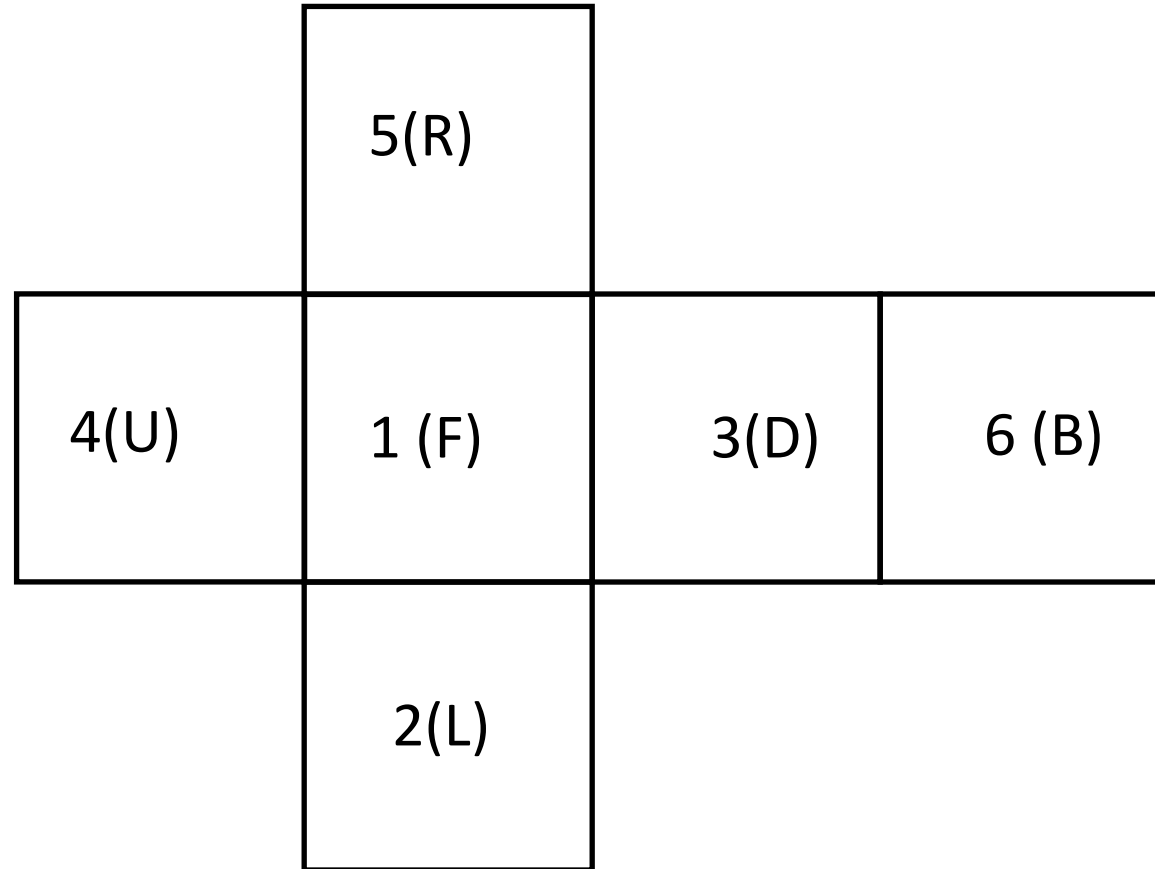- Right (R)

	U		
L	F	R	B
	D		

Cube

Standard dice order
Opposite sides add to 7

U(5)

L(4)

B(6)

R(3)

F(1)

D(2)

Cube

	5(R)		
4(U)	1 (F)	3(D)	6 (B)
	2(L)		

Face permutations of cube

```
FBUDLR                                      FBUDLR
162534   Element           Order            162534   Element           Order
------   -------           -----            ------   -------           -----
162534   (1)               1                432516   (1463)            4
164325   (2453)            4                436125   (145)(263)        3
165243   (25)(34)          2                435261   (14)(25)(36)      2
163452   (2354)            4                431652   (142)(356)        3
251643   (12)(56)(34)      2                521634   (1562)            4
253416   (123)(465)        3                524316   (153)(246)        3
256134   (1265)            4                526143   (15)(26)(34)      2
254361   (124)(365)        3                523461   (154)(236)        3
342561   (1364)            4                613425   (16)(23)(45)      2
341625   (132)(456)        3                615234   (16)(25)          2
345216   (13)(25)(46)      2                614352   (16)(24)(35)      2
346152   (135)(264)        3                612543   (16)(34)          2
```

Subgroups

- G = {(1), (2453), (25)(34), (2354), (12)(34)(56), (123)(465),
  (1265), (124)(365), (1364), (132)(456), (13)(25)(46), (135)(264),
  (1463), (145)(263), (14)(25)(36), (142)(356), (1562), (153)(245),
  (15)(26)(34), (154)(236), (16)(23)(45), (16)(24)(35), (16)(25), (16)(34)}
- H = {(1), (25)(34), (123)(465), (124)(365), (132)(465), (135)(264),
  (145)(263), (142)(356), (153)(245), (154)(236), (16)(25), (16)(34)}
- V = {(1), (25)(34), (16)(25), (16)(34)}
- $H \lhd G, V \lhd G$
- C_1 = {(1), (2453), (25)(34), (2354)}
- C_2 = {(1), (123)(465), (132)(456)}
- $N_1 = N(C_1)$ = {(1), (2453), (25)(34), (2354), (16)(25), (16)(34), (16)(24)(35), (16)(23)(45)}
- D_1 = <(15)(26)(34), (14)(25)(36)> = {(1), (15)(26)(34), (14)(25)(36), (123)(465), (132)(456), (16)(24)(35)}
- VC_2 = H, $VC_1 = N_1$, $N_1 \epsilon S_2(G), C_2 \epsilon S_3(G)$
- |C((12)(34)(56))| = 12, |C((25)(34))| = 8, |C((123)(465))| = 6
- ccls: $(4,4)_3$, $(3,2,2,2)_2$
- Subgroup orders: 1, 2, 3, 4, 6, 8, 12
- Element orders: 1 (1), 2 (9), 3 (8), 4 (6)
- $G=S_4$, $H=A_4$

Dodecahedron

Opposite sides add to 13

Face adjacency

     1: 2,a,5,6,4

     2: 1,4,8,7,a

     3: 4,6,b,c,8

     4: 1,6,3,8,2
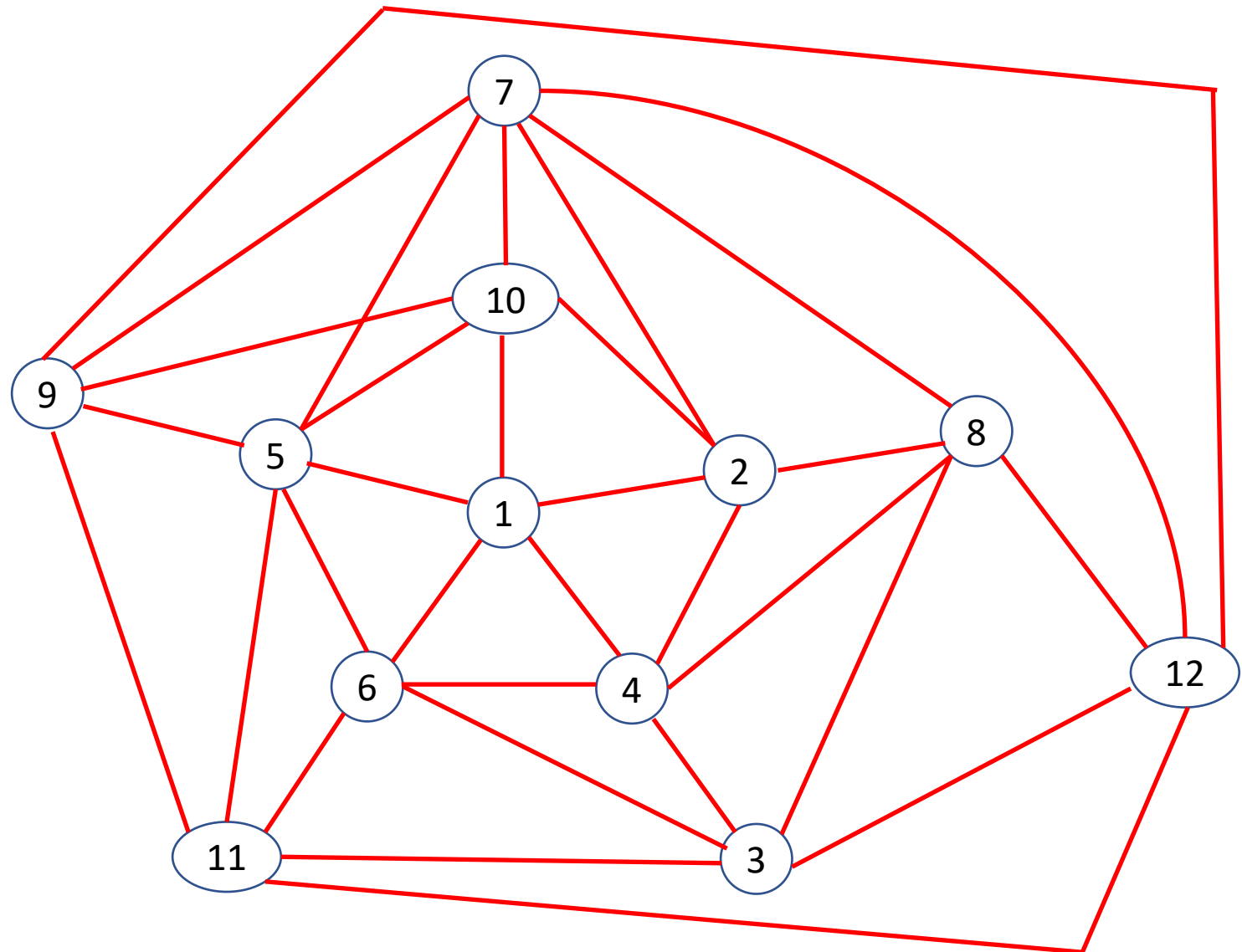
     5: 1,a,9,b,6

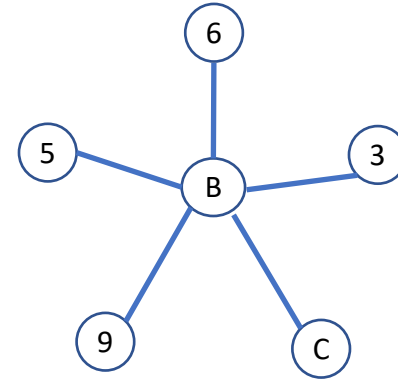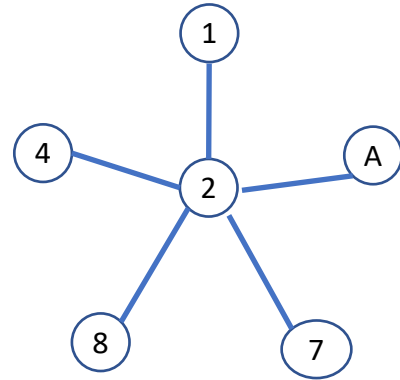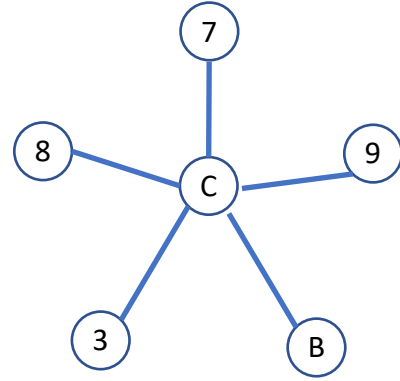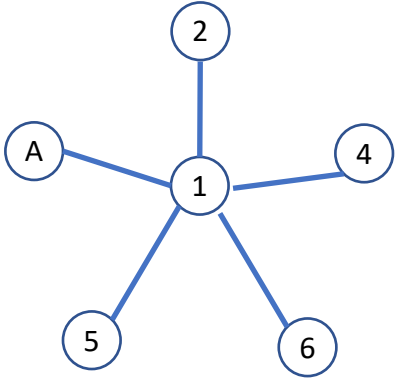   6: 1,5,b,3,4

     7: 2,8,c,9,a

     8: 2,4,3,c,7

     9: 5,a,7,c,b

     a: 1,2,7,9,5

     b: 3,6,5,9,c

     c: 3,b,9,7,8

$|G| = 60$, $G = A_5$

Dodecahedron

Dodecahedron
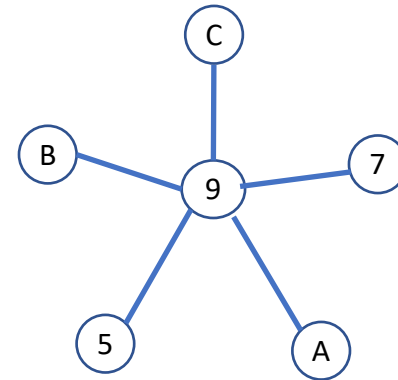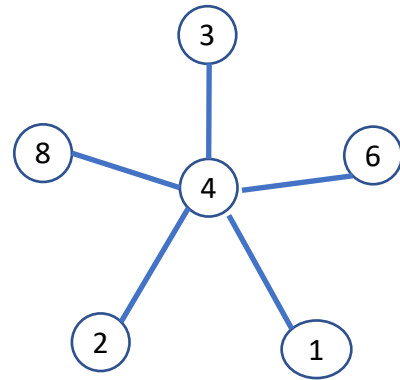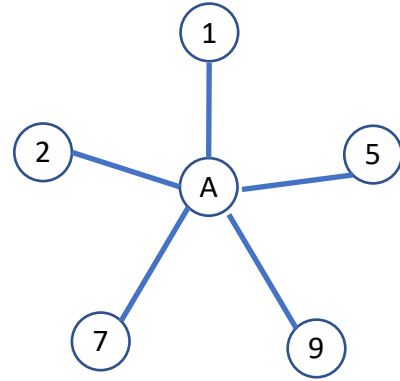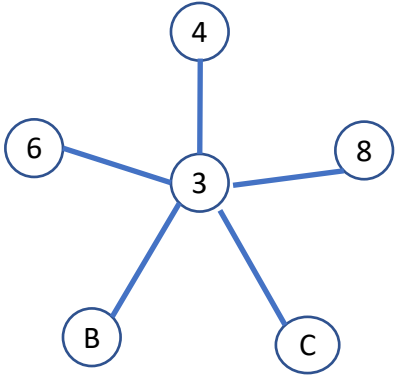
Dodecahedron

Dodecahedron Elements

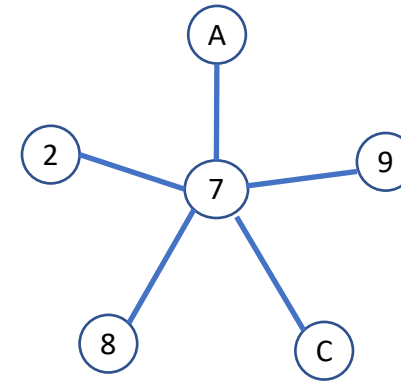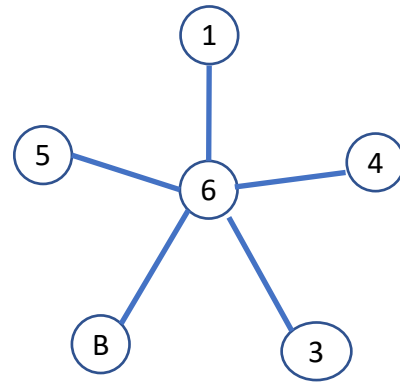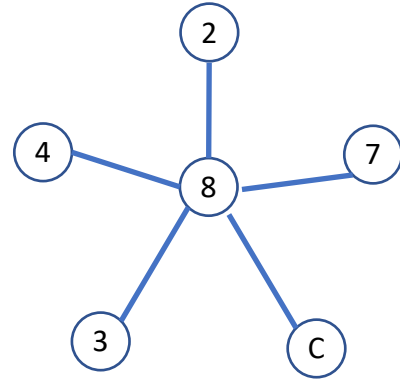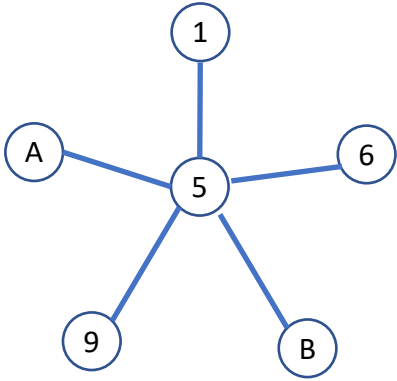123456789abc   Multiplier: (2a564)(79b38), (254a6)(7b893), (26a45)(7398b),(465a2)(83b97), (1)
123456789abc   (1)

123456789abc   Multiplier: (1487a)(563c9), (18a47)(5396c), (174a8)(5c693),(a7841)(9c365), (1)
219a876534cb   (12)(39)(4a)(58)(67)(bc)

123456789abc   Multiplier: (846bc)(21597), (86c4b)(25719), (8b4c6)(29175), (cb648)(79512), (1)
3478bc12569a   (137)(248)(5b9)(6ca)

123456789abc   Multiplier: (5a7cb)(36128), (57bac)(31862), (5cab7)(32681), (bc7a5)(82163), (1)
435621cb78a9   (146)(235)(7c9)(8ba)

123456789abc   Multiplier: (1a9b6)(427c3), (196ab)(4732c), (1ba69)(4c237), (6b9a1)(3c724), (1)
51369b247ac8   (15972)(46bc8)

123456789abc   Multiplier: (15b34)(2a9c8),(1b453)(298ac), (1354b)(2ca89), (43b51)(8c9a2), (1)
6184b3a295c7   (16382)(5bc7a)

Dodecahedron Elements

```
123456789abc      Multiplier: (15b34)(2a9c8),(1b453)(298ac), (1354b)(2ca89), (43b51)(8c9a2), (1)
7ab98c154236                 (17)(2a)(3b)(49)(58)(6c)


123456789abc      Multiplier: (1a9b6)(427c3), (196ab)(4732c), (1ba69)(4c237), (6b9a1)(3c724), (1)
82973c1a64b5                 (18a47)(396c5)


123456789abc      Multiplier: (5a7cb)(36128), (57bac)(31862), (5cab7)(32681), (bc7a5)(82163), (1)
9c275a386b14                 (196ab)(2c473)


123456789abc      Multiplier: (846bc)(21597), (86c4b)(25719), (8b4c6)(29175), (cb648)(79512), (1)
a1b5794682c3                 (1a2)(3bc)(457)(698)


123456789abc      Multiplier: (1487a)(563c9), (18a47)(5396c), (174a8)(5c693),(a7841)(9c365), (1)
b6839c14a572                 (1b7)(26c)(384)(59a)


123456789abc      Multiplier: (2a564)(79b38), (254a6)(7b893), (26a45)(7398b),(465a2)(83b97), (1)
c7593b2a4861                 (1c)(27)(35)(6b)(49)(8a)
```

Dodecahedron Element List

```
(1)
(2a564)(79b38)
(254a6)(7b893)
(26a45)(7398b)
(465a2)(83b97)
(12)(39)(4a)(58)(67)(bc)
(12)(39)(4a)(58)(67)(bc)  (1487a)(563c9)  =  (124)(357)(6a8)(9cb)
(12)(39)(4a)(58)(67)(bc)  (18a47)(5396c)  =  (28361)(5a7cb)
(12)(39)(4a)(58)(67)(bc)  (174a8)(5c693  =  (12795)(48cb6)
(12)(39)(4a)(58)(67)(bc)  (a7841)(9c365)  =  (12a)(3cb)(475)(689)
(137)(248)(5b9)(6ca)
(137)(248)(5b9)(6ca)   (846bc)(21597)  =  (13268)(5cab7)
(137)(248)(5b9)(6ca)  (86c4b)(25719)  =  (13)(2b)(46)(58)(79)(ac)
(137)(248)(5b9)(6ca)  (8b4c6)(29175)  =  (1354b)(2ca89)
(137)(248)(5b9)(6ca)  (cb648)(79512)  =  (139)(287)(4ca)(56b)
```

Dodecahedron Element List

```
(146)(235)(7c9)(8ba)
(146)(235)(7c9)(8ba)  (5a7cb)(36128)  =  (14)(26)(3a)(58)(7b)(9c)
(146)(235)(7c9)(8ba)  (57bac)(31862)  =  (142)(375)(68a)(9bc)
(146)(235)(7c9)(8ba)  (5cab7)(32681)  =  (1487a)(3c956)
(146)(235)(7c9)(8ba)  (bc7a5)(82163)  =  (143b5)(28c9a)
(16382)(5bc7a)
(16382)(5bc7a)  (1a9b6)(427c3)  =  (2a564)(79b38)
(16382)(5bc7a)  (196ab)(4732c)  =  (1a5)(296)(38c)(47b)
(16382)(5bc7a)  (1ba69)(4c237)  =  (19)(2b)(38)(4c)(5a)(67)
(16382)(5bc7a)  (6b9a1)(3c724)  =  (1b7)(26c)(384)(59a)
(15972)(46bc8)
(15972)(46bc8)  (1a9b6)(427c3)  =  (15b34)(2a9c8)
(15972)(46bc8)  (196ab)(4732c)  =  (156)(293)(4ab)(7c8)
(15972)(46bc8)  (1ba69)(4c237)  =a(15)(2b)(37)(49)(6a)(8c)
(15972)(46bc8)  (6b9a1)(3c724)  =  (15a)(269)(3c8)(467)
```

Dodecahedron Element List

```
(17)(2a)(3b)(49)(58)(6c)
(17)(2a)(3b)(49)(58)(6c)  (15b34)(2a9c8) = (17529)(4c68b)
(17)(2a)(3b)(49)(58)(6c)  (1b453)(298ac) = (17b)(2c6)(348)(5a9)
(17)(2a)(3b)(49)(58)(6c)  (1354b)(2ca89) = (173)(284)(59b)(6ac)
(17)(2a)(3b)(49)(58)(6c)  (43b51)(8c9a2) = (174a8)(35c69)
(18a47)(396c5)
(18a47)(396c5)  (1a9b6)(427c3) = (189)(27a)(3b6)(4c5)
(18a47)(396c5)  (196ab)(4732c) = (18b)(2c5)(364)(79a)
(18a47)(396c5)  (1ba69)(4c237) = (18623)(57bac)
(18a47)(396c5)  (6b9a1)(3c724) = (18)(24)(3a)(5c)(67)(b9)
(196ab)(2c473)
(196ab)(2c473)  (5a7cb)(36128) = (19)(2b)(38)(4c)(5a)(67)
(196ab)(2c473)  (57bac)(31862) = (19257)(4b86c)
(196ab)(2c473)  (5cab7)(32681) = (198)(2a7)(36b)(45c)
(196ab)(2c473)  (bc7a5)(82163) = (193)(278)(4ac)(5b6)
```

Dodecahedron Element List

```
(1a2)(3bc)(457)(698)
(1a2)(3bc)(457)(698)  (846bc)(21597)  =  (1a)(25)(3c)(49)(67)(8b)
(1a2)(3bc)(457)(698)  (86c4b)(25719)  =  (1a5)(296)(38c)(47b)
(1a2)(3bc)(457)(698)  (8b4c6)(29175)  =  (1a9b6)(27c34)
(1a2)(3bc)(457)(698)  (cb648)(79512)  =  (1a784)(3659c)
(1b7)(26c)(384)(59a)
(1b7)(26c)(384)(59a)  (1487a)(563c9)  =  (1ba69)(2374c)
(1b7)(26c)(384)(59a)  (18a47)(5396c)  =  (1b)(2c)(3a)(49)(56)(78)
(1b7)(26c)(384)(59a)  (174a8)(5c693)  =  (1b453)(298ac)
(1b7)(26c)(384)(59a)  (a7841)(9c365)  =  (1b8)(25c)(346)(7a9)
(1c)(27)(35)(6b)(49)(8a)
(1c)(27)(35)(6b)(49)(8a)  (2a564)(79b38)  =  (1c)(29)(36)(4b)(58)(7a)
(1c)(27)(35)(6b)(49)(8a)  (254a6)(7b893)  =  (1c)(2b)(34)(57)(68)(9a)
(1c)(27)(35)(6b)(49)(8a)  (26a45)(7398b)  =  (1c)(23)(48)(59)(67)(ab)
(1c)(27)(35)(6b)(49)(8a)  (465a2)(83b97)  =  (1c)(28)(3a)(47)(5b)(69)
```
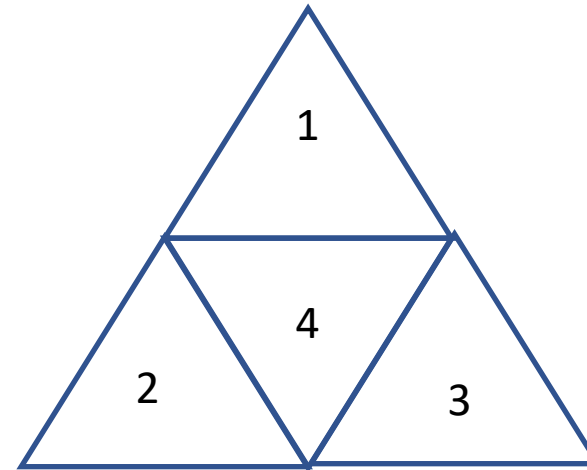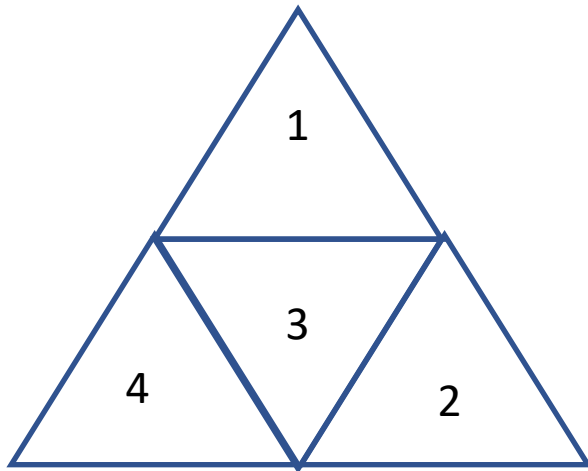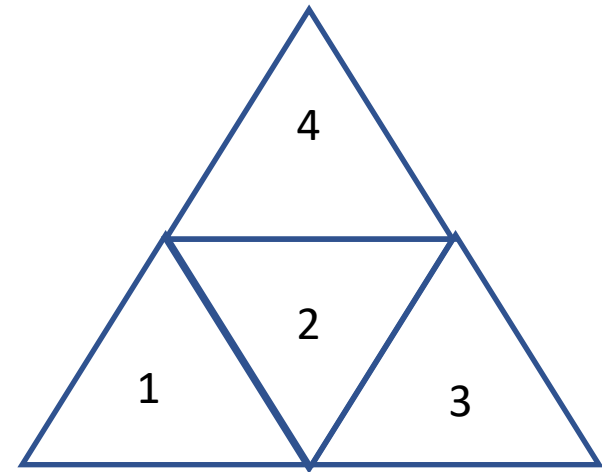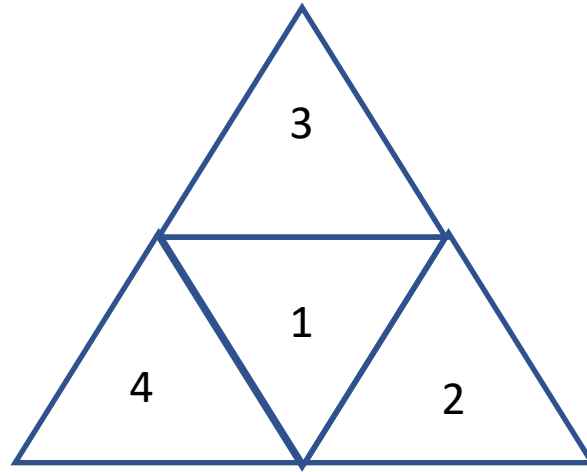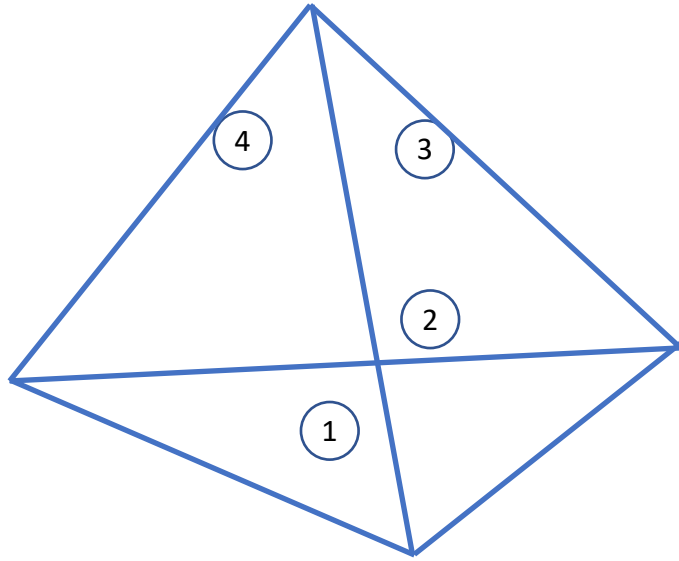
Tetrahedron

Tetrahedron elements

```
(1), (234), (243)
(12)(34), (12)(34)(134)= (123), (12)(34)(143)= (124)
(13)(24), (13)(24)(142)= (134), (13)(24)(124)= (132)
(14)(23), (14)(23)(123)= (142), (14)(23)(132)= (143)



(1),(234),(243),(12)(34),(123),(124),
(13)(24),(134),(132),(14)(23),(142),(143)
```