1010100

10011000

10001111100

1011100101011100

101100011101001

1011110100011010

00001010010110010

1001010101100111

1111010101000101

1101001101010011

001010010101010

1010101000110010

010101001011000

110101100011010

11010100001011

001010100110

1001010010

**IP Addressing**

**and Subnetting**

# Workbook

**Version 2.0**

11111110

101

001

10010101

00011011

11010011

Student Name:

10000110

Irvin Jair

Carrillo Beltran

### 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 |

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and to everyone who has sent in suggestions to improve the series.

**Workbooks included in the series:**

IP Addressing and Subnetting Workbooks ACLs - Access Lists Workbooks

VLSM Variable-Length Subnet Mask Workbooks

Inside Cover

## Binary To Decimal Conversion

*146 4*

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **128** | **64** | **32** | **16** | **8** | **4** | **2** | **1** | **Answers** | **Scratch Area** |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | *146* | *128 64*  *16 32* |
| 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | *119* | *2 16* |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 256 | *2* |
| 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |  | *1*  *119* |
| 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 246 |  |
| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 19 |  |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 129 |  |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 49 |  |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 120 |  |
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 240 |  |
| 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 59 |  |
| 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 7 |  |

197

27

00011011

10101010

197

01101111

11

11111000 248

00100000

37

01010101

85

00111110

62

00000011

3

11101101

237

11000000

192

1

## 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*

*0 0 1 0 0 0 1 0*

01111011238

00001010

11001000

11111111

00110010

34

123

50

255

200

10

*238*

*-128*

*110*

*-64*

*46*

*-32*

*14*

*-8*

*6*

*-4*

*2*

*-2*

*0*

*34*

*-32*

*2*

*-2*

*0*

10001010

138

00000001

1

00001100

13

11111010

250

01101011

107

11100000

224

01110010

114

11000000

192

10101100

172

01100100

100

01110111

119

00111001

57

01100010

98

10110011

179

00000010

2

## 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 C

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 3

## 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

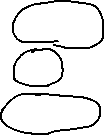


148.17.9.1



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

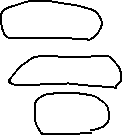


223.250.200.222



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



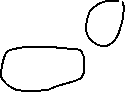
171.102.77.77



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:

188.10.18.2

255.255.0.0

10.10.48.80

255.255.255.0

*188 . 10 . 0 . 0*

*10 . 10 . 48 . 0*

192.149.24.191 192.149.24.0

255.255.255.0

150.203.23.19 150.203.0.0

255.255.0.0

10.10.10.10 10.0.0.0

255.0.0.0

186.13.23.110 186.13.23.0

255.255.255.0

223.69.230.250 223.69.0.0

255.255.0.0

200.120.135.15 200.120.135.15

255.255.255.0

27.125.200.151 27.0.0.0

255.0.0.0

199.20.150.35 199.20.150.0

255.255.255.0

191.55.165.135 191.55.165.0

255.255.255.0

28.212.250.254 28.212.0.0

255.255.0.0

## Host Addresses

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

188.10.18.2

255.255.0.0

10.10.48.80

255.255.255.0

*0 . 0 . 18 . 2*

*0 . 0 . 0 . 80*

222.49.49.11 0.0.0.11

255.255.255.0

128.23.230.19 0.0.230.19

255.255.0.0

10.10.10.10 0.10.10.10

255.0.0.0

200.113.123.11 0.0.0.11

255.255.255.0

223.169.23.20 0.0.23.20

255.255.0.0

203.20.35.215 0.0.0.215

255.255.255.0

117.15.2.51 0.15.2.51

255.0.0.0

199.120.15.135 0.0.0.135

255.255.255.0

191.55.165.135 0.0.0.135

255.255.255.0

48.21.25.54 0.0.25.54

255.255.0.0

## Default Subnet Masks

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

177.100.18.4

119.18.45.0

*255 . 255 . 0 . 0*

*255 . 0 . 0 . 0*

191.249.234.191 255.255.0.0

223.23.223.109 255.255.255.0

10.10.250.1 255.0.0.0

126.123.23.1 255.0.0.0

223.69.230.250 255.255.255.0

192.12.35.105 255.255.255.0

77.251.200.51 255.0.0.0

189.210.50.1 255.255.0.0

88.45.65.35 255.0.0.0

128.212.250.254 255.255.0.0

193.100.77.83 255.255.255.0

125.125.250.1 255.0.0.0

1.1.10.50 255.0.0.0

220.90.130.45 255.255.255.0

134.125.34.9 255.255.0.0

95.250.91.99 255.0.0.0

**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.

IP Address: Default Subnet Mask:

AND:

**Network Host**

(192 . 100 . 10 . 33)

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

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

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

(255 . 255 . 255 . 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: Custom Subnet Mask:

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 1 (192 . 100 . 10 . 33)

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)



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 = 2s - 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 23 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 25 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 hosts created by leaving 6 bits is 26 - 2 or

2 x 2 x 2 x 2 x 2 x 2 = 64 - 2 = 62

usable hosts per subnet.

The number of subnets created by borrowing 2 bits is 22 or 2 x 2 = 4 subnets.

### 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*

**Class C Address subnetted** (2 bits borrowed):

***195. 223 . 50 . 0 0 0 0 0 0 0 0***

*(Invalid range) (0)*

*(1) 195.223.50.64 to 195.223.50.127*

*195.223.50.0*

*to 195.223.50.63*

*(Invalid range) (3)*

*(2)*

*195.223.50.128 to 195.223.50.191*

*195.223.50.192 to 195.223.50.255*

Notice that the subnet and broadcast addresses match.

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 **2s - 2** formula and **don’t use** the zero and broadcast ranges if... | Use the **2s** 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.

*Number o/ Subnets -*

#### 192 . 10 . 10 . 0 0 0 0

#### 0 0 0 0

*Number o/*

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

*128*

*64*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *256 128 64* | *32* | *16* | *8* | *4* | *2* | *- Hosts* |
| *2 4 8* | *16* | *32* | *64 128 256* | | | |
| *128 64 32* | *16* | *8* | *4* | *2* | *1* | *- Binary values* |

*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 Total number of host addresses Number of usable addresses Number of bits borrowed

*1,024*

*64*

*62*

*10*

### Show your work for Problem 2 in the space below.

*512*

*1,024*

*2,048*

*4,096*

*8,192*

*16,384*

*32,768*

*Number o/*

*65,536*

*Hosts -*

*1024*

*512*

*. 256 128*

*64 32 16 8 4 2*

*65,536*

*32,768*

*16,384*

*8,192*

*4,096*

*2048*

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

*128*

*64*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Number o/ Subnets* | *-* | *2* | *4 8* | *16* | *32* | *64* | *128 256.* | | | | | | |
| *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*** |

*32*

*16*

*8*

*4*

*2*

*+1*

*128*

*+64*

*192*

*64*

*-2 62*

Observe the total number of hosts.

Subtract 2 for the number of usable hosts.

*255*

## Problem 3

**Custom Subnet Masks**

Network Address **148.75.0.0 /26**

**/26** indicates the total number of bits used for the network and subnetwork portion of the address. All bits remaining belong to the host portion of the address.

Address class  *B*

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

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

Total number of subnets Total number of host addresses Number of usable addresses Number of bits borrowed

*1,024*

*64*

*62*

*10*

### Show your work for Problem 3 in the space below.

*512*

*1,024*

*2,048*

*4,096*

*8,192*

*16,384*

*32,768*

*65,536*

*Number o/*

*Hosts -*

*1024*

*512*

*. 256 128*

*64 32 16 8 4 2*

*65,536*

*32,768*

*16,384*

*8,192*

*4,096*

*2048*

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

*128*

*64*

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Number o/ Subnets* | *-* | *2* | *4 8* | *16 32* | *64* | *128 256.* | | | | | | |
| *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*** |

*32*

*16*

*8*

*4*

*128*

*+64*

*192*

*64*

*-2 62*

Observe the total number of hosts.

Subtract 2 for the number of usable hosts.

*2*

*+1 255*

*1024*

*-2 1,022*

Subtract 2 for the total number of subnets to get the usable number of subnets.

## Custom Subnet Masks

**Problem 4**

Number of needed subnets **6**

Number of needed usable hosts **30**

Network Address **195.85.8.0**

Address class C

Default subnet mask 255.255.255.0 Custom subnet mask 255.255.255.224

Total number of subnets 8 Total number of host addresses 32 Number of usable addresses 30 Number of bits borrowed 3

### Show your work for Problem 5 in the space below.

*Number o/*

*256 128 64*

*Number o/*

*32 16 8 4 2 - Hosts*

*Subnets - 2 4 8 16 32 64 128 256*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *128* | *64* | *32* | *16* | *8* | *4* | *2* | *1* | *- Binary values* |
| ***195 . 85 . 8 . 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 **210.100.56.0**

Address class C

Default subnet mask 255.255.255.0 Custom subnet mask 255.255.255.224

Total number of subnets 8 Total number of host addresses 32 Number of usable addresses 30 Number of bits borrowed 3

### Show your work for Problem 4 in the space below.

*Number o/*

*256 128 64*

*Number o/*

*32 16 8 4 2 - Hosts*

*Subnets - 2 4 8*

*128 64 32*

#### 210 . 100 . 56 . 0 0 0

*16 32 64 128 256*

*16 8 4 2 1 - Binary values*

***0 0 0 0 0***

## 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 A

Default subnet mask 255.0.0.0 Custom subnet mask 255.254.0.0.

Total number of subnets 128 Total number of host addresses 131072 Number of usable addresses 131070 Number of bits borrowed 7

### Show your work for Problem 6 in the space below.

*Number o/*

*Hosts -*

*. 256 128 64 32 16 8 4 2*

*Number o/*

*4,194,304*

*2,097,152*

*1,048,576*

*524,288*

*262,144*

*131,072*

*512*

*1,024*

*2,048*

*4,096*

*8,192*

*65,536*

*32,768*

*16,384*

*8,192*

*4,096*

*16,384*

*32,768*

*65,536*

*2,048*

*1,024*

*512*

*131,072*

*262,144*

*524,288*

*1,048,576*

*2,097,152*

*4,194,304*

*.*

*Subnets - 2 4 8 16 32 64 128 256 .*

*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 B

Default subnet mask 255.255.0.0 Custom subnet mask 255.255.255.224

Total number of subnets 2048 Total number of host addresses 32 Number of usable addresses 30 Number of bits borrowed 11

### Show your work for Problem 7 in the space below.

*Number o/*

*65,536*

*Hosts -*

*Number o/*

*32,768*

*16,384*

*8,192*

*4,096*

*2048*

*1024*

*512*

*512*

*1,024*

*2,048*

*4,096*

*8,192*

*16,384*

*32,768*

*. 256 128 64 32 16 8 4 2*

*Subnets - 2 4 8 16 32 64 128 256.*

*Binary values -*

*65,536*

*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 C

Default subnet mask 255.255.255.0 Custom subnet mask 255.255.255.192

Total number of subnets 4 Total number of host addresses 64 Number of usable addresses 62 Number of bits borrowed 2

**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 B

Default subnet mask 255.255.0.0 Custom subnet mask 255.255.252.0

Total number of subnets 64 Total number of host addresses 1024 Number of usable addresses 1022 Number of bits borrowed 6

**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 C

Default subnet mask 255.255.255.0 Custom subnet mask 255.255.255.192

Total number of subnets 4 Total number of host addresses 64 Number of usable addresses 62 Number of bits borrowed 2

**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 A

Default subnet mask 255.0.0.0 Custom subnet mask 255.255.0.0

Total number of subnets 256 Total number of host addresses 65536 Number of usable addresses 65534 Number of bits borrowed 8

**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 C

Default subnet mask 255.255.255.0 Custom subnet mask 255.255.255.224

Total number of subnets 8 Total number of host addresses 32 Number of usable addresses 30 Number of bits borrowed 3

**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 C

Default subnet mask 255.255.255.0 Custom subnet mask 255.255.255.224

Total number of subnets 8 Total number of host addresses 32 Number of usable addresses 30 Number of bits borrowed 3

**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 B

Default subnet mask 255.255.0.0 Custom subnet mask 255.255.240.0

Total number of subnets 16 Total number of host addresses 4096 Number of usable addresses 4094 Number of bits borrowed 4

**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 B

Default subnet mask 255.255.0.0 Custom subnet mask 255.255.255.192

Total number of subnets 1024 Total number of host addresses 64 Number of usable addresses 62 Number of bits borrowed 10

**Show your work for Problem 15 in the space below.**

## Custom Subnet Masks

**Problem 16**

Number of needed usable hosts **29**

Network Address **23.0.0.0**

Address class A

Default subnet mask 255.0.0.0 Custom subnet mask 255.255.255.224

Total number of subnets 524288 Total number of host addresses 32 Number of usable addresses 30 Number of bits borrowed 19

**Show your work for Problem 16 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?

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

What are the assignable addresses for the 9th

*192 . 10 . 10 . 112*

*192 . 10 . 10 . 207*

subnet?  *192.10.10.129 to 192.10.10.142*

### Show your work for Problem 1 in the space below.

*Number o/*

*Number o/*

*256 128 64 32 16 8 4 2 - Hosts*

*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*** |  |

*(1) 0*

*(2) 0*

*(3) 0*

*(4) 0*

*(5) 0*

*(6) 0*

*(7) 0*

*(8) 0*

*(9) 1*

*(10) 1*

*(11) 1*

*(12) 1*

*(13) 1*

*(14) 1*

*(15) 1*

*(16) 1*

*0 0 0*

*0 0 1*

*0 1 0*

*0 1 1*

*1 0 0*

*1 0 1*

*1 1 0*

*1 1 1*

*0 0 0*

*0 0 1*

*0 1 0*

*0 1 1*

*1 0 0*

*1 0 1*

*1 1 0*

*1 1 1*

*192.10.10.0 to 192.10.10.15*

*192.10.10.16 to 192.10.10.31*

*192.10.10.32 to 192.10.10.47*

*192.10.10.48 to 192.10.10.63*

*192.10.10.64 to 192.10.10.79*

*192.10.10.80 to 192.10.10.95*

*192.10.10.96 to 192.10.10.111*

*192.10.10.112 to 192.10.10.127*

*192.10.10.128 to 192.10.10.143*

*192.10.10.144 to 192.10.10.159*

*192.10.10.160 to 192.10.10.175*

*192.10.10.176 to 192.10.10.191*

*192.10.10.192 to 192.10.10.207*

*192.10.10.208 to 192.10.10.223*

*192.10.10.224 to 192.10.10.239*

*192.10.10.240 to 192.10.10.255*

Custom subnet

mask

*128*

*64*

*32*

*+16 240*

Usable subnets

*16*

*-2 14*

*16*

Usable hosts *-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.

## 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 Total number of host addresses Number of usable addresses Number of bits borrowed

*1,024*

*64*

*62*

*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?

What is the subnet broadcast address for

the 6th subnet?

What are the assignable addresses for the 9th

*165 . 100 . 1 . 64*

*165 . 100 . 1 . 127*

subnet?  *165.100.2.1 to 165.100.0.62*

*Number o/*

*65,536*

*Hosts -*

*Number o/*

*32,768*

*16,384*

*8,192*

*4,096*

*2048*

*1024*

*512*

*512*

*1,024*

*2,048*

*4,096*

*8,192*

*16,384*

*32,768*

**Show**

*. 256 128*

*64 32 16 8 4 2*

*65,536*

*Subnets - 2 4 8 16 32 64 128 256.*

*Binary values - 128 64 32 16 8 4 2 1* ***.*** *128 64 32 16 8 4 2 1*

**your**

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

*64*

Usable *-2*

hosts *62*

*128*

*64*

*32*

*16*

*(1)*

*(2)*

*(3)*

*(4)*

*(5)*

*(6)*

*. 0*

*1*

*1*

*0*

*1*

*1*

*1 . 0 0*

*1 . 0 1*

*165.100.0.0 to 165.100.0.63*

*165.100.0.64 to 165.100.0.127*

**work**

*165.100.0.128 to 165.100.0.191*

*165.100.0.192 to 165.100.0.255*

**for**

*165.100.1.0 to 165.100.1.63*

**Problem 2**

*165.100.1.64 to 165.100.1.127*

Custom

*128*

*8 (7)*

*1 . 1*

*0 165.100.1.128 to 165.100.1.191*

subnet mask  *+64*

*192*

*4 (8)*

*2 (9)*

*1 . 1 1*

*1 0 . 0 0*

*165.100.1.192 to 165.100.1.255*

*165.100.2.0 to 165.100.2.63*

**in**

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

*+1 255*

*(10) 1 0 . 0 1*

*(11) 1 0 . 1 0*

*165.100.2.64 to 165.100.2.127*

*165.100.2.128 to 165.100.2.191*

**the**

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

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

*(12) 1 0 . 1 1*

*(13)*

*1*

*1 .*

*0*

*0*

*(14) 1 1 . 0 1*

*(15) 1 1 . 1 0*

*(16) 1 1 . 1 1*

*165.100.2.192 to 165.100.2.255*

*165.100.3.0 to 165.100.3.63*

**space**

*165.100.3.64 to 165.100.3.127*

**below.**

*165.100.3.128 to 165.100.3.191*

*165.100.3.192 to 165.100.3.255*

*Down to*

*(1023) 1 1 1 1 1 1*

*(1024) 1 1 1 1 1 1*

31

*1 1 . 1*

*1 1 . 1*

*0 165.100.255.128 to 165.100.255.191*

*1 165.100.255.192 to 165.100.255.255*

## Subnetting

**Problem 3**

**Hint: It is possible to borrow one bit to create two subnets.**

Number of needed subnets **2**

Network Address **195.223.50.0**

Address class C

Default subnet mask 255.255.255.0 Custom subnet mask 255.255.255.128

Total number of subnets 4 Total number of host addresses 126 Number of usable addresses 124 Number of bits borrowed 1

What is the 2nd

subnet range? 195.223.51.0 – 195.223.51.127

What is the subnet number

for the 2nd subnet? 127.223.50.1

What is the subnet broadcast address for

the 1st subnet? 195.223.51.0

What are the assignable addresses for the 1st.20.09

subnet? 195.223.50.129 – 195.223.50.254

**Show your work for Problem 3 in the space below.**

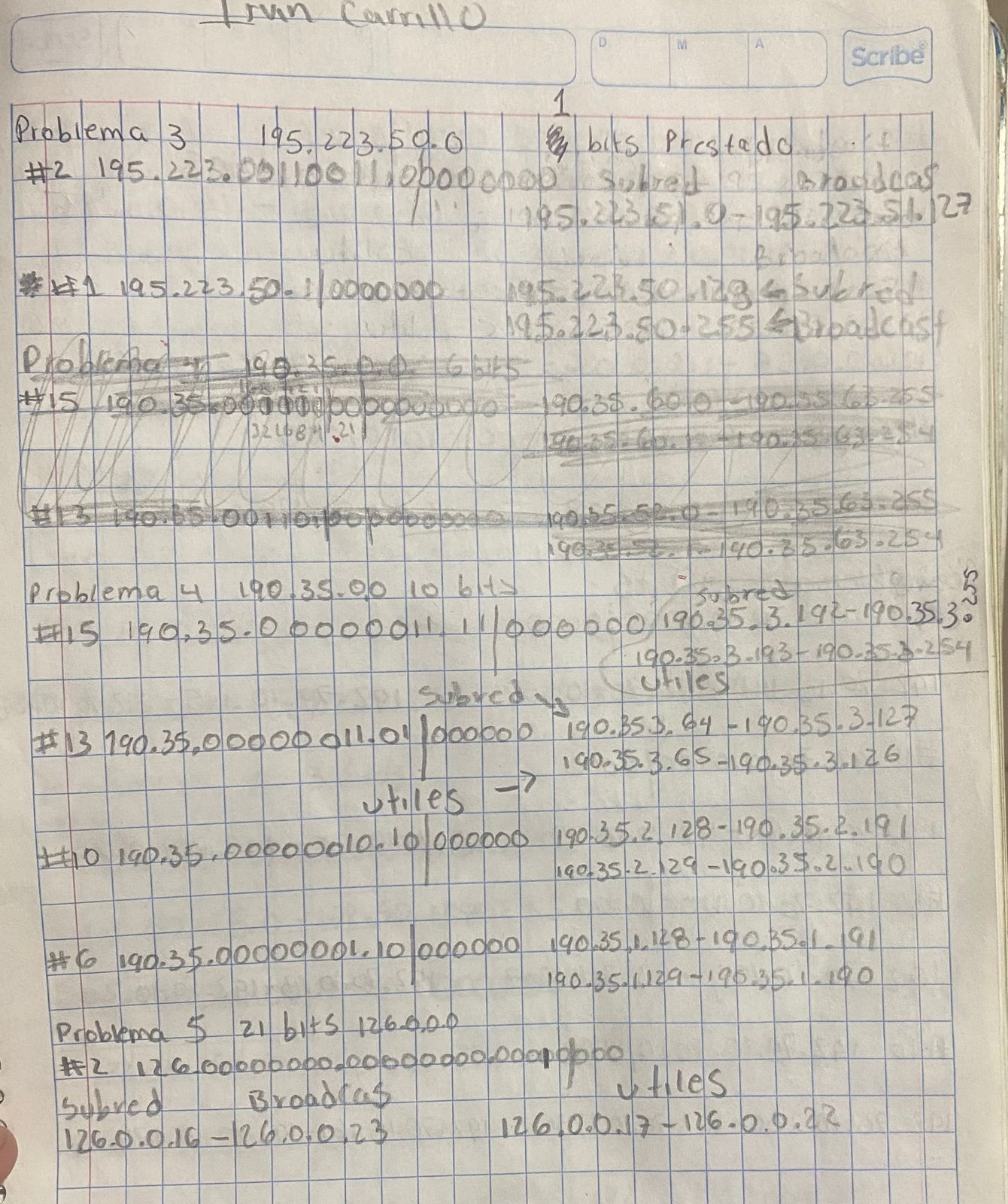
*Number o/*

*256 128 64 32 16 8 4 2*

*- Hosts*

*Number o/*

*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 B

Default subnet mask 255.255.0.0 Custom subnet mask 255.255.255.192

Total number of subnets1024 Total number of host addresses 64 Number of usable addresses 62 Number of bits borrowed 10

What is the 15th

subnet range? 190.35.3.192 – 190.35.3.255

What is the subnet number

for the 13th subnet? 190.35.3.64

What is the subnet broadcast address for

the 10th subnet? 190.35.2.191

What are the assignable addresses for the 6th

subnet? 190.35.1.129 - 190.35.1.190

**Show your work for Problem 4 in the space below.**

Texto

El contenido generado por IA puede ser incorrecto.

## Subnetting

**Problem 5**

Number of needed usable hosts **6**

Network Address **126.0.0.0**

Address class B

Default subnet mask 255.255.0.0 Custom subnet mask 255.255.255.254

Total number of subnets 8192 Total number of host addresses 8

Number of usable addresses 6 Number of bits borrowed 13

What is the 2nd

subnet range? 126.0.0.16 – 126.0.0.23

What is the subnet number

for the 5th subnet? 126.0.0.40

What is the subnet broadcast address for

the 7th subnet? 126.0.0.62

What are the assignable addresses for the 10th

subnet? 1 2 6.0.0.81.-1 2 6.0.0.8 6

**Show your work for Problem 5 in the space below.**

Texto

El contenido generado por IA puede ser incorrecto.

Texto, Carta

El contenido generado por IA puede ser incorrecto.

## Subnetting

**Problem 6**

Number of needed subnets **10**

Network Address **192.70.10.0**

Address class C

Default subnet mask 255.255.255.0 Custom subnet mask 255. 2 5 5. 2 5 5. 2 40

Total number of subnets 16 Total number of host addresses 16 Number of usable addresses 14 Number of bits borrowed 4

What is the 9th

subnet range? 192.70.10.144 – 192.70.10.159

What is the subnet number

for the 4th subnet? 192.70.10.64

What is the subnet broadcast address for

the 12th subnet? 192.70.10.207

What are the assignable addresses for the 10th

subnet? .192.70.10.161 – 192.70.10.174

**Show your work for Problem 6 in the space below.**

Texto, Carta

El contenido generado por IA puede ser incorrecto.

## Problem 7

**Subnetting**

Network Address **10.0.0.0 /16**

Address class A

Default subnet mask 255.0.0.0 Custom subnet mask 255.255.0.0

Total number of subnets 256 Total number of host addresses 65536 Number of usable addresses 65534 Number of bits borrowed 8

What is the 11th

subnet range? 10.11.0.0 – 10.11.255.255

What is the subnet number

for the 6th subnet? 10.6.0.0

What is the subnet broadcast address for

the 2nd subnet? 10.2.255.255

What are the assignable addresses for the 9th

subnet? 10.9.0.1 – 10. 9. 255. 254

**Show your work for Problem 7 in the space below.**

Texto

El contenido generado por IA puede ser incorrecto.

## Subnetting

**Problem 8**

Number of needed subnets **5**

Network Address **172.50.0.0**

Address 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 8192 Number of usable addresses 8190 Number of bits borrowed 3

What is the 4th

subnet range? 172.50.128.0 – 172.50.159.255

What is the subnet number

for the 5th subnet? 172.50.160.0

What is the subnet broadcast address for

the 6th subnet? 172.50.223.255

What are the assignable addresses for the 3rd

subnet? 172.50.92.1 – 172.50.127.254

**Show your work for Problem 8 in the space below.**

Texto

El contenido generado por IA puede ser incorrecto.

Texto

El contenido generado por IA puede ser incorrecto.

## Subnetting

**Problem 9**

Number of needed usable hosts **28**

Network Address **172.50.0.0**

Address class B

Default subnet mask 255.255.0.0 Custom subnet mask 255.255.255.224

Total number of subnets 2048 Total number of host addresses 32 Number of usable addresses 30 Number of bits borrowed 11

What is the 2nd

subnet range? 172.50.0.64 – 172.50.0.95

What is the subnet number

for the 10th subnet? 172.50.1.64

What is the subnet broadcast

address for

the 4th subnet? 172.50.0.159

What are the assignable addresses for the 6th

subnet? 172.50.0.193 – 172.50.0.222

**Show your work for Problem 9 in the space below.**

Texto

El contenido generado por IA puede ser incorrecto.

## Subnetting

**Problem 10**

Number of needed subnets **45**

Network Address **220.100.100.0**

Address class C

Default subnet mask 255.255.255.0 Custom subnet mask 255.255.255.252

Total number of subnets 64 Total number of host addresses 4 Number of usable addresses 2 Number of bits borrowed 6

What is the 5th

subnet range? 220.100.100.20 – 220.100.100.23

What is the subnet number

for the 4th subnet? 220.100.100.16

What is the subnet broadcast address for

the 13th subnet? 220.100.100.55

What are the assignable addresses for the 12th

subnet? 220.100.100.49 – 220.100.100.50

**Show your work for Problem 10 in the space below.**

Texto

El contenido generado por IA puede ser incorrecto.

## Subnetting

**Problem 11**

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

Network Address **135.70.0.0**

Address 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 8192 Number of usable addresses 8190 Number of bits borrowed 3

What is the 6th

subnet range? 135.70.192.0 – 135.70.223.255

What is the subnet number

for the 7th subnet? 135.70.229.0

What is the subnet broadcast address for

the 3rd subnet? 135.70.127.255

What are the assignable addresses for the 5th

subnet? 135.70.160.1 – 135.70.191.254

**Show your work for Problem 11 in the space below.**

Texto

El contenido generado por IA puede ser incorrecto.

## Subnetting

**Problem 12**

Number of needed usable hosts **45**

Network Address **198.125.50.0**

Address class C

Default subnet mask 255.255.255.0 Custom subnet mask 255.255.255.192

Total number of subnets 4 Total number of host addresses 64 Number of usable addresses 32 Number of bits borrowed 2

What is the 2nd

subnet range? 198.125.50.128 – 192.125.50.191

What is the subnet number

for the 2nd subnet? 198.125.50.128

What is the subnet broadcast address for

the 4th subnet? 198.125.51.63

What are the assignable addresses for the 3rd

subnet? 19 8.125.5 0.193 – 19 8.125.5 0.254

**Show your work for Problem 12 in the space below.**

Texto, Carta

El contenido generado por IA puede ser incorrecto.

## Problem 13

**Subnetting**

Network Address **165.200.0.0 /26**

Address class B

Default subnet mask 255.255.0.0 Custom subnet mask 255.255.255.198

Total number of subnets 1024 Total number of host addresses 64 Number of usable addresses 62 Number of bits borrowed 10

What is the 10th

subnet range? 165.200.2.128 – 165.200.2.191

What is the subnet number

for the 11th subnet? 165.200.2.192

What is the subnet broadcast address for

the 1023rd subnet? 165.200.255.191

What are the assignable addresses for the 1022nd

subnet? 165.200.255.193 – 165.200.255.254

**Show your work for Problem 13 in the space below.**

Texto, Carta

El contenido generado por IA puede ser incorrecto.

## Subnetting

**Problem 14**

Number of needed usable hosts **16**

Network Address **200.10.10.0**

Address class C

Default subnet mask 255.255.255.0 Custom subnet mask 255.255.255.224

Total number of subnets 8 Total number of host addresses 32 Number of usable addresses 30 Number of bits borrowed 3

What is the 7th

subnet range? 200.10.10.224 – 200.10.10.255

What is the subnet number

for the 5th subnet? 200.10.10.160

What is the subnet broadcast address for

the 4th subnet? 200.10.10.159

What are the assignable addresses for the 6th

subnet? 200.10.10.193 – 200.10.10.222

**Show your work for Problem 14 in the space below.**

Texto, Carta

El contenido generado por IA puede ser incorrecto.

## Problem 15

**Subnetting**

Network Address **93.0.0.0 \19**

Address 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? 93.1.224.0 - 93.1.255.255

What is the subnet number

for the 9th subnet? 93.1.32.0

What is the subnet broadcast address for

the 7th subnet? 93.0.255.255

What are the assignable addresses for the 12th

subnet? 93.1.128.1 – 93.1.159.254

**Show your work for Problem 15 in the space below.**

Texto, Carta

El contenido generado por IA puede ser incorrecto.

## 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**



**F0/0**

Router A

**S0/0/0**

**S0/0/1**

**F0/0**

**F0/1**

Router B

Marketing 24 Hosts

Reasearch 60 Hosts

Management 15 Hosts

Address class Custom subnet mask

Minimum number of subnets needed

*B*

*255.255.224.0*

*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

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

*60*

+ *60*

= *120*

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

IP address range for Research IP address range for Marketing

IP address range for Management

IP address range for Router A to Router B serial connection

*172.16.0.0 to 172.31.255*

*172.16.32.0 to 172.63.255*

*172.16.64.0 to 172.95.255*

*172.16.96.0 to 172.127.255*

*Number o/*

*16,384*

*32,768*

*65,536*

*Hosts -*

*8,192*

*2048*

*1024*

*512*

*. 256 128 64 32 16 8 4 2*

*32,768*

*16,384*

*4,096*

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Number o/ Subnets* | *-* | | *2* | *4 8* | *16 32 64 128 256.* | | | | | |
| *Binary values* | *-* | *128 64 32* | | | *16 8 4 2* | *1* ***.*** *128 64 32 16* | *8* | *4* | *2* | *1* |
| ***172 . 16*** | ***.*** | ***0 0 0*** | | | ***0 0 0 0*** | ***0 . 0 0 0 0*** | ***0*** | ***0*** | ***0*** | ***0*** |

*4 x1.0*

*4*

*60 x1.0*

*60*

*(1) 0*

*(2) 1*

*(3) 1 0*

*(4) 1 1*

*(5) 1 0 0*

*(6) 1 0 1*

*(7) 1 1 0*

*(8) 1 1 1*

*172.16.0.0*

*172.16.32.0*

*172.16.64.0*

*172.16.96.0*

*172.16.128.0*

*172.16.160.0*

*172.16.192.0*

*172.16.224.0*

*to 172.16.31.255*

*to 172.16.63.255*

*65,536*

*to 172.16.95.255*

*to 172.16.127.255*

*to 172.16.159.255*

*to 172.16.191.255*

*to 172.16.223.255*

*to 172.16.255.255*

*512*

*1,024*

*2,048*

*4,096*

*8,192*

**Show**

**your**

**work**

**for**

**Practical**

**Subnetting**

**1**

**in**

**the**

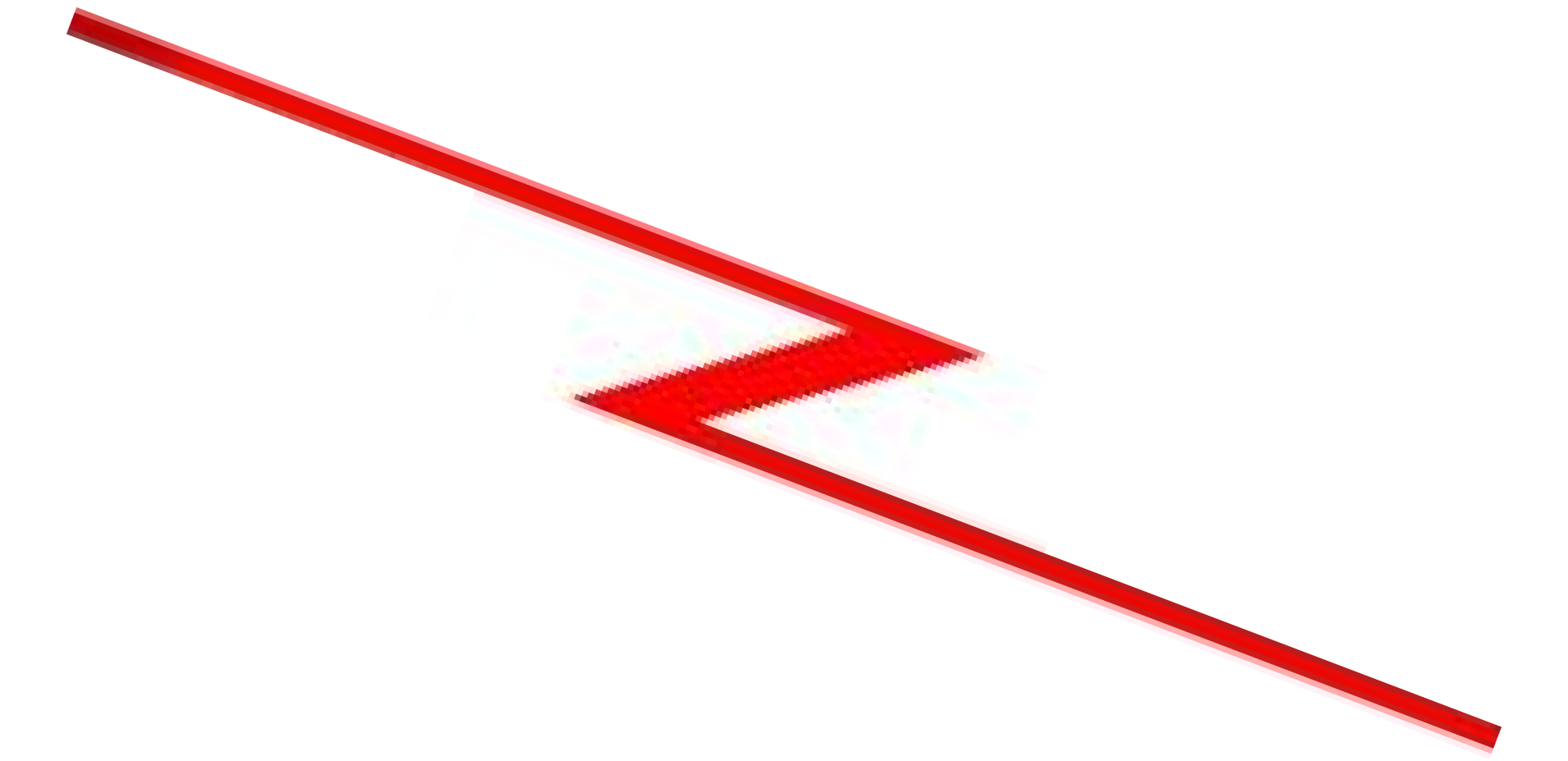
**space**

**below.**

59

## 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 subne**t, 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**

**S0/0/0**

**F0/0**

Router A **S0/0/1**

**S0/0/1**

**F0/0**

Router B

**F0/1**

**S0/0/0**

Tech Ed Lab 20 Hosts

**F0/1**

Router C

Science Lab 10 Hosts

English Department 15 Hosts

Address class Custom subnet mask

Minimum number of subnets needed

Extra subnets required for 30% 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 30% growth in the largest subnet

(Round up to the next whole number)

Total number of address needed for the largest subnet

*B*

*255.255.255.224*

*5*

+ *2*

= *7*

*20*

+ *6*

= *26*

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

IP address range for Tech Ed IP address range for English IP address range for Science

IP address range for Router A to Router B serial connection

IP address range for Router A

*135.126.0.0 to 135.126.0.31*

*135.126.0.32 to 135.126.0.63*

*135.126.0.64 to 135.126.0.95*

*135.126.0.96 to 135.126.0.127*

to Router B serial connection*135.126.0.128 to 135.126.0.159*

*Number o/*

*65,536*

*Hosts -*

*Number o/*

*32,768*

*16,384*

*8,192*

*4,096*

*2048*

*1024*

*512*

*512*

*1,024*

*2,048*

*4,096*

*8,192*

*16,384*

*32,768*

*. 256 128 64 32 16 8 4 2*

*Subnets - 2 4 8 16 32 64 128 256.*

*Binary values -*

*65,536*

*128 64 32 16 8 4 2 1* ***.***

*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

*5*

*x.3 1.5*

*(Round up to 2)*

*20*

*x.3*

*6*

*(1) . 0*

*(2) 1*

*(3) 1 0*

*(4) 1 1*

*(5) 1 0 0*

*(6) 1 0 1*

*(7) 1 1 0*

*(8) 1 1 1*

*(9) 1 . 0 0 0*

*(10) 1 . 0 0 1*

*(11) 1 . 0 1 0*

*(12) 1 . 0 1 1*

*(13) 1 1 0 0*

*.*

*(14) 1 . 1 0 1*

*(15) 1 . 1 1 0*

*(16) 1 . 1 1 1*

*135.126.0.0 to*

*135.126.0.32 to*

*135.126.0.64 to*

*135.126.0.96 to*

*135.126.0.128 to*

*135.126.0.160 to*

*135.126.0.192 to*

*135.126.0.224 to*

*135.126.1.0 to*

*135.126.1.32 to*

*135.126.1.64 to*

*135.126.1.96 to*

*135.126.1.128 to*

*135.126.1.160 to*

*135.126.1.192 to*

*135.1261.224 to*

*135.126.0.31*

*135.126.0.63*

*135.126.0.95*

*135.126.0.127*

*135.126.0.159*

*135.126.0.191*

*135.126.0.223*

*135.126.0.255*

*135.126.1.31*

*135.126.1.63*

*135.126.1.95*

*135.126.1.127*

*135.126.1.159*

*135.126.1.191*

*135.126.1.223*

*135.126.1.255*

**Show**

**your**

**work**

**for**

**Problem 2**

**in**

**the**

**space**

**below.**

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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**

Administrative

**F0/0**

Router A

**S0/0/1**

**F0/0**

Sales 185 Hosts

30 Hosts

**F0/1 S0/0/0**

Router B

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

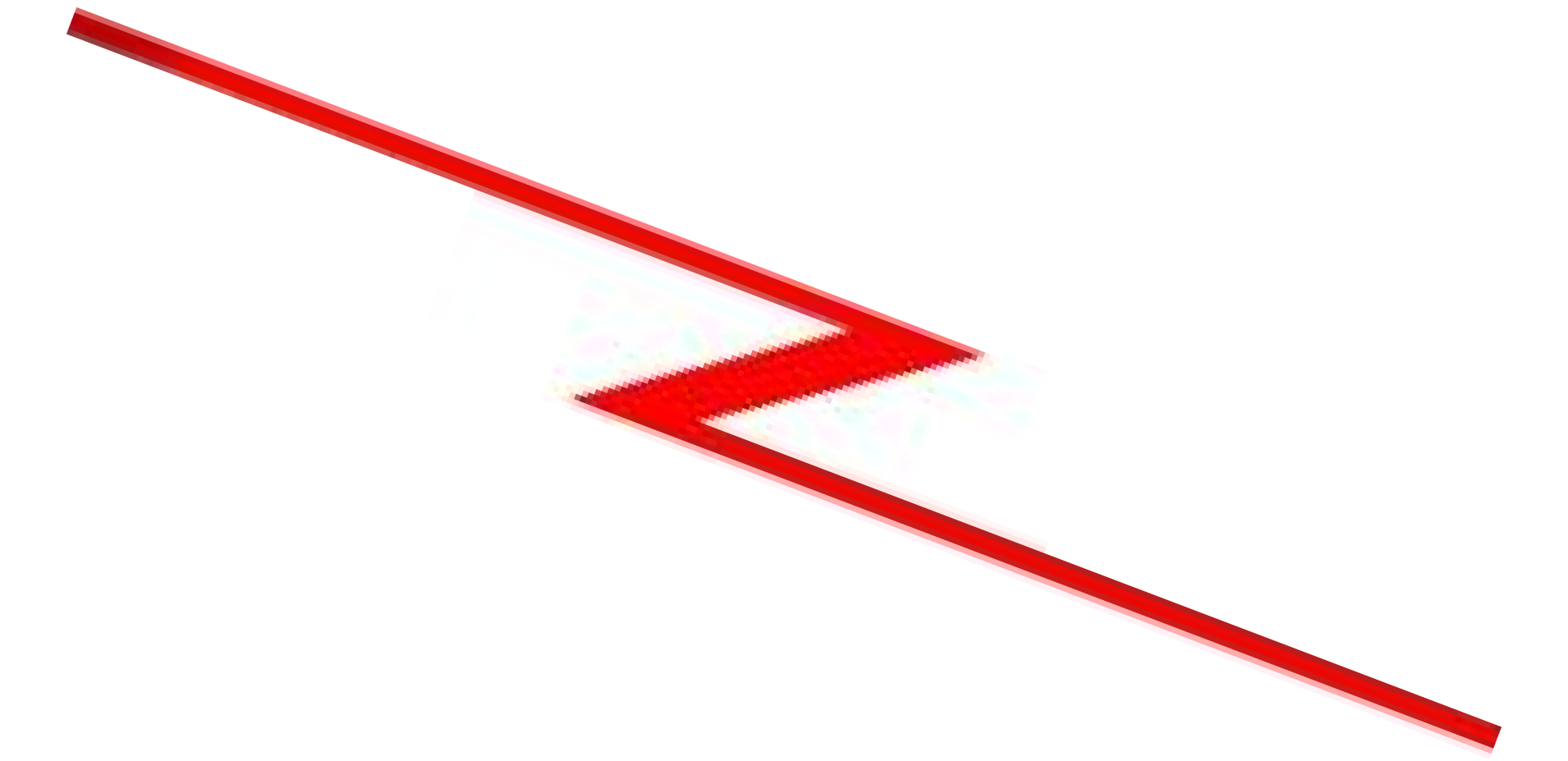
**Show your work for Problem 3 in the space below.**

## 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**

**F0/0 S0/0/0**



Router A

**S0/0/1**

**S0/0/1**

**F0/0**

**S0/0/0**

Router B

Dallas

**F0/1**

Router C **F0/0**

150 Hosts New York

Washington D.C. 220 Hosts

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

**Show your work for Problem 4 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**

**F0/1**



**F0/0**

Science Room 10 Hosts

Tech Ed Lab 18 Hosts

English classroom 15 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.

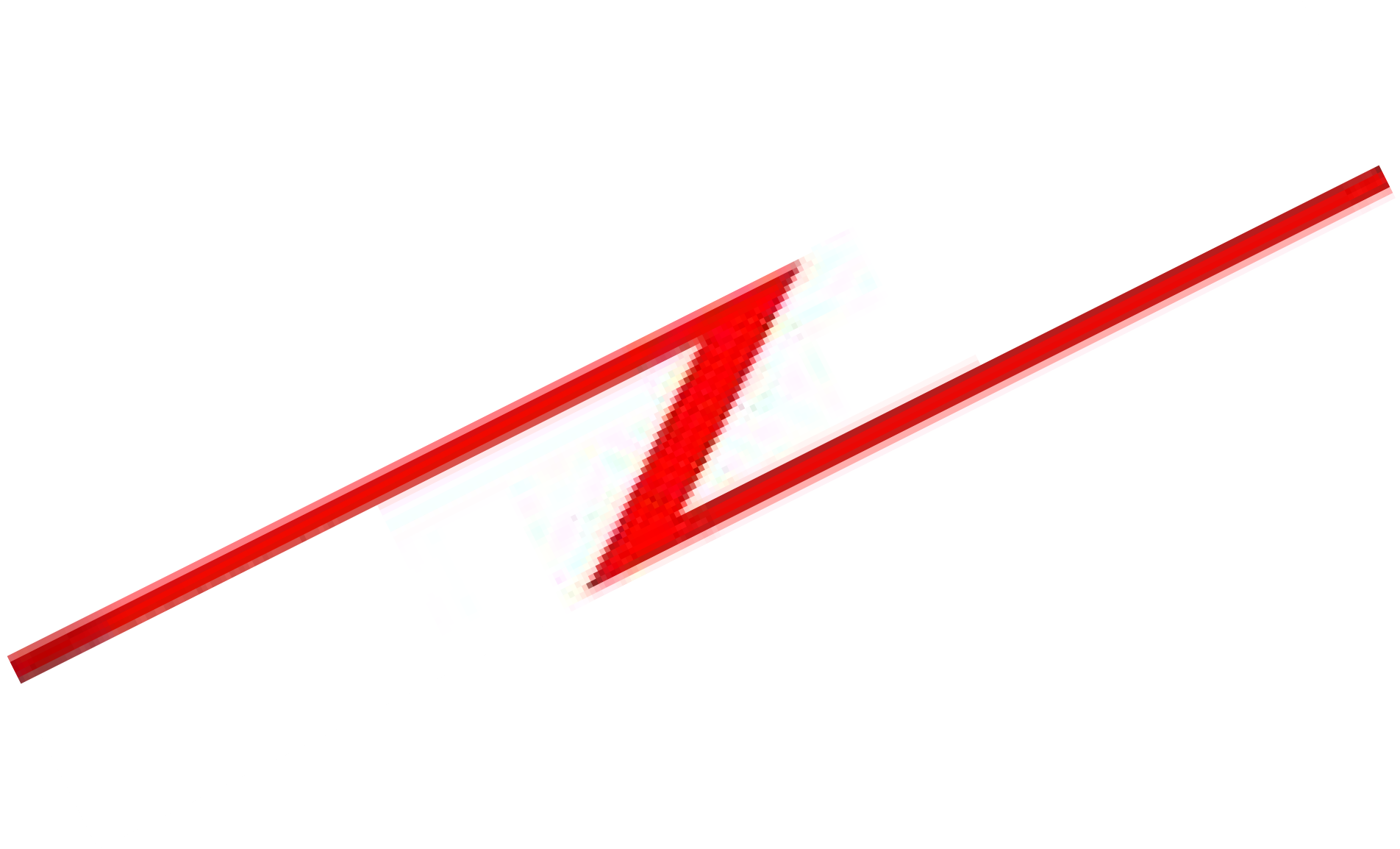
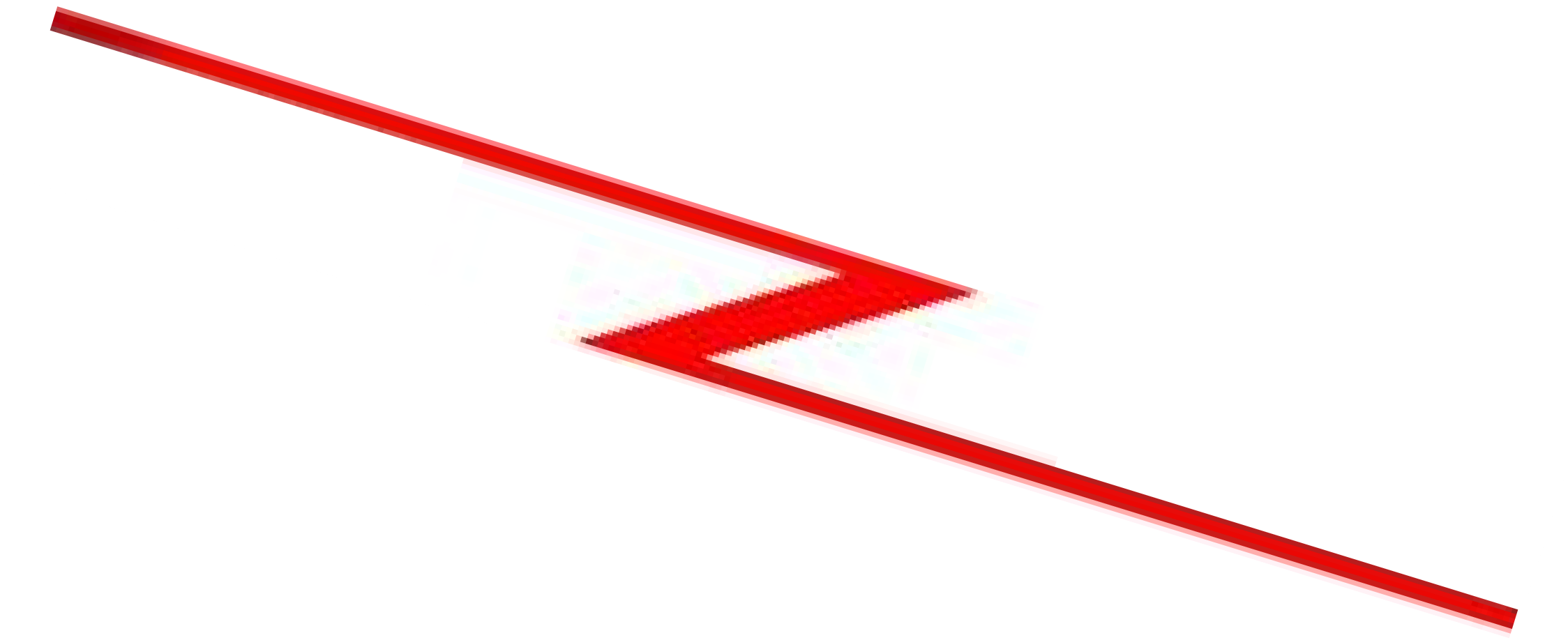
IP address range for Router F0/0 Port IP address range for Router F0/1 Port

**Show your work for Problem 5 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**



**S0/0/0**

Router A

**F0/0**

**S0/0/1**

**S0/0/1**

**S0/0/0**

Technology Building 320 Hosts

**S0/0/0**

Art & Drama

**S0/0/1**

Router B

**F0/1**

75 Hosts

Router C

**F0/0**

**F0/1**

Administration 35 Hosts

Science Building 225 Hosts

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 Problem 6 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 F0/0**

Router B

**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 Problem 7 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.



**F0/0**

Router A

**IP Address 192.168.1.0 S0/0/0**

**S0/0/1**

**F0/0**

**F0/1**

Router B

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

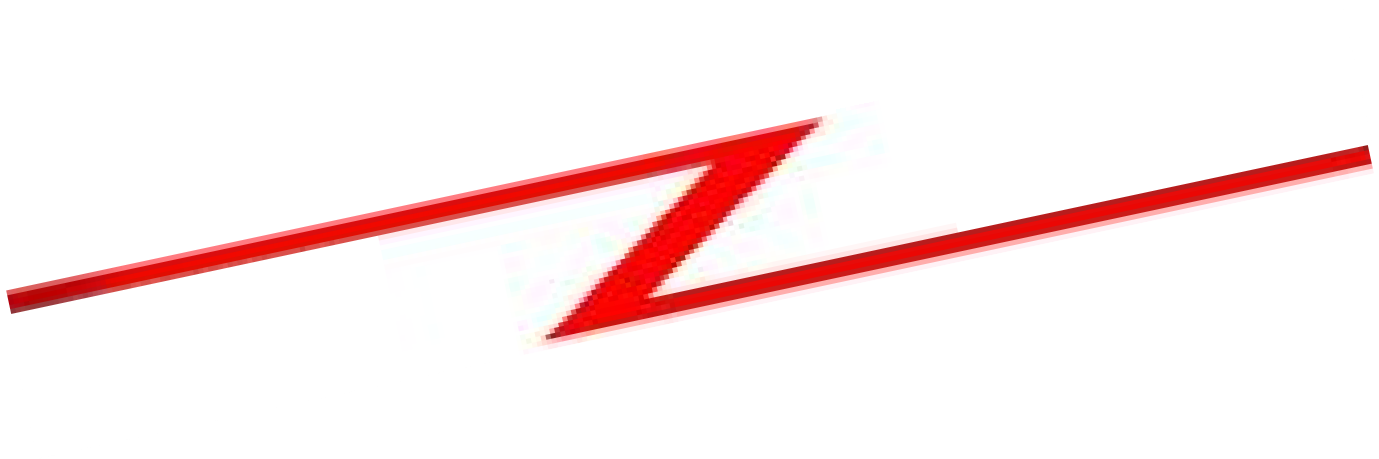
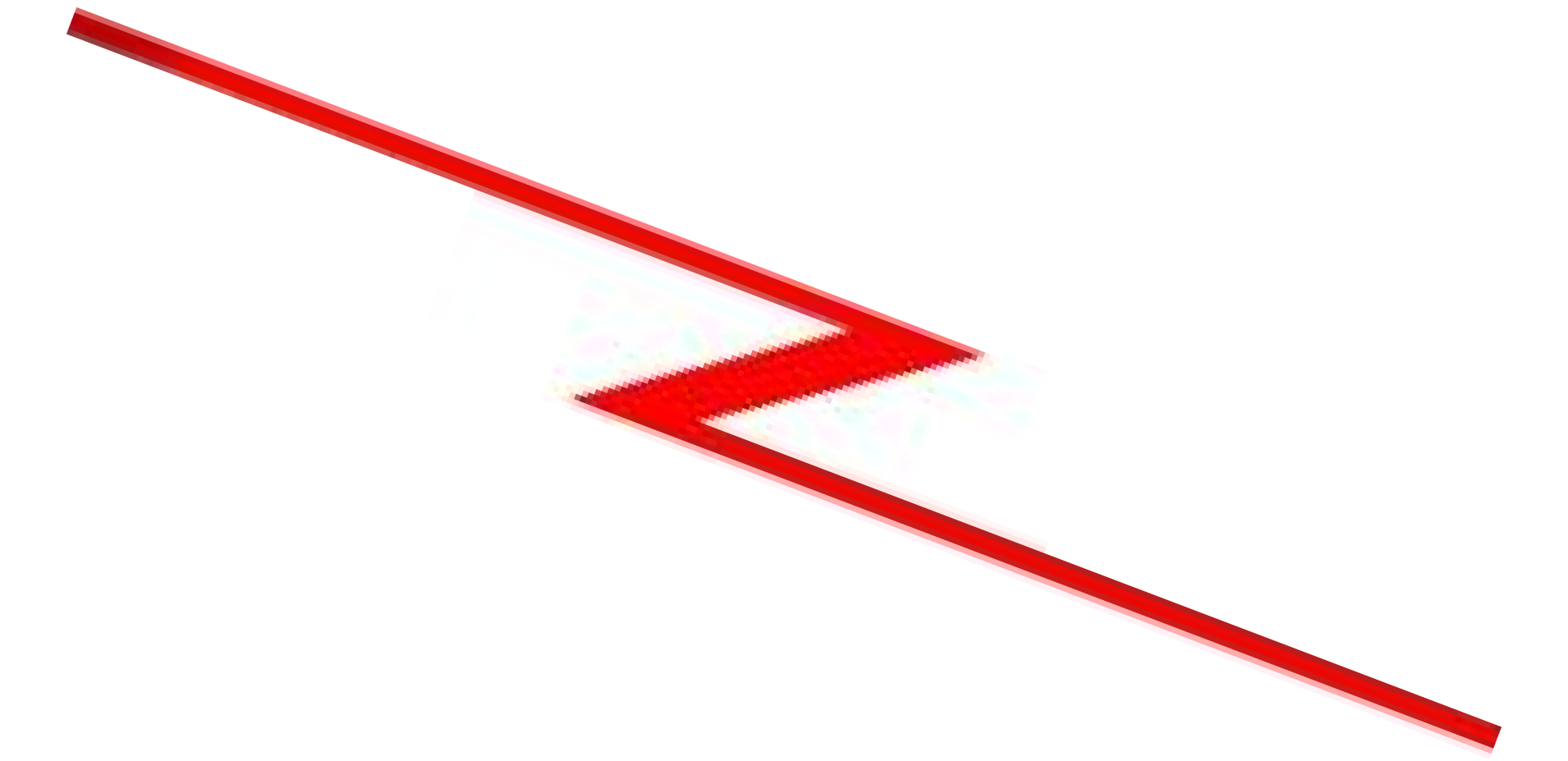
IP address range for Router A

to Router B serial connection

**Show your work for Problem 8 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 subne**t, and allow enough extra subnets and hosts for 15% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Router A

**IP Address 148.55.0.0 S0/0/0**

**S0/0/1**

**F0/1**

**S0/0/1**

**F0/0**

Router B

**S0/0/0**

Dallas 1500 Hosts

**F0/0**

Router C

**S0/0/1**

Router D

Ft. Worth

**S0/0/0**

2300 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

74 to Router D serial connection

**Show your work for Problem 9 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**

Router A **S0/0/1**

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

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### Show your work for Problem 10 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

*The network ID cannot be 0.*

Subnet Mask: 255.0.0.0

*Reference Page Inside Front Cover*

IP Address: 192.10.10.1

*OK*

Subnet Mask: 255.255.255.0

*Reference Pages 28-29*

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*

78

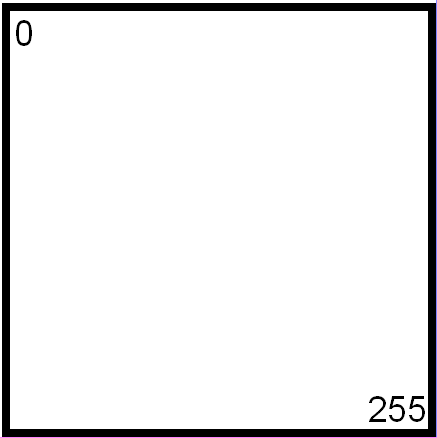
# IP Address Breakdown

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **/24** | **/25** | **/26** | **/27** | **/28** | **/29** | **/30** |
| 8+8+8  255.255.255.0  256 Hosts | 8+8+8+1  255.255.255.128  128 Hosts | 8+8+8+2  255.255.255.192  64 Hosts | 8+8+8+3  255.255.255.224  32 Hosts | 8+8+8+4  255.255.255.240  16 Hosts | 8+8+8+5  255.255.255.248  8 Hosts | 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



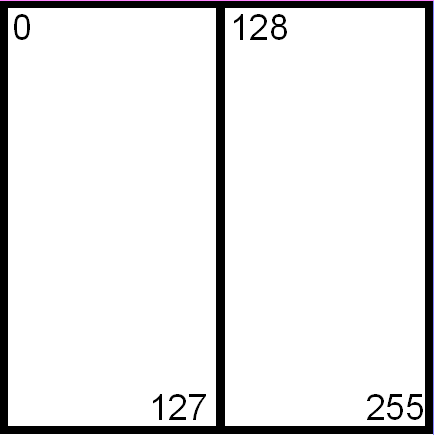
addresses.

/24 255.255.255.0

256 Hosts

1 Subnet

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

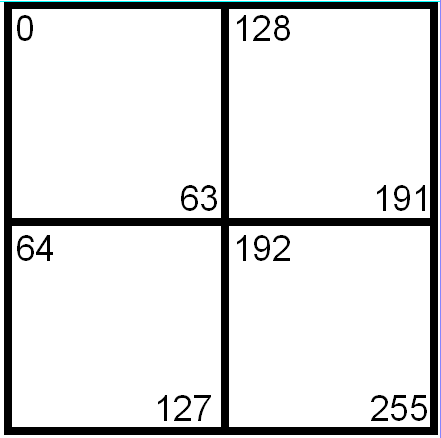


/25 255.255.255.128

128 Hosts

2 Subnets

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



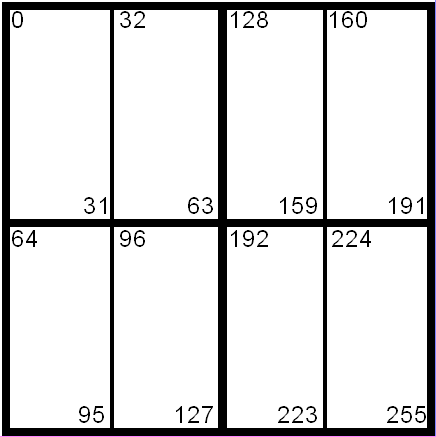
/26 255.255.255.192

64 Hosts

4 Subnets

80

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

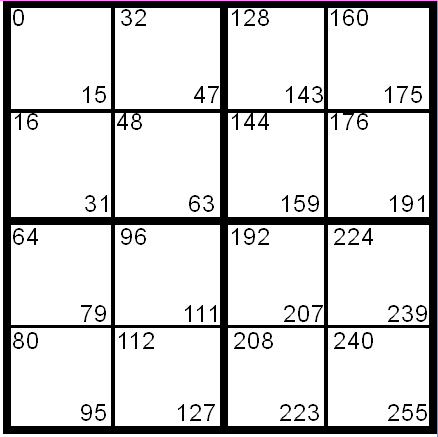


/27 255.255.255.224

32 Hosts

8 Subnets

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



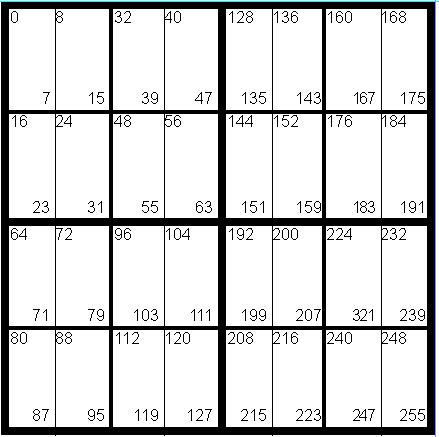
addresses,

/28 255.255.255.240

16 Hosts

16 Subnets

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

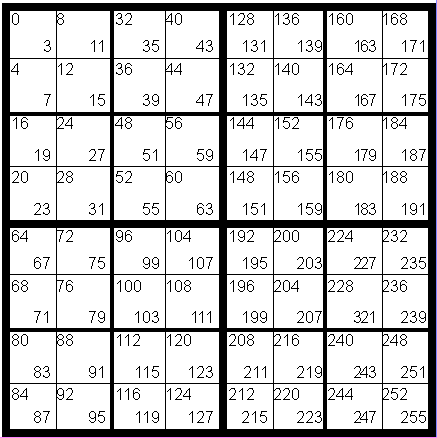


/29 255.255.255.248

8 Hosts

32 Subnets

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



/30 255.255.255.252

4 Hosts

64 Subnets

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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 |

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Inside Cover