1. What **networks** do the following host IP Addresses belong to?

Fairly standard, the addresses below are classful addresses so just work out what class they are; A for example is a Class B address so the network is 132.86.0.0, B is a Class A address so the network is 14.0.0.0

	IP Address	Subnet Mask	Network Address
A.	132.86.97.10	255.255.0.0	***132.86.0.0***
B.	14.255.255.0	255.0.0.0	***14.0.0.0***
C.	176.176.176.32	255.255.0.0	***176.176.0.0***
D.	216.126.250.54	/24	***216.126.250.0***
E.	19.0.0.69	/8	***19.0.0.0***
F.	163.150.0.22	/16	***163.150.0.0***

2. Develop a **subnet design** for a network – 198.23.42.0 (with current subnet mask of 255.255.255.0) so that it has at least 8 **useable** subnets.

   Only list the **first** and **last** subnets that are available for use.
   (N)etwork bits+(S)ubnet bits+(H)ost bits=32 total bits, 24N+S+H=32, 24N+4S+H=32, 32-(24N+4S)=32, 32-28=4H, 24N+4S+4H=-32Bits

   First determine class, Class C so the standard mask starts with 255.255.255.0 which means we have used 24 bits out of the total 32 so far, we need to work out how many bits will be needed for 8 usable subnets, 2 to the power of 3 gives 8 but 2 are unavailable so we need to use 2 to the power of 4 which gives 16 – 2 = 14. Using the conversion table make a mark at the 4th number in as we used 4 bits then add up the bits before the mark.

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

   128+64+32+16 = 240 this is the value for the last Octet of the subnet mask.

   255.255.255.240 or /28

   To work out the first subnet ID select the first value before the mark you made above ie: 16 (which is the magic number) so the first subnet ID is 198.23.42.16 the first usable value on that range is 17 as 16 is the network ID and can't be used. To work out the last available subnet ID add up all the marks used minus the magic number which is 16 so 240 -16 = 224 so the last available subnet ID is 224. The* ***Custom Subnet Mask is: *255.255.255.240 or /28_***

Subnet ID 198.23.42.16

128	64	32	16	8	4	2	1
0	***0***	***0***	***1***	***0***	***0***	***0***	***0***

First Valid host ID 198.23.42.17

128	64	32	16	8	4	2	1
0	***0***	***0***	***1***	***0***	***0***	***0***	***1***

Last valid host ID 198.23.42.30

128	64	32	16	8	4	2	1
0	***0***	***0***	***1***	***1***	***1***	***1***	***0***

Broadcast Address 198.23.42.31

128	64	32	16	8	4	2	1
0	***0***	***0***	***1***	***1***	***1***	***1***	***1***

To work out the last valid subnet ID set all bits to the left of the magic number to 1 and the rest to 0 add those up 128+64+32=224 so 198.23.42.224

128	64	32	16	8	4	2	1
1	***1***	***1***	***0***	***0***	***0***	***0***	***0***

First valid host ID on the last subnet

128	64	32	16	8	4	2	1

1	1	1	0	|0	0	0	1

To work out the broadcast add all the bits except the magic number 128+64+32+8+4+2+1=239

128	64	32	16	|8	4	2	1
1	1	1	0	|1	1	1	1

Subnet to the left and including the magic number, Hosts to the right of the magic number.

1st Subnet ID = 16

128	64	32	16	|8	4	2	1	
0	0	0	1	|0	0	0	0	Subnet ID 16
128	64	32	16	|8	4	2	1	
0	0	0	1	|0	0	0	1	1st Host 17
128	64	32	16	|8	4	2	1	
0	0	0	1	|1	1	1	0	Last Host 30
128	64	32	16	|8	4	2	1	
0	0	0	1	|1	1	1	1	Broadcast 31

Last Subnet ID = 224

128	64	32	16	|8	4	2	1	
1	1	1	0	|0	0	0	0	Subnet ID 224
128	64	32	16	|8	4	2	1	
1	1	1	0	|0	0	0	1	1st Host 225
128	64	32	16	|8	4	2	1	
1	1	1	0	|1	1	1	0	Last Host 238
128	64	32	16	|8	4	2	1	
1	1	1	0	|1	1	1	1	Broadcast 239

Subnet ID	First Valid Host ID	Last valid Host ID	Broadcast Address
198.23.42.16	*198.23.42.17*	*198.23.42.30*	*198.23.42.31*
198.23.42.224	*198.23.42.225*	*198.23.42.238*	*198.23.42.239*

3. Define a **subnet mask** for each of the following scenarios. **Do not subnet** unless there is a need to do so.

	Scenario	**Subnet Mask**
A.	Class B network address on a local network	***255.255.0.0 or /16***
B.	Class A network address on a local network with as many subnets as possible, with up to 4,010 hosts per subnet. ***Class A, 8 bits cannot be used.*** ***2 to the power of 12 = 4096*** ***8+12=20 so 20 bits used*** ***4 bits into the 3rd Octet*** ***128+64+32+16 = 240***	***255.255.240.0 or /20***
C.	Class B network address with 26 subnets. ***Class B, 16 bits cannot be used.*** ***2 to the power of 5 = 32*** ***8+8+5 = 21 so 21 bits used***	***255.255.248.0 or /21***

5 bits into the 3rd Octet
128+64+32+16+8=248

D. Class C network address with 20 subnets — ***255.255.255.248 or /29***
Class C, 24 bits cannot be used
2 to the power of 5 = 32
8+8+8+5 = 29 so 29 bits used
5 bits into the 4th Octet
128+64+32+16+8=248

E. Class A network address with 2000 subnets — ***_255.255.224.0 or /19***
Class A, 8 bits cannot be used.
2 to the power of 11 = 2048
8+11=19 so 19 bits used
3 bits into the 3rd Octet
128+64+32=224

F. Class C network address with as many subnets as possible, with up to 17 hosts per subnet — ***255.255.255.248 or /32***
Class C, 24 bits cannot be used
2 to the power of 5 = 32
8+8+8+5= 29 so 29 bits used
5 bits into the 4th Octet
128+64+32+16+8=248

4. What is the maximum number of hosts available, per subnet, on a class C network that is subnetted to allow for 13 subnets? (1 mark)
Class C, 24 bits cannot be used 2 to the power of 4 = 16 – 2 = 14, 8+8+8+4=28 so 28 bits used.
32 total bits – 28 bits used = 4 left, 2 to the power of 4 = 16 -2 = 14 Hosts.

5. Develop a **subnet design** for a network – 195.18.124.0 (current subnet mask is 255.255.255.0) – so that it has 5 **usable** subnets.

Class C, 24 bits cannot be used
2 to the power of 3 = 8 -2 =6
8+8+8+3=27 so 27 bits used

Using the conversion table make a mark 3 places in add up the values.

128	64	32	|16	8	4	2	1
1	1	1	|0	0	0	0	0

Subnet mask:255.255.255.224 or /27

Using the conversion table make a mark 3 places in and select the first value available which is 32 so 32 is our magic number making that our first valid subnet ID.

128	64	32	|16	8	4	2	1
0	0	1	|0	0	0	0	0

The next value up is 33 by adding 1.

128	64	32	|16	8	4	2	1
0	0	1	|0	0	0	0	1

So the first valid host ID is 195.18.124.33

To work out the broadcast address add up the magic number and all the bits to the right of it.

128	64	32	|16	8	4	2	1

0	0	1	|1	1	1	1	1

32+16+8+4+2+1=63 making the broadcast address 195.18.124.63

The last valid host address is one value before the broadcast address.

128	64	32	|16	8	4	2	1
0	0	1	|1	1	1	1	0

To work out the rest add the magic number to each value, Once the first line is complete you can just add the magic number to each value.

Subnet ID	First Valid Host ID	Last Valid Host ID	Broadcast ID
195.18.124.32	*195.18.124.33*	*195.18.124.62*	*195.18.124.63*
195.18.124.64	*195.18.124.65*	*195.18.124.94*	*195.18.124.95*
195.18.124.96	*195.18.124.97*	*195.18.124.126*	*195.18.124.127*
195.18.124.128	*195.18.124.129*	*195.18.124.158*	*195.18.124.159*
195.18.124.160	*195.18.124.161*	*195.18.124.190*	*195.18.124.191*

6. Are the following pairs of IP Addresses on the same subnet? Circle Yes or No.

	IP Address	Subnet Mask	Circle your answer
A.	196.24.109.65 and 196.24.109.62	255.255.255.224	***Yes / <u>No</u>***
B.	163.50.99.100 and 163.50.100.255	255.255.240.0	***<u>Yes</u> / No***
C.	22.245.64.5 and 22.245.120.56	255.255.192.0	***<u>Yes</u> / No***

Example A. Determine how many bits were borrowed first. 224 = 128+64+32, 3 bits were borrowed. Now using the decimal to binary table convert the Octet values you want to compare to binary

A – Class C 224 = 128+64+32, 3 bits

	128	*64*	*32*	*|16*	*8*	*4*	*2*	*1*
62	*0*	*0*	*1*	*|1*	*1*	*1*	*1*	*0*
65	*0*	*1*	*0*	*|0*	*0*	*0*	*0*	*1*
Anding	*0*	*0*	*0*	*|*				

Since the values don't match before the mark the answer is No.

B – Class B 240 = 128+64+32+16. 4 bits

	128	*64*	*32*	*16*	*8*	*4*	*2*	*1*
99	*0*	*1*	*1*	*0*	*|1*	*1*	*0*	*1*
100	*0*	*1*	*1*	*0*	*|1*	*1*	*1*	*0*
Anding	*0*	*1*	*1*	*0*	*|*			

Since the values match up before the mark the answer is Yes

C – Class A 192 = 128+64, 2 bits

	128	*64*	*|32*	*|16*	*8*	*4*	*2*	*1*
64	*0*	*1*	*|0*	*0*	*0*	*0*	*0*	*0*
120	*0*	*1*	*|1*	*1*	*1*	*0*	*0*	*0*
Anding	*0*	*1*	*|*					

Since the values match up before the mark the answer is Yes

If the two results are the same, they are on the same subnet. Otherwise, no.

7. For each of the following host IP address, determine the **subnet ID** that they belong to, and whether the **host address** is a valid or invalid address for that subnet, If the IP address is invalid, explain why?

	Host Address	Subnet Mask	Subnet ID	Circle your answer
A.	200.3.7.63	255.255.255.224	**200.3.7.32**	**Valid/Invalid**

If invalid why? Broadcast address

Determine class – Class C, First 3 Octets fixed. 200.3.7.0 Convert 224 to binary 11100000 we have borrowed the first 3 bits from the 4th Octet make a mark. Convert 63 to binary 00111111 and add up the 1's before the mark = 32. Our subnet ID is 200.3.7.32 looking at the table below we can see that 63 is the broadcast address on the subnet id 32 as all values to the right of the mark are set to 1

	128	64	32	|16	8	4	2	1
224	1	1	1	|0	0	0	0	0
63	0	0	1	|1	1	1	1	1

B.	38.33.0.0	255.224.0.0	**38.32.0.0**	**Valid/Invalid**

If Invalid, why?

Determine class – Class A, First Octet fixed, 38.0.0.0 Convert 224 to binary 11100000 we have borrowed the first 3 bits from the 2nd Octet make a mark, Convert 33 to binary 00100001 and add up the 1's before the mark = 32, Our subnet ID is 38.32.0.0 We can see from the table below that 33 is the first usable host on the 32 subnet.

	128	64	32	|16	8	4	2	1
224	1	1	1	|0	0	0	0	0
33	0	0	1	|0	0	0	0	1

C.	205.160.3.96	255.255.255.240	**205.160.3.96**	**Valid/Invalid**

If invalid, why? Same as host address

Determine class – Class C, First 3 Octets fixed. 205.160.3.0 Convert 240 to binary 11110000 we have borrowed the first 4 bits from the 4th Octet make a mark, Convert 96 to binary 01000000 and add up the 1's before the mark = 96, Our subnet ID is 205.160.3.96 which is the same as our host address so it is invalid.

	128	64	32	16	8	4	2	1
240	1	1	1	1	|0	0	0	0
96	0	1	1	0	|0	0	0	0

D.	173.200.158.0	255.255.192.0	173.200.128.0	**Valid/Invalid**

If invalid, why?

Determine class – Class B, First 2 Octets fixed. 173.200.0.0 Convert 192 to binary 11000000 we have borrowed the first 2 bits from the 3rd Octet make a mark. Convert 158 to binary 10011110 and add up the 1's before the mark = 128, Our subnet ID is 173.200.128.0

	128	64	32	16	8	4	2	1
192	1	1	|0	0	0	0	0	0
158	1	0	|0	1	1	1	1	0

8. Which of the following IP addresses is an example of a **broadcast address**
A broadcast address has all the host bits turned into 1's

A. 172.18.225.225 /16 ***Class B First 2 Octets fixed, 225 into binary is 11100001***
B. **201.32.22.255 /24 Class C First 3 Octets fixed last Octet is 255 which converted to binary is all 1's, 11111111 hence a broadcast address.**
C. 188.44.254.254 /16 ***Class B First 2 Octets fixed 254 into binary 1111110***
D. 18.255.255.254 /8 ***Class A First Octet fixed 254 into binary 11111110***

9. Circle whether the following IP Addresses are invalid or valid **host addresses.** That is, can be assigned to a host computer on a network?
Things to look for
- ***Are there 4 Octets***
- ***Are there 3 dots***
- ***1st Octet is not 0***
- ***No Octets > 255***
- ***1st Octet not 127***
- ***1st Octet not > 223***

	IP Address	***Subnet Mask***	***Circle your answer***
A.	126.0.0.0	255.0.0.0	***Valid / Invalid Network ID***
B.	168.171.25.255	255.255.0.0	***Valid/Invalid***
C.	10.10.10.10.1	255.255.255.0	***Valid/Invalid IP has 5 Octets***
D.	265.11.22.99	255.255.255.0	***Valid/Invalid Not within a valid class***
E.	10.8.9.0	255.255.0.0	***Valid/Invalid***
F.	25.12.7.64	255.255.255.224	***Valid/Invalid Network ID 224 to binary 11100000 3 bits borrowed 64 to binary 010|00000 Hosts bits all 0***
G.	165.66.255.254	255.255.0.0	***Valid Last usable host/Invalid***
H.	242.48.99.150	255.255.255.0	***Valid/Invalid Class E not for use***
I.	127.12.34.11	255.240.0.0	***Valid/Invalid Loopback Address***

10. What **networks** are the following host IP Addresses on?

	IP Address	Subnet Mask	Network Address
A.	82.85.27.66	/14	***82.84.0.0***
B.	152.222.55.78	/21	***152.222.48.0***
C.	85.176.110.123	/19	***85.176.96.0***
D.	220.186.191.91	/26	***220.186.191.64***
E.	164.130.210.135	/25	***164.130.210.128***

Determine Class first then subtract how many Octets are fixed from the / number.

A. 82.85.27.66 /14 Class A – First Octet is fixed 8, 14-8=6, 6 bits were borrowed from the 2nd Octet using the table below make a mark 6 bits in. Convert 85 to binary then add up the 1's before the mark. 01010101 64+16+4=84 So the Network address is 82.84.0.0

128	64	32	16	8	4	|2	1
0	*1*	*0*	*1*	*0*	*1*	*|0*	*1*

B. 152.222.55.78 /21 Class B – First 2 Octets are fixed 8+8=16, 21-16=5, 5 bits were borrowed from the 3rd Octet, make a mark 5 bits in. Convert 55 to binary 00110111, Add up the 1's before the mark, 32+16=48, The network address is 152.222.48.0

128	64	32	16	8	|4	2	1
0	*0*	*1*	*1*	*0*	*|1*	*1*	*1*

C. 85.176.110.123 /19 Class A – But first 2 Octets are fixed 8+8=16, 19-16= 3, 3 bits were borrowed from the 3rd Octet, make a mark 3 bits in. Convert 110 to binary 01101110, Add up the 1's before the mark 64+32=96, The network address is 85.176.96.0

128	64	32	|16	8	4	2	1
0	*1*	*1*	*|0*	*1*	*1*	*1*	*0*

D. 220.186.191.91 /26 Class C – First 3 Octets are fixed 8+8+8=24, 26-24=2, 2 bits were borrowed from the 4th Octet, make a mark 2 bits in. Convert 91 to binary 01011011, Add up the 1's before the mark 64, The network address is 220.186.191.64

128	64	|32	16	8	4	2	1
0	*1*	*|0*	*1*	*1*	*0*	*1*	*1*

E. 164.130.210.135 /25 Class B – But first 3 Octets are fixed 8+8+8=24, 25-24=1, 1 bit was borrowed from the 4th Octet, make a mark 1 bit in. Convert 135 to binary 10000111, Add up the 1's before the mark 128, The network address is 164.130.210.128

128	|64	32	16	8	4	2	1
1	*|0*	*0*	*0*	*0*	*1*	*1*	*1*