IP Addressing and Subnetting

Workbook
Version 1.5

11111110

10010101

00011011

10000110

11010011

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IP Address Classes

Class A	1 – 127	(Network 127 is reserved for loopback and internal testing)		
		Leading bit pattern	0	00000000.00000000.00000000.00000000 Network . Host . Host . Host
Class B	128 – 191	Leading bit pattern	10	10000000.00000000.00000000.00000000 Network . Network . Host . Host
Class C	192 – 223	Leading bit pattern	110	11000000.00000000.00000000.00000000 Network . Network . Network . Host
Class D	224 – 239	(Reserved for multicast)		
Class E	240 – 255	(Reserved for experimental, used for research)		

Private Address Space

Class A   10.0.0.0 to 10.255.255.255

Class B   172.16.0.0 to 172.31.255.255

Class C   192.168.0.0 to 192.168.255.255

Default Subnet Masks

Class A   255.0.0.0

Class B   255.255.0.0

Class C   255.255.255.0

Workbooks included in the series:

IP Addressing and Subnetting Workbooks
ACLs - Access Lists Workbooks
VLSM Variable-Length Subnet Mask IWorkbooks

Inside Cover

Binary To Decimal Conversion

128	64	32	16	8	4	2	1	Answers	Scratch Area
1	0	0	1	0	0	1	0	*146*	*128 64*
0	1	1	1	0	1	1	1	*119*	*16 32*
1	1	1	1	1	1	1	1	255	*2 16*
1	1	0	0	0	1	0	1	197	*146 4*
1	1	1	1	0	1	1	0	246	128 + 64 + 32 + 16 + 8 + 4 + 2 + 1
0	0	0	1	0	0	1	1	19	*2 119* 128 + 64 + 4 + 1
1	0	0	0	0	0	0	1	129	128 + 64 + 32 + 16 + 4 + 2
0	0	1	1	0	0	0	1		16 + 2 + 1
0	1	1	1	1	0	0	0		128 + 1
1	1	1	1	0	0	0	0		
0	0	1	1	1	0	1	1		
0	0	0	0	0	1	1	1		

	Answers	Scratch Area
00011011		
10101010		
01101111		
11111000		
00100000		
01010101		
00111110		
00000011	3	2 + 1
11101101		
11000000	192	128 + 64

Decimal To Binary Conversion
Use all 8 bits for each problem

128	64	32	16	8	4	2	1	= 255		Scratch Area
1	1	1	0	1	1	1	0	238		238 34
0	0	1	0	0	0	1	0	34		−128 −32
0	1	1	1	1	0	1	1	123		110 2
0	0	1	1	0	0	1	0	50		−64 −2
1	1	1	1	1	1	1	1	255		46 0
1	1	0	0	1	0	0	0	200		−32
0	0	0	0	1	0	1	0	10		14
1	0	0	0	1	0	1	0	138		−8
								1		6
								13		−4
								250		2
								107		−2
								224		0
								114		
								192		
								172		
								100		
								119		
								57		
								98		
								179		
								2		

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Address Class Identification

Address	Class
10.250.1.1	_A_
150.10.15.0	_B_
192.14.2.0	C
148.17.9.1	B
193.42.1.1	C
126.8.156.0	A
220.200.23.1	C
230.230.45.58	D
177.100.18.4	B
119.18.45.0	A
249.240.80.78	E
199.155.77.56	C
117.89.56.45	A
215.45.45.0	C
199.200.15.0	C
95.0.21.90	A
33.0.0.0	A
158.98.80.0	B
219.21.56.0	C

Network & Host Identification

Circle the network portion of these addresses:

(177.100.)18.4

(119.)18.45.0

(209.240.80.)78

(199.155.77.)56

(117.)89.56.45

(215.45.45.)0

(192.200.15.)0

(95.)0.21.90

(33.)0.0.0

(158.98.)80.0

(217.21.56.)0

(10.)250.1.1

(150.10.)15.0

(192.14.2.)0

(148.17.)9.1

(193.42.1.)1

(126.)8.156.0

(220.200.23.)1

Circle the host portion of these addresses:

10.(15.123.50)

171.2.(199.31)

198.125.87.(177)

223.250.200.(222)

17.(45.222.45)

126.(201.54.231)

191.41.(35.112)

155.25.(169.227)

192.15.155.(2)

123.(102.45.254)

148.17.(9.155)

100.(25.1.1)

195.0.21.(98)

25.(250.135.46)

171.102.(77.77)

55.(250.5.5)

218.155.230.(14)

10.(250.1.1)

Network Addresses

Using the IP address and subnet mask shown write out the network address:

IP address / Subnet mask	Network address
188.10.18.2 255.255.0.0	*188 . 10 . 0 . 0*
10.10.48.80 255.255.255.0	*10 . 10 . 48 . 0*
192.149.24.191 255.255.255.0	192.149.24.0
150.203.23.19 255.255.0.0	150.203.0.0
10.10.10.10 255.0.0.0	10.0.0.0
186.13.23.110 255.255.255.0	186.13.23.0
223.69.230.250 255.255.0.0	223.69.0.0
200.120.135.15 255.255.255.0	200.120.135.0
27.125.200.151 255.0.0.0	27.0.0.0
199.20.150.35 255.255.255.0	199.20.150.0
191.55.165.135 255.255.255.0	191.55.165.0
28.212.250.254 255.255.0.0	28.212.0.0

Host Addresses

Using the IP address and subnet mask shown write out the host address:

188.10.18.2
255.255.0.0
_____ *0 . 0 . 18 . 2* _____

10.10.48.80
255.255.255.0
_____ *0 . 0 . 0 . 80* _____

222.49.49.11
255.255.255.0
_____ 0.0.0.11 _____

128.23.230.19
255.255.0.0
_____ 0.0.230.19 _____

10.10.10.10
255.0.0.0
_____ 0.10.10.10 _____

200.113.123.11
255.255.255.0
_____ 0.0.0.11 _____

223.169.23.20
255.255.0.0
_____ 0.0.23.20 _____

203.20.35.215
255.255.255.0
_____ 0.0.0.215 _____

117.15.2.51
255.0.0.0
_____ 0.15.2.51 _____

199.120.15.135
255.255.255.0
_____ 0.0.0.135 _____

191.55.165.135
255.255.255.0
_____ 0.0.0.135 _____

48.21.25.54
255.255.0.0
_____ 0.0.25.54 _____

Default Subnet Masks

Write the correct default subnet mask for each of the following addresses:

177.100.18.4   _255 . 255 . 0 . 0_

119.18.45.0   _255 . 0 . 0 . 0_

191.249.234.191   _____

223.23.223.109   _____

10.10.250.1   _____

126.123.23.1   _____

223.69.230.250   _____

192.12.35.105   _____

77.251.200.51   _____

189.210.50.1   _____

88.45.65.35   _____

128.212.250.254   _____

193.100.77.83   _____

125.125.250.1   _____

1.1.10.50   _____

220.90.130.45   _____

134.125.34.9   _____

95.250.91.99   _____

ANDING With
Default subnet masks

Every IP address must be accompanied by a subnet mask. By now you should be able to look at an IP address and tell what class it is. Unfortunately your computer doesn't think that way. For your computer to determine the network and subnet portion of an IP address it must "AND" the IP address with the subnet mask.

Default Subnet Masks:

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

ANDING Equations:

1 AND 1 = 1
1 AND 0 = 0
0 AND 1 = 0
0 AND 0 = 0

Sample:

What you see...

IP Address:	192 . 100 . 10 . 33

What you can figure out in your head...

Address Class:	C
Network Portion:	**192 . 100 . 10** . 33
Host Portion:	192 . 100 . 10 . **33**

In order for you computer to get the same information it must AND the IP address with the subnet mask in binary.

	Network	Host	
IP Address:	1 1 0 0 0 0 0 0 . 0 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0 .	0 0 1 0 0 0 0 1	(192 . 100 . 10 . 33)
Default Subnet Mask:	1 1 1 1 1 1 1 1 . 0 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 .	0 0 0 0 0 0 0 0	(255 . 255 . 255 . 0)
AND:	1 1 0 0 0 0 0 0 . 0 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0 .	0 0 0 0 0 0 0 0	(192 . 100 . 10 . 0)

ANDING with the default subnet mask allows your computer to figure out the network portion of the address.

ANDING With
Custom subnet masks

When you take a single network such as 192.100.10.0 and divide it into five smaller networks (192.100.10.16, 192.100.10.32, 192.100.10.48, 192.100.10.64, 192.100.10.80) the outside world still sees the network as 192.100.10.0, but the internal computers and routers see five smaller subnetworks. Each independent of the other. This can only be accomplished by using a custom subnet mask. A custom subnet mask borrows bits from the host portion of the address to create a subnetwork address between the network and host portions of an IP address. In this example each range has 14 usable addresses in it. The computer must still AND the IP address against the custom subnet mask to see what the network portion is and which subnetwork it belongs to.

IP Address:	192 . 100 . 10 . 0
Custom Subnet Mask:	255.255.255.240

Address Ranges:
192.10.10.0 to 192.100.10.15
192.100.10.16 to 192.100.10.31
192.100.10.32 to 192.100.10.47   (Range in the sample below)
192.100.10.48 to 192.100.10.63
192.100.10.64 to 192.100.10.79
192.100.10.80 to 192.100.10.95
192.100.10.96 to 192.100.10.111
192.100.10.112 to 192.100.10.127
192.100.10.128 to 192.100.10.143
192.100.10.144 to 192.100.10.159
192.100.10.160 to 192.100.10.175
192.100.10.176 to 192.100.10.191
192.100.10.192 to 192.100.10.207
192.100.10.208 to 192.100.10.223
192.100.10.224 to 192.100.10.239
192.100.10.240 to 192.100.10.255

	Network	Sub Network	Host	
IP Address:	1 1 0 0 0 0 0 0 . 0 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0 .	0 0 1 0	0 0 0 1	(192 . 100 . 10 . 33)
Custom Subnet Mask:	1 1 1 1 1 1 1 1 . 0 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 .	1 1 1 1	0 0 0 0	(255 . 255 . 255 . 240)
AND:	1 1 0 0 0 0 0 0 . 0 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0 .	0 0 1 0	0 0 0 0	(192 . 100 . 10 . 32)

Four bits borrowed from the host portion of the address for the custom subnet mask.

The ANDING process of the four borrowed bits shows which range of IP addresses this particular address will fall into.

In the next set of problems you will determine the necessary information to determine the correct subnet mask for a variety of IP addresses.

How to determine the number of subnets and the number of hosts per subnet

Two formulas can provide this basic information:

Number of subnets = 2^s   (Second subnet formula: **Number of subnets = 2^s - 2**)

Number of hosts per subnet = 2^h - 2

Both formulas calculate the number of hosts or subnets based on the number of binary bits used. For example if you borrow three bits from the host portion of the address use the *number of subnets* formula to determine the total number of subnets gained by borrowing the three bits. This would be 2^3 or 2 x 2 x 2 = 8 subnets

To determine the number of hosts per subnet you would take the number of binary bits used in the host portion and apply this to the *number of hosts per subnet* formula If five bits are in the host portion of the address this would be 2^5 or 2 x 2 x 2 x 2 x 2 = 32 hosts.

When dealing with the *number of hosts per subnet* you have to subtract two addresses from the range. The first address in every range is the subnet number. The last address in every range is the broadcast address. These two addresses cannot be assigned to any device in the network which is why you have to subtract two addresses to find the number of usable addresses in each range.

For example if two bits are borrowed for the network portion of the address you can easily determine the number of subnets and hosts per subnets using the two formulas.

195 . 223 . 50 . 0 0 | 0 0 0 0 0 0

The number of subnets created by borrowing 2 bits is 2^2 or 2 x 2 = 4 subnets.	The number of hosts created by leaving 6 bits is 2^6 - 2 or 2 x 2 x 2 2 x 2 x 2 = 64 - 2 = 62 usable hosts per subnet.

What about that second subnet formula:

Number of subnets = 2^s - 2

In some instances the first and last subnet range of addresses are reserved. This is similar to the first and last host addresses in each range of addreses.

The first range of addresses is the ***zero subnet***. The subnet number for the *zero subnet* is also the subnet number for the classful subnet address.

The last range of addresses is the ***broadcast subnet***. The broadcast address for the last subnet in *the broadcast subnet* is the same as the classful broadcast address.

Class C Address unsubnetted:

195. 223 . 50 . 0

195.223.50.0 to 195.223.50.255

> Notice that the subnet and broadcast addresses match.

Class C Address subnetted (2 bits borrowed):

195. 223 . 50 . 0 0 | 0 0 0 0 0 0

(Invalid range) *(0)*	*195.223.50.0*	*to*	*195.223.50.63*
(1)	*195.223.50.64*	*to*	*195.223.50.127*
(2)	*195.223.50.128*	*to*	*195.223.50.191*
(Invalid range) *(3)*	*195.223.50.192*	*to*	*195.223.50.255*

The primary reason the the zero and broadcast subnets were not used had to do pirmarily with the broadcast addresses. If you send a broadcast to 195.223.255 are you sending it to all 255 addresses in the classful C address or just the 62 usable addresses in the broadcast range?

The **CCNA** and **CCENT** certification exams may have questions which will require you to determine which formula to use, and whehter or not you can use the first and last subnets. Use the chart below to help decide.

When to use which formula to determine the number of subnets	
Use the $2^S - 2$ formula and **don't use** the zero and broadcast ranges if...	Use the 2^S formula and **use** the zero and broadcast ranges if...
Classful routing is used	Classless routing or VLSM is used
RIP version 1 is used	RIP version 2, EIGRP, or OSPF is used
The *no ip subnet zero* command is configured on your router	The *ip subnet zero* command is configured on your router (default setting)
	No other clues are given

Bottom line for the CCNA exams; if a question does not give you any clues as to whether or not to allow these two subnets, assume you can use them.

This workbook has you use the number of subnets = 2^S formula.

Custom Subnet Masks

Problem 1

Number of needed subnets **14**
Number of needed usable hosts **14**
Network Address **192.10.10.0**

Address class _____*C*_____

Default subnet mask _____*255 . 255 . 255 . 0*_____

Custom subnet mask _____*255 . 255 . 255 . 240*_____

Total number of subnets _____*16*_____

Total number of host addresses _____*16*_____

Number of usable addresses _____*14*_____

Number of bits borrowed _____*4*_____

Show your work for Problem 1 in the space below.

	256	128	64	32	16	8	4	2	— Number of Hosts
Number of Subnets —	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	— Binary values

192 . 10 . 10 . 0 0 0 0 | 0 0 0 0

Add the binary value numbers to the left of the line to create the custom subnet mask.

128
64
32
+16
240

16
−2
14

Observe the total number of hosts.

Subtract 2 for the number of usable hosts.

Custom Subnet Masks

Problem 2

Number of needed subnets **1000**
Number of needed usable hosts **60**
Network Address **165.100.0.0**

Address class _____ *B* _____

Default subnet mask _____ *255 . 255 . 0 . 0* _____

Custom subnet mask _____ *255 . 255 . 255 . 192* _____

Total number of subnets _____ *1,024* _____

Total number of host addresses _____ *64* _____

Number of usable addresses _____ *62* _____

Number of bits borrowed _____ *10* _____

Show your work for Problem 2 in the space below.

Number of Hosts –	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	. 256	128	64	32	16	8	4	2
Number of Subnets –	2	4	8	16	32	64	128	256.	512	1024	2048	4,096	8,192	16,384	32,768	65,536
Binary values –	128	64	32	16	8	4	2	1 .	128	64	32	16	8	4	2	1
165 . 100 .0	0	0	0	0	0	0	0.	. 0	0	0	0	0	0	0	0

```
        128   128
         64  +64
         32  ----
         16   192
          8
          4
          2
         +1
        -----
        255
```

Add the binary value numbers to the left of the line to create the custom subnet mask.

```
 64
 -2
----
 62
```

Observe the total number of hosts.

Subtract 2 for the number of usable hosts.

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Custom Subnet Masks

Problem 3

Network Address **148.75.0.0 /26**

Address class _____B_____

Default subnet mask _____255 . 255 . 0 . 0_____

Custom subnet mask _____255 . 255 . 255 . 192_____

Total number of subnets _____1,024_____

Total number of host addresses _____64_____

Number of usable addresses _____62_____

Number of bits borrowed _____10_____

Show your work for Problem 3 in the space below.

Number of Hosts –	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	.	256	128	64	32	16	8	4	2
Number of Subnets –	2	4	8	16	32	64	128	256	.	512	1024	2048	4,096	8,192	16,384	32,768	65,536
Binary values –	128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1

148 . 75 . 0 0 0 0 0 0 0 0 . 0 0 | 0 0 0 0 0 0

Add the binary value numbers to the left of the line to create the custom subnet mask.

```
 128     128
  64    +64
  32    ───
  16     192
   8
   4
   2
  +1
 ───
 255
```

```
  64   Observe the total number of
  ~2   hosts.
 ───
  62   Subtract 2 for the number of
       usable hosts.
```

```
1024   Subtract 2 for the total number of
  ~2   subnets to get the usable number of
 ───   subnets.
1,022
```

14

Custom Subnet Masks

Problem 4

Number of needed subnets **6**
Number of needed usable hosts **30**
Network Address **210.100.56.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for <u>Problem 4</u> in the space below.

									Number of
	256	128	64	32	16	8	4	2	─ Hosts
Number of Subnets ─	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	─ Binary values

210 . 100 . 56 . 0 0 0 | 0 0 0 0 0

Custom Subnet Masks

Problem 5

Number of needed subnets **6**
Number of needed usable hosts **30**
Network Address **195.85.8.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 5 in the space below.

	256	128	64	32	16	8	4	2	— Number of Hosts
Number of Subnets —	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	— Binary values

195 . 85 . 8 . O O O | O O O O O

Custom Subnet Masks

Problem 6

Number of needed subnets **126**
Number of needed usable hosts **131,070**
Network Address **118.0.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 6 in the space below.

Number of Hosts	—	4,194,304	2,097,152	1,048,576	524,288	262,144	131,072	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	.	256	128	64	32	16	8	4	2
Number of Subnets	—	2	4	8	16	32	64	128	256	.	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536	.	131,072	262,144	524,288	1,048,576	2,097,152	4,194,304
Binary values	—	128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1

118. 0 0 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0

Custom Subnet Masks

Problem 7

Number of needed subnets **2000**
Number of needed usable hosts **15**
Network Address **178.100.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 7 in the space below.

Number of Hosts — 65,536 | 32,768 | 16,384 | 8,192 | 4,096 | 2,048 | 1,024 | 512 | . 256 128 64 32 16 8 4 2

Number of Subnets — 2 4 8 16 32 64 128 256 . 512 1024 2048 4,096 8,192 16,384 32,768 65,536

Binary values — 128 64 32 16 8 4 2 1 . 128 64 32 16 8 4 2 1

178 . 100 . 0 0 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0

Custom Subnet Masks

Problem 8

Number of needed subnets **3**
Number of needed usable hosts **45**
Network Address **200.175.14.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 8 in the space below.

Custom Subnet Masks

Problem 9

Number of needed subnets **60**
Number of needed usable hosts **1,000**
Network Address **128.77.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 9 in the space below.

Custom Subnet Masks

Problem 10

Number of needed usable hosts **60**

Network Address **198.100.10.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 10 in the space below.

Custom Subnet Masks

Problem 11

Number of needed subnets **250**

Network Address **101.0.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 11 in the space below.

Custom Subnet Masks

Problem 12

Number of needed subnets **5**

Network Address **218.35.50.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 12 in the space below.

Custom Subnet Masks

Problem 13

Number of needed usable hosts **25**

Network Address **218.35.50.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 13 in the space below.

Custom Subnet Masks

Problem 14

Number of needed subnets **10**

Network Address **172.59.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 14 in the space below.

Custom Subnet Masks

Problem 15

Number of needed usable hosts **50**

Network Address **172.59.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 15 in the space below.

Custom Subnet Masks

<u>Problem 16</u>

Number of needed usable hosts **29**

Network Address **23.0.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for <u>Problem 16</u> in the space below.

Subnetting

Problem 1

Number of needed subnets **14**
Number of needed usable hosts **14**
Network Address **192.10.10.0**

Address class _____*C*_____

Default subnet mask _____*255 . 255 . 255 . 0*_____

Custom subnet mask _____*255 . 255 . 255 . 240*_____

Total number of subnets _____*16*_____

Total number of host addresses _____*16*_____

Number of usable addresses _____*14*_____

Number of bits borrowed _____*4*_____

What is the 4th
subnet range? ___*192.10.10.48 to 192.10.10.63*___

What is the subnet number
for the 8th subnet? ___*192 . 10 . 10 . 112*___

What is the subnet
broadcast address for
the 13th subnet? ___*192 . 10 . 10 . 207*___

What are the assignable
addresses for the 9th
subnet? ___*192.10.10.129 to 192.10.10.142*___

Show your work for <u>Problem 1</u> in the space below.

	256	128	64	32	16	8	4	2	−	Number of Hosts
Number of Subnets	−	**2**	**4**	**8**	**16**	32	64	128	256	
		128	64	32	16	8	4	2	1	− Binary values

192. 10 . 10 . 0   0   0   0 | 0   0   0   0

(0)	0	0	0	0	192.10.10.0	to	192.10.10.15
(1)	0	0	0	1	192.10.10.16	to	192.10.10.31
(2)	0	0	1	0	192.10.10.32	to	192.10.10.47
(3)	0	0	1	1	192.10.10.48	to	192.10.10.63
(4)	0	1	0	0	192.10.10.64	to	192.10.10.79
(5)	0	1	0	1	192.10.10.80	to	192.10.10.95
(6)	0	1	1	0	192.10.10.96	to	192.10.10.111
(7)	0	1	1	1	192.10.10.112	to	192.10.10.127
(8)	1	0	0	0	192.10.10.128	to	192.10.10.143
(9)	1	0	0	1	192.10.10.144	to	192.10.10.159
(10)	1	0	1	0	192.10.10.160	to	192.10.10.175
(11)	1	0	1	1	192.10.10.176	to	192.10.10.191
(12)	1	1	0	0	192.10.10.192	to	192.10.10.207
(13)	1	1	0	1	192.10.10.208	to	192.10.10.223
(14)	1	1	1	0	192.10.10.224	to	192.10.10.239
(15)	1	1	1	1	192.10.10.240	to	192.10.10.255

Custom subnet mask
```
  128
   64
   32
 + 16
 ----
  240
```

Usable subnets
```
   16
  − 2
 ----
   14
```

Usable hosts
```
   16
  − 2
 ----
   14
```

The binary value of the last bit borrowed is the range. In this problem the range is 16.

The first address in each subnet range is the subnet number.

The last address in each subnet range is the subnet broadcast address.

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Subnetting

Problem 2

Number of needed subnets **1000**
Number of needed usable hosts **60**
Network Address **165.100.0.0**

Address class _____*B*_____

Default subnet mask _____*255 . 255 . 0 . 0*_____

Custom subnet mask _____*255 . 255 . 255 . 192*_____

Total number of subnets _____*1,024*_____

Total number of host addresses _____*64*_____

Number of usable addresses _____*62*_____

Number of bits borrowed _____*10*_____

What is the 15th
subnet range? _____*165.100.3.128 to 165.100.3.191*_____

What is the subnet number
for the 6th subnet? _____*165 . 100 . 1 . 64*_____

What is the subnet
broadcast address for
the 6th subnet? _____*165 . 100 . 1 . 127*_____

What are the assignable
addresses for the 9th
subnet? _____*165.100.2.1 to 165.100.0.62*_____

Number of Hosts ~ 512 1,024 2,048 4,096 8,192 16,384 32,768 65,536

Number of Subnets ~ 128 64 32 16 8 4 2

Binary values ~ 128 64 32 16 8 4 2 1 . 128 64 32 16 8 4 2 1 . 128 64 32 16 8 4 2 1 . 128 64 32 16 8 4 2 1

165 . 100 . 0 0 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0 . 0 0 . 0 . 0 0 . 0 0 0 0

Number of Hosts ~ 256 128 . 512 1024 2048 4096 8192 16,384 32,768 65,536

Usable hosts:
64
~2
62

Custom subnet mask:
128
+64
192
+1
255

```
 64  128
```

(0) 165.100.0.0   to 165.100.0.63
(1) 165.100.0.64 to 165.100.0.127
(2) 165.100.0.128 to 165.100.0.191
(3) 165.100.0.192 to 165.100.0.255
(4) 165.100.1.0   to 165.100.1.63
(5) 165.100.1.64 to 165.100.1.127
(6) 165.100.1.128 to 165.100.1.191
(7) 165.100.1.192 to 165.100.1.255
(8) 165.100.2.0   to 165.100.2.63
(9) 165.100.2.64 to 165.100.2.127
(10) 165.100.2.128 to 165.100.2.191
(11) 165.100.2.192 to 165.100.2.255
(12) 165.100.3.0   to 165.100.3.63
(13) 165.100.3.64 to 165.100.3.127
(14) 165.100.3.128 to 165.100.3.191
(15) 165.100.3.192 to 165.100.3.255

Down to

(1022) 165.100.255.128 to 165.100.255.191
(1023) 165.100.255.192 to 165.100.255.255

The binary value of the last bit borrowed is the range. In this problem the range is 64.

The first address in each subnet range is the subnet number.

The last address in each subnet range is the subnet broadcast address.

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Subnetting

Problem 3

Number of needed subnets **2**

Network Address **195.223.50.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 3rd
subnet range? _____

What is the subnet number
for the 2nd subnet? _____

What is the subnet
broadcast address for
the 1st subnet? _____

What are the assignable
addresses for the 3rd
subnet? _____

Show your work for <u>Problem 3</u> in the space below.

		256	128	64	32	16	8	4	2	–	Number of Hosts
Number of Subnets	–	2	4	8	16	32	64	128	256		
		128	64	32	16	8	4	2	1	–	Binary values

195 . 223 . 50 . 0   0 | 0   0   0   0   0   0

Subnetting

Problem 4

Number of needed subnets **750**

Network Address **190.35.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 15th
subnet range? _____

What is the subnet number
for the 13th subnet?

_____

What is the subnet
broadcast address for
the 10th subnet?

_____

What are the assignable
addresses for the 6th
subnet?

_____

Show your work for <u>Problem 4</u> in the space below.

Subnetting

Problem 5

Number of needed usable hosts **6**

Network Address **126.0.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 2nd
subnet range? _____

What is the subnet number
for the 5th subnet? _____

What is the subnet
broadcast address for
the 7th subnet? _____

What are the assignable
addresses for the 10th
subnet? _____

Show your work for <u>Problem 5</u> in the space below.

Subnetting

Problem 6

Number of needed subnets **10**

Network Address **192.70.10.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 9th
subnet range? _____

What is the subnet number
for the 4th subnet? _____

What is the subnet
broadcast address for
the 12th subnet? _____

What are the assignable
addresses for the 10th
subnet? _____

Show your work for <u>Problem 6</u> in the space below.

Subnetting

Problem 7

Network Address **10.0.0.0 /16**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 11th
subnet range? _____

What is the subnet number
for the 6th subnet? _____

What is the subnet
broadcast address for
the 2nd subnet? _____

What are the assignable
addresses for the 9th
subnet? _____

Show your work for <u>Problem 7</u> in the space below.

Subnetting

Problem 8

Number of needed subnets **5**
Network Address **172.50.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 4th
subnet range? _____

What is the subnet number
for the 5th subnet? _____

What is the subnet
broadcast address for
the 6th subnet? _____

What are the assignable
addresses for the 3rd
subnet? _____

Show your work for <u>Problem 8</u> in the space below.

Subnetting

Problem 9

Number of needed usable hosts **28**

Network Address **172.50.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 2nd
subnet range? _____

What is the subnet number
for the 10th subnet? _____

What is the subnet broadcast
address for
the 4th subnet? _____

What are the assignable
addresses for the 6th
subnet? _____

Show your work for <u>Problem 9</u> in the space below.

Subnetting

Problem 10

Number of needed subnets **45**

Network Address **220.100.100.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 5th
subnet range? _____

What is the subnet number
for the 4th subnet? _____

What is the subnet
broadcast address for
the 13th subnet? _____

What are the assignable
addresses for the 12th
subnet? _____

Show your work for <u>Problem 10</u> in the space below.

Subnetting

Problem 11

Number of needed usable hosts **8,000**

Network Address **135.70.0.0**

Address class __Class B__

Default subnet mask __255.255.0.0__

Custom subnet mask __255.255.224.0__

Total number of subnets __8__

Total number of host addresses __8,192__

Number of usable addresses __8,190__

Number of bits borrowed __3__

What is the 6th subnet range? __135.70.160.0 – 135.70.191.255__

What is the subnet number for the 7th subnet? __135.70.192.0__

What is the subnet broadcast address for the 3rd subnet? __135.70.95.255__

What are the assignable addresses for the 5th subnet? __135.70.128.1 – 135.70.159.254__

Show your work for <u>Problem 11</u> in the space below.

Subnetting

Problem 12

Number of needed usable hosts **45**

Network Address **198.125.50.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 2nd
subnet range? _____

What is the subnet number
for the 2nd subnet? _____

What is the subnet
broadcast address for
the 4th subnet? _____

What are the assignable
addresses for the 3rd
subnet? _____

Show your work for <u>Problem 12</u> in the space below.

Subnetting

Problem 13

Network Address **165.200.0.0 /26**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 10th
subnet range? _____

What is the subnet number
for the 11th subnet? _____

What is the subnet
broadcast address for
the 1023rd subnet? _____

What are the assignable
addresses for the 1022nd
subnet? _____

Show your work for <u>Problem 13</u> in the space below.

Subnetting

Problem 14

Number of needed usable hosts **16**

Network Address **200.10.10.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 7th
subnet range? _____

What is the subnet number
for the 5th subnet? _____

What is the subnet
broadcast address for
the 4th subnet? _____

What are the assignable
addresses for the 6th
subnet? _____

Show your work for <u>Problem 14</u> in the space below.

Subnetting

Problem 15

Network Address **93.0.0.0 \19**

Address class __Class A__

Default subnet mask __255.0.0.0__

Custom subnet mask __255.255.224.0__

Total number of subnets __2048__

Total number of host addresses __8192__

Number of usable addresses __8190__

Number of bits borrowed __11__

What is the 15th subnet range? __93.1.192.0 – 93.1.223.255__

What is the subnet number for the 9th subnet? __93.1.0.0__

What is the subnet broadcast address for the 7th subnet? __93.0.223.255__

What are the assignable addresses for the 12th subnet? __93.1.96.1 – 93.1.127.254__

Show your work for <u>Problem 15</u> in the space below.

Practical Subnetting 1

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of subnets**, and allow enough extra subnets and hosts for 100% growth in both areas. Circle each subnet on the graphic and answer the questions below.

IP Address 172.16.0.0
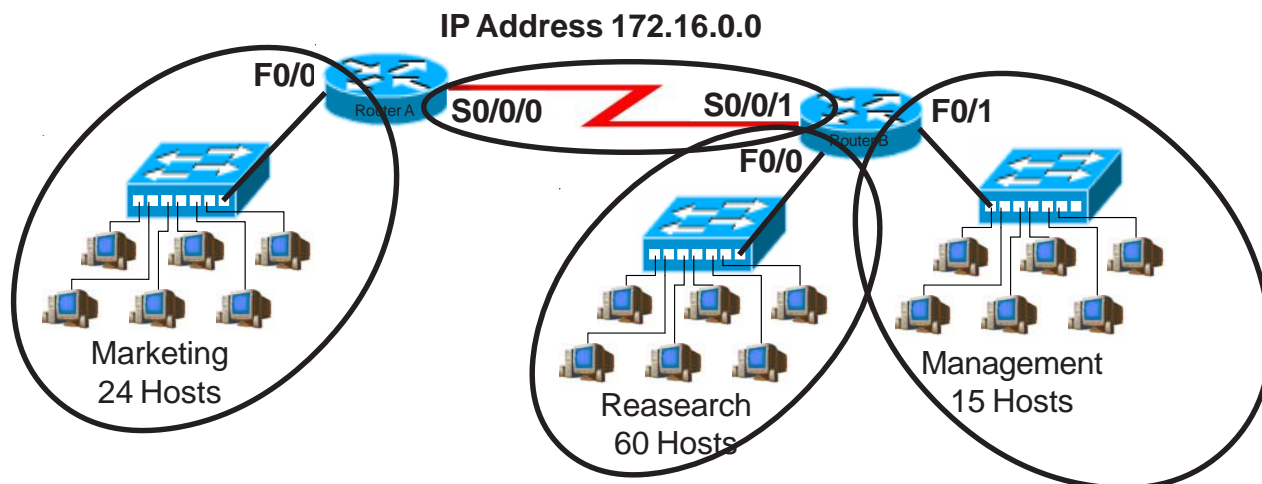
Address class _____ B _____

Custom subnet mask _____ 255.255.224.0 _____

Minimum number of subnets needed _____ 4 _____

Extra subnets required for 100% growth **+** _____ 4 _____
(Round up to the next whole number)

Total number of subnets needed **=** _____ 8 _____

Number of host addresses in the largest subnet group _____ 60 _____

Number of addresses needed for 100% growth in the largest subnet **+** _____ 60 _____
(Round up to the next whole number)

Total number of address needed for the largest subnet **=** _____ 120 _____

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Research ___172.16.0.0 to 172.31.255___

IP address range for Marketing ___172.16.32.0 to 172.63.255___

IP address range for Management ___172.16.64.0 to 172.95.255___

IP address range for Router A to Router B serial connection ___172.16.96.0 to 172.127.255___

Show your work for Practical Subnetting 1 in the space below.

Number of Hosts ~ 512 — 1,024 — 2,048 — 4,096 — 8,192 — 16,384 — 32,768 — 65,536

Number of Subnets ~ 256 128 64 32 16 8 4 2

.256 128 64 32 16 8 4 2 1 . 512 1024 2048 4096 8,192 16,384 32,768 65,536

Binary values ~ 128 64 32 16 8 4 2 1 . 128 256.

172 . 16 . 0 . 0 . 0 0 0 0 . 0 0 0 0 . 0 0 0 0 0

			172.16.0.0	to	172.16.31.255
(0)	0		172.16.0.0	to	172.16.31.255
(1)	1		172.16.32.0	to	172.16.63.255
(2)	0 1		172.16.64.0	to	172.16.95.255
(3)	0 1 1		172.16.96.0	to	172.16.127.255
(4)	1 0 0		172.16.128.0	to	172.16.159.255
(5)	1 0 1		172.16.160.0	to	172.16.191.255
(6)	1 1 0		172.16.192.0	to	172.16.223.255
(7)	1 1 1		172.16.224.0	to	172.16.255.255

$$\begin{array}{r} 4 \\ \times\ 1.0 \\ \hline 4 \end{array}$$

$$\begin{array}{r} 60 \\ \times\ 1.0 \\ \hline 60 \end{array}$$

Practical Subnetting 2

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 30% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 135.126.0.0

Address class _____B_____

Custom subnet mask _____255.255.255.224_____

Minimum number of subnets needed ____5____

Extra subnets required for 30% growth + ____2____
(Round up to the next whole number)

Total number of subnets needed = ____7____

Number of host addresses
in the largest subnet group ____20____

Number of addresses needed for
30% growth in the largest subnet + ____6____
(Round up to the next whole number)

Total number of address
needed for the largest subnet = ____26____

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Tech Ed _135.126.0.0 to 135.126.0.31_

IP address range for English _135.126.0.32 to 135.126.0.63_

IP address range for Science _135.126.0.64 to 135.126.0.95_

IP address range for Router A
to Router B serial connection _135.126.0.96 to 135.126.0.127_

IP address range for Router A
to Router B serial connection _135.126.0.128 to 135.126.0.159_

Number of Hosts ~

| 65,536 | 32,768 | 16,384 | 8,192 | 4,096 | 2048 | 1024 | 512 |
| 2 | 4 | 8 | 16 | 32 | 64 | 128 | 256 |

| 512 | 1,024 | 2,048 | 4,096 | 8,192 | 16,384 | 32,768 | 65,536 |

Number of Subnets ~

| 128 | 256. | 2 | 64 | 4 | 32 | 8 | 16 | 16 | 8 | 32 | 4 | 64 | 2 | 128 |

Binary values ~ 128 64 32 16 8 4 2 1 . 128 64 32 16 8 4 2 1 . 256 128 64 32 16 8 4 2 1

135.126. 0 0 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0 . 0 0 0

(0) 135.126.0.0 to 135.126.0.31
(1) 135.126.0.32 to 135.126.0.63
(2) 135.126.0.64 to 135.126.0.95
(3) 135.126.0.96 to 135.126.0.127
(4) 135.126.0.128 to 135.126.0.159
(5) 135.126.0.160 to 135.126.0.191
(6) 135.126.0.192 to 135.126.0.223
(7) 135.126.0.224 to 135.126.0.255
(8) 135.126.1.0 to 135.126.1.31
(9) 135.126.1.32 to 135.126.1.63
(10) 135.126.1.64 to 135.126.1.95
(11) 135.126.1.96 to 135.126.1.127
(12) 135.126.1.128 to 135.126.1.159
(13) 135.126.1.160 to 135.126.1.191
(14) 135.126.1.192 to 135.126.1.223
(15) 135.126.1.224 to 135.126.1.255
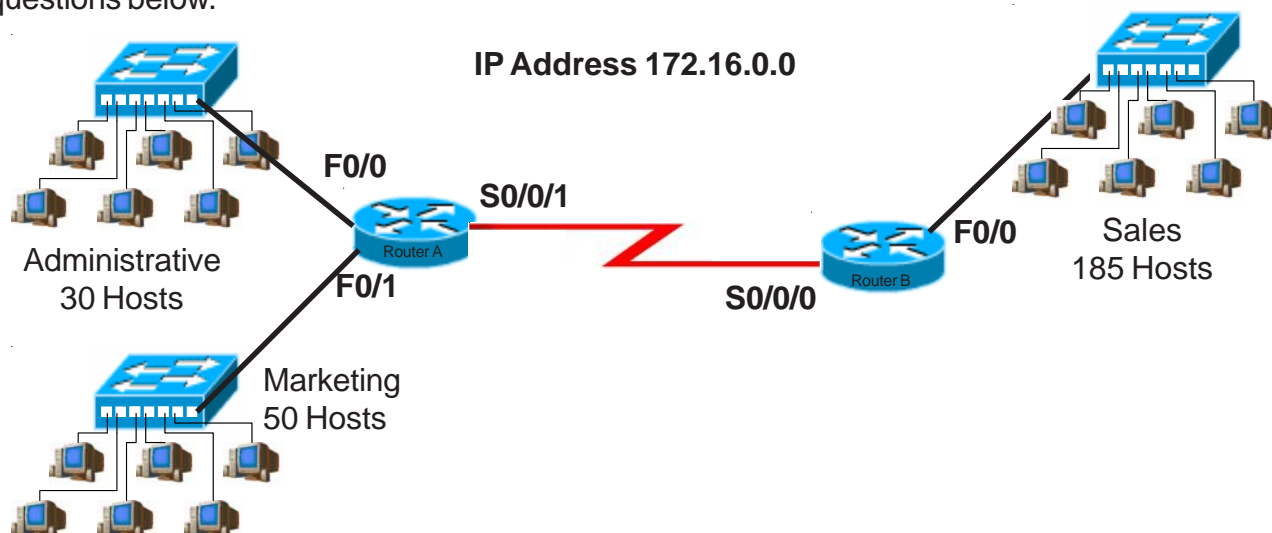
$$\begin{array}{r} 5 \\ \times\,3 \\ \hline 1.5 \end{array}$$
(Round up to 2)

$$\begin{array}{r} 20 \\ \times\,3 \\ \hline 6 \end{array}$$

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Practical Subnetting 3

Based on the information in the graphic shown, design a classfull network addressing scheme that will supply the **minimum number of hosts per subne**t, and allow enough extra subnets and hosts for 25% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 172.16.0.0

F0/0

S0/0/1

Router A

Administrative
30 Hosts

F0/1

S0/0/0

Router B

F0/0

Sales
185 Hosts

Marketing
50 Hosts

Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 25% growth **+**_____
(Round up to the next whole number)

Total number of subnets needed **=**_____

Number of host addresses
in the largest subnet group _____

Number of addresses needed for
25% growth in the largest subnet **+**_____
(Round up to the next whole number)

Total number of address
needed for the largest subnet **=**_____

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Sales _____

IP address range for Marketing _____

IP address range for Administrative _____

IP address range for Router A
to Router B serial connection _____

Show your work for <u>Problem 3</u> in the space below.

Practical Subnetting 4

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of subnets**, and allow enough extra subnets and hosts for 70% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 135.126.0.0

Dallas
150 Hosts

Washington D.C.
220 Hosts

New York
325 Hosts

Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 70% growth $+$_____
(Round up to the next whole number)

Total number of subnets needed $=$_____

Number of host addresses
in the largest subnet group _____

Number of addresses needed for
70% growth in the largest subnet $+$_____
(Round up to the next whole number)

Total number of address
needed for the largest subnet $=$_____

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for New York _____

IP address range for Washington D. C. _____
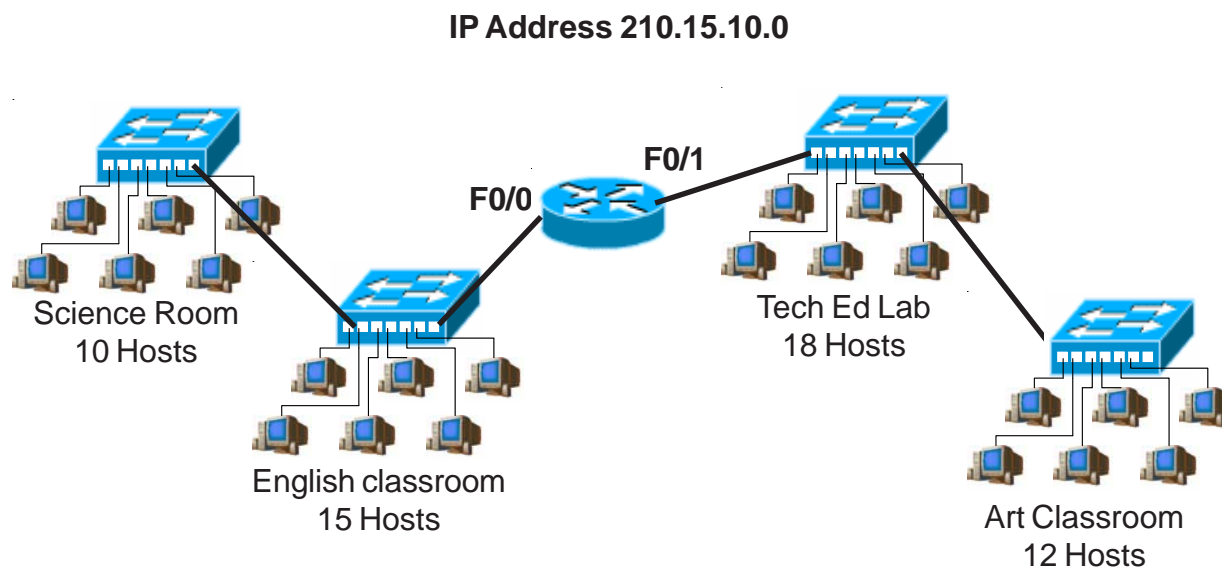
IP address range for Dallas _____

IP address range for Router A
to Router B serial connection _____

IP address range for Router A
to Router C serial connection _____

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Show your work for <u>Problem 4</u> in the space below.

Practical Subnetting 5

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 100% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 210.15.10.0

Science Room
10 Hosts

English classroom
15 Hosts

F0/1

F0/0

Tech Ed Lab
18 Hosts

Art Classroom
12 Hosts

Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 100% growth +_____
(Round up to the next whole number)

Total number of subnets needed =_____

Number of host addresses
in the largest subnet group _____

Number of addresses needed for
100% growth in the largest subnet +_____
(Round up to the next whole number)

Total number of address
needed for the largest subnet =_____

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Router F0/0 Port _____

IP address range for Router F0/1 Port _____

Show your work for <u>Problem 5</u> in the space below.

Practical Subnetting 6

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of subnets**, and allow enough extra subnets and hosts for 20% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 10.0.0.0

Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 20% growth **+**_____
(Round up to the next whole number)

Total number of subnets needed **=**_____

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Technology _____

IP address range for Science _____

IP address range for Arts & Drama _____

IP Address range Administration _____

IP address range for Router A
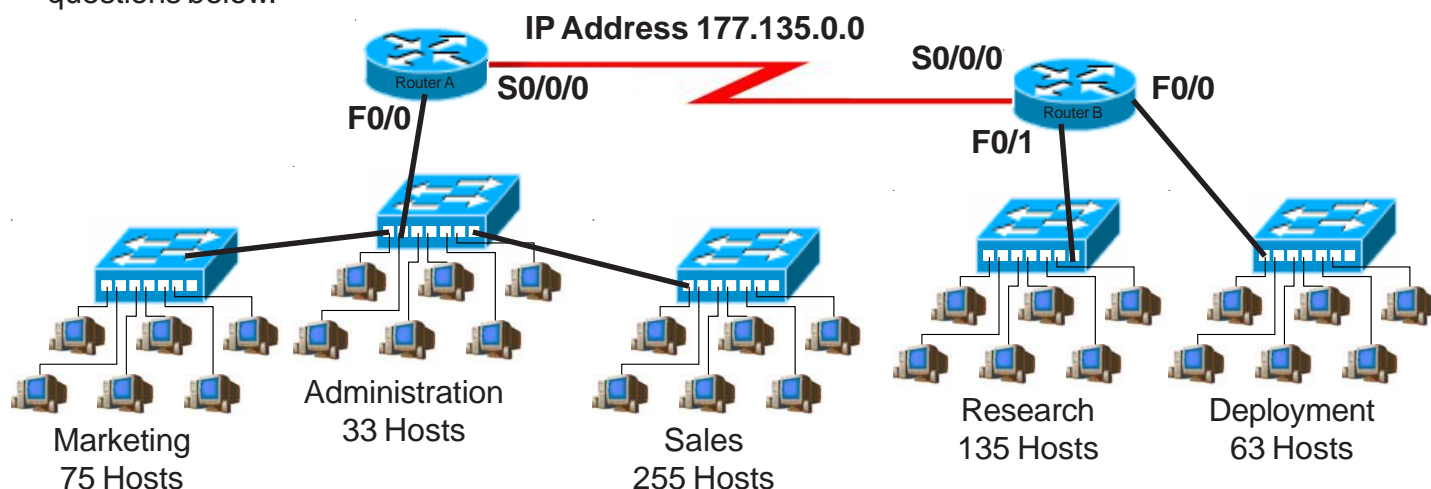to Router B serial connection _____

IP address range for Router A
to Router C serial connection _____

IP address range for Router B
to Router C serial connection _____

Show your work for <u>Problem 6</u> in the space below.

Practical Subnetting 7

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subne**t, and allow enough extra subnets and hosts for 125% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 177.135.0.0

S0/0/0

Router A

F0/0   S0/0/0

Router B

F0/0

F0/1

Marketing
75 Hosts

Administration
33 Hosts

Sales
255 Hosts

Research
135 Hosts

Deployment
63 Hosts

Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 125% growth $+$_____
(Round up to the next whole number)

Total number of subnets needed $=$_____

Number of host addresses
in the largest subnet group _____

Number of addresses needed for
125% growth in the largest subnet $+$_____
(Round up to the next whole number)

Total number of address
needed for the largest subnet $=$_____

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Router A Port F0/0 _____
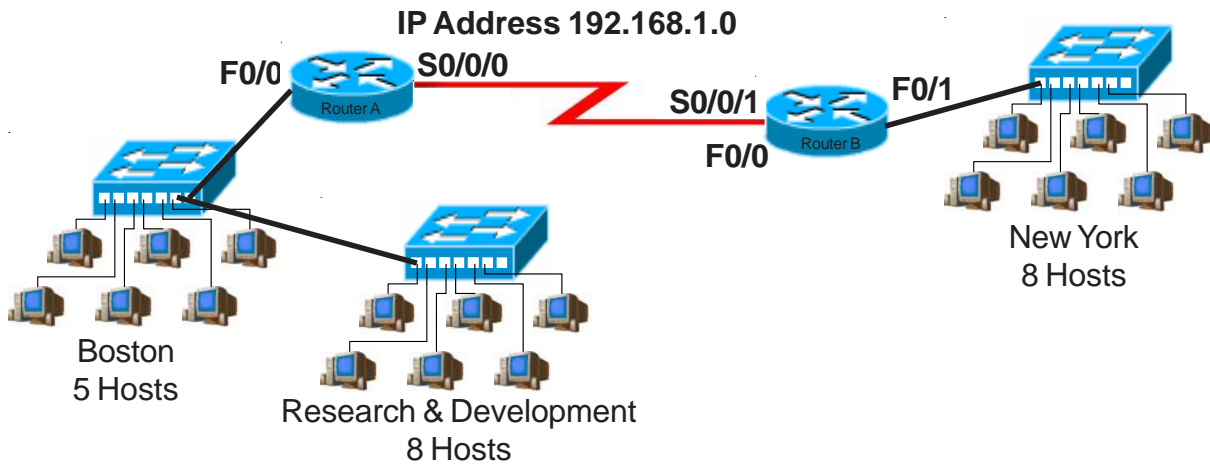
IP address range for Research _____

IP address range for Deployment _____

IP address range for Router A
to Router B serial connection _____

Show your work for <u>Problem 7</u> in the space below.

Practical Subnetting 8

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number subnets**, and allow enough extra subnets and hosts for 85% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 192.168.1.0

F0/0   Router A   S0/0/0

S0/0/1   Router B   F0/1

F0/0

New York
8 Hosts

Boston
5 Hosts

Research & Development
8 Hosts

Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 85% growth **+**_____
(Round up to the next whole number)

Total number of subnets needed **=**_____

Number of host addresses
in the largest subnet group _____

Number of addresses needed for
85% growth in the largest subnet **+**_____
(Round up to the next whole number)

Total number of address
needed for the largest subnet **=**_____

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Router A F0/0 _____

IP address range for New York _____

IP address range for Router A
to Router B serial connection _____

Show your work for <u>Problem 8</u> in the space below.

Practical Subnetting 9

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 15% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 148.55.0.0

Ft. Worth
2300 Hosts

Dallas
1500 Hosts

Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 15% growth **+** _____
(Round up to the next whole number)

Total number of subnets needed **=** _____

Number of host addresses
in the largest subnet group _____

Number of addresses needed for
15% growth in the largest subnet **+** _____
(Round up to the next whole number)

Total number of address
needed for the largest subnet **=** _____

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Ft. Worth _____

IP address range for Dallas _____

IP address range for Router A
to Router B serial connection _____

IP address range for Router A
to Router C serial connection _____

IP address range for Router C
to Router D serial connection _____

Show your work for <u>Problem 9</u> in the space below.

Practical Subnetting 10

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of subnets**, and allow enough extra subnets and hosts for 110% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 172.16.0.0

Sales
115 Hosts

Marketing
56 Hosts

F0/0

S0/0/0

F0/0

F0/0

S0/0/1

Router A

Router B

F0/1

Management
25 Hosts

Research
35 Hosts

Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 110% growth $+$_____
(Round up to the next whole number)

Total number of subnets needed $=$_____

Number of host addresses
in the largest subnet group _____

Number of addresses needed for
110% growth in the largest subnet $+$_____
(Round up to the next whole number)

Total number of address
needed for the largest subnet $=$_____

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for Sales/Managemnt _____

IP address range for Marketing _____

IP address range for Research _____

IP address range for Router A
to Router B serial connection _____

Show your work for <u>Problem 10</u> in the space below.

Valid and Non-Valid IP Addresses

Using the material in this workbook identify which of the addresses below are correct and usable. If they are not usable addresses explain why.

IP Address: 0.230.190.192
Subnet Mask: 255.0.0.0
Reference Page Inside Front Cover

The network ID cannot be 0.
_____

IP Address: 192.10.10.1
Subnet Mask: 255.255.255.0
Reference Pages 28-29

_OK_____
_____

IP Address: 245.150.190.10
Subnet Mask: 255.255.255.0
Reference Page Inside Front Cover

_____
_____

IP Address: 135.70.191.255
Subnet Mask: 255.255.254.0
Reference Pages 48-49

_____
_____

IP Address: 127.100.100.10
Subnet Mask: 255.0.0.0
Reference Pages Inside Front Cover

_____
_____

IP Address: 93.0.128.1
Subnet Mask: 255.255.224.0
Reference Pages 56-57

_____
_____

IP Address: 200.10.10.128
Subnet Mask: 255.255.255.224
Reference Pages 54-55

_____
_____

IP Address: 165.100.255.189
Subnet Mask: 255.255.255.192
Reference Pages 30-31

_____
_____

IP Address: 190.35.0.10
Subnet Mask: 255.255.255.192
Reference Pages 34-35

_____
_____

IP Address: 218.35.50.195
Subnet Mask: 255.255.0.0
Reference Page Inside Front Cover

_____
_____

IP Address: 200.10.10.175 /22
Reference Pages 54-55 and/or Inside Front Cover

_____
_____

IP Address: 135.70.255.255
Subnet Mask: 255.255.224.0
Reference Pages 48-49

_____
_____

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IP Address Breakdown

/24 (8+8+8) 255.255.255.0 256 Hosts	/25 (8+8+8+1) 255.255.255.128 128 Hosts	/26 (8+8+8+2) 255.255.255.192 64 Hosts	/27 (8+8+8+3) 255.255.255.224 32 Hosts	/28 (8+8+8+4) 255.255.255.240 16 Hosts	/29 (8+8+8+5) 255.255.255.248 8 Hosts	/30 (8+8+8+6) 255.255.255.252 4 Hosts
0-255	0-127	0-63		0-15	0-7	0-3
						4-7
					8-15	8-11
						12-15
				16-31	16-23	16-19
						20-23
					24-31	24-27
						28-31
				32-47	32-39	32-35
						36-39
					40-47	40-43
						44-47
				48-63	48-55	48-51
						52-55
					56-63	56-59
						60-63
		64-127		64-79	64-71	64-67
						68-71
					72-79	72-75
						76-79
				80-95	80-87	80-83
						84-87
					88-95	88-91
						92-95
				96-111	96-103	96-99
						100-103
					104-111	104-107
						108-111
				112-127	112-119	112-115
						116-119
					120-127	120-123
						124-127
	128-255	128-191		128-143	128-135	128-131
						132-135
					136-143	136-139
						140-143
				144-159	144-151	144-147
						148-151
					152-159	152-155
						156-159
				160-175	16-167	160-163
						164-167
					168-175	168-171
						172-175
				176-191	176-183	176-179
						180-183
					184-191	184-187
						188-191
		192-255		192-207	192-199	192-195
						196-199
					200-207	200-203
						204-207
				208-223	208-215	208-211
						212-215
					216-223	216-219
						220-223
				224-239	224-231	224-227
						228-231
					232-239	232-235
						236-239
				240-255	240-247	240-243
						244-247
					248-255	248-251
						252-255

Visualizing Subnets Using
The Box Method

The box method is the simplest way to visualize the breakdown of subnets and addresses into smaller sizes.
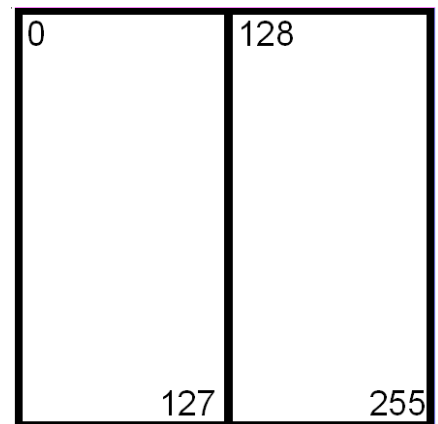
Start with a square. The whole square is a single subnet comprised of 256 addresses.
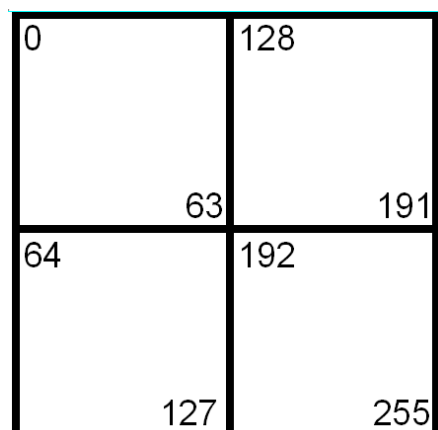
/24
255.255.255.0
256 Hosts
1 Subnet

Split the box in half and you get two subnets with 128 addresses,

/25
255.255.255.128
128 Hosts
2 Subnets

Divide the box into quarters and you get four subnets with 64 addresses,

/26
255.255.255.192
64 Hosts
4 Subnets

Split each individual square and you get eight subnets with 32 addresses,

/27
255.255.255.224
32 Hosts
8 Subnets

0	32	128	160
31	63	159	191
64	96	192	224
95	127	223	255

Split the boxes in half again and you get sixteen subnets with sixteen addresses,

/28
255.255.255.240
16 Hosts
16 Subnets

0	32	128	160
15	47	143	175
16	48	144	176
31	63	159	191
64	96	192	224
79	111	207	239
80	112	208	240
95	127	223	255

The next split gives you thirty two subnets with eight addresses,

/29
255.255.255.248
8 Hosts
32 Subnets

0	8	32	40	128	136	160	168
7	15	39	47	135	143	167	175
16	24	48	56	144	152	176	184
23	31	55	63	151	159	183	191
64	72	96	104	192	200	224	232
71	79	103	111	199	207	321	239
80	88	112	120	208	216	240	248
87	95	119	127	215	223	247	255

The last split gives sixty four subnets with four addresses each,

/30
255.255.255.252
4 Hosts
64 Subnets

0	8	32	40	128	136	160	168
3	11	35	43	131	139	163	171
4	12	36	44	132	140	164	172
7	15	39	47	135	143	167	175
16	24	48	56	144	152	176	184
19	27	51	59	147	155	179	187
20	28	52	60	148	156	180	188
23	31	55	63	151	159	183	191
64	72	96	104	192	200	224	232
67	75	99	107	195	203	227	235
68	76	100	108	196	204	228	236
71	79	103	111	199	207	321	239
80	88	112	120	208	216	240	248
83	91	115	123	211	219	243	251
84	92	116	124	212	220	244	252
87	95	119	127	215	223	247	255

Class A Addressing Guide

CIDR	# of Bits Borrowed	Subnet Mask	Total # of Subnets	Total # of Hosts	Usable # of Hosts
/8	0	255.0.0.0	1	16,777,216	16,777,214
/9	1	255.128.0.0	2	8,388,608	8,388,606
/10	2	255.192.0.0	4	4,194,304	4,194,302
/11	3	255.224.0.0	8	2,097,152	2,097,150
/12	4	255.240.0.0	16	1,048,576	1,048,574
/13	5	255.248.0.0	32	524,288	524,286
/14	6	255.252.0.0	64	262,144	262,142
/15	7	255.254.0.0	128	131,072	131,070
/16	8	255.255.0.0	256	65,536	65,534
/17	9	255.255.128.0	512	32,768	32,766
/18	10	255.255.192.0	1,024	16,384	16,382
/19	11	255.255.224.0	2,048	8,192	8,190
/20	12	255.255.240.0	4,096	4,096	4,094
/21	13	255.255.248.0	8,192	2,048	2,046
/22	14	255.255.252.0	16,384	1,024	1,022
/23	15	255.255.254.0	32,768	512	510
/24	16	255.255.255.0	65,536	256	254
/25	17	255.255.255.128	131,072	128	126
/26	18	255.255.255.192	262,144	64	62
/27	19	255.255.255.224	524,288	32	30
/28	20	255.255.255.240	1,048,576	16	14
/29	21	255.255.255.248	2,097,152	8	6
/30	22	255.255.255.252	4,194,304	4	2

Class B Addressing Guide

CIDR	# of Bits Borrowed	Subnet Mask	Total # of Subnets	Total # of Hosts	Usable # of Hosts
/16	0	255.255.0.0	1	65,536	65,534
/17	1	255.255.128.0	2	32,768	32,766
/18	2	255.255.192.0	4	16,384	16,382
/19	3	255.255.224.0	8	8,192	8,190
/20	4	255.255.240.0	16	4,096	4,094
/21	5	255.255.248.0	32	2,048	2,046
/22	6	255.255.252.0	64	1,024	1,022
/23	7	255.255.254.0	128	512	510
/24	8	255.255.255.0	256	256	254
/25	9	255.255.255.128	512	128	126
/26	10	255.255.255.192	1,024	64	62
/27	11	255.255.255.224	2,048	32	30
/28	12	255.255.255.240	4,096	16	14
/29	13	255.255.255.248	8,192	8	6
/30	14	255.255.255.252	16,384	4	2

Class C Addressing Guide

CIDR	# of Bits Borrowed	Subnet Mask	Total # of Subnets	Total # of Hosts	Usable # of Hosts
/24	0	255.255.255.0	1	256	254
/25	1	255.255.255.128	2	128	126
/26	2	255.255.255.192	4	64	62
/27	3	255.255.255.224	8	32	30
/28	4	255.255.255.240	16	16	14
/29	5	255.255.255.248	32	8	6
/30	6	255.255.255.252	64	4	2