Part A – IP Addressing Basics

1. What is an IP address and why is it important in a network?

Answer: An IP address is a unique numerical identifier assigned to every device connected to a network. It serves two key roles: identifying the host or network interface, and locating the device within the network. IP addresses enable devices to communicate by routing data packets to their correct destinations—whether it's a web browser requesting a page from a server, or two machines exchanging information across a local or global network. Without IP addresses, data would essentially wander, unable to find its target. They are fundamental to everything from browsing the internet to managing secure internal networks, making them one of the cornerstones of modern connectivity.

2. Differentiate between IPv4 and IPv6 in terms of Address length, Notation format, and Number of available addresses

Answer: I. Address Length
   IPv4: 32 bits
   IPv6: 128 bits
         II. Notation Format
   IPv4: Dotted decimal (e.g., 192.0.2.1)
   IPv6: Hexadecimal with colons (e.g., 2001:db8::1)
         III. Number of Available Addresses
   IPv4: 4.3 billion (2^{32})
   IPv6: 340 undecillion (2^{128}) — that's 340 trillion trillion trillion! 😲

3. Write the binary equivalent of the IPv4 address 192.168.10.1.
Answer: 192 -> 11000000
        168 -> 10101000
         10 -> 00001010
          1 -> 00000001
   192.168.10.1-> 11000000.10101000.00001010.00000001

4. Convert the following binary IP address to decimal:
11000000.10101000.00000001.00000010

Answer: 11000000 -> 192
         10101000 -> 168
          00000001 -> 1
          00000010 -> 2
11000000.10101000.00000001.00000010 -> 192.168.1.2

5. What are the ranges of Class A, B, and C IPv4 addresses?

Answer: Class A: 1.0.0.0 to 126.255.255.255
          Class B: 128.0.0.0 to 191.255.255.255
          Class C: 192.0.0.0 to 223.255.255.255

6. Which IP class does the address 172.16.5.4 belong to?

Answer: Since the first octet 172 falls between 128 and 191, that places the address in   Class B.

7. What is the difference between public IP and private IP? List private IP ranges.

Answer: The main difference between public and private IP addresses is how far they reach, and what they're connected to. A public IP address identifies you to the wider internet so that all the information you're searching for can find you. A private IP address is used within a private network to connect securely to other devices within that same network.
   private IP ranges:
          Class A: 10.0.0.0 – 10.255.255.255
          Class B: 172.16.0.0 – 172.31.255.255
          Class C: 192.168.0.0 – 192.168.255.255

8. What is the role of the loopback address in IP networking?

Answer: A loopback address allows for a reliable method of testing the functionality of an Ethernet card and its drivers and software without a physical network. It also allows information technology professionals to test IP software without worrying about broken or corrupted drivers or hardware.

9. Explain the use of static IP vs dynamic IP with examples.

Answer: Static IP: Manually set, never changes. Used for servers, printers, cameras—devices needing constant access. Example: Office printer with fixed IP so everyone can print reliably.

   Dynamic IP: Automatically assigned by DHCP, changes over time. Used in homes, cafés, mobile devices. Example: Laptop gets a new IP each time it joins Wi-Fi.

10. What is the default subnet mask for:
- Class A →
- Class B →
- Class C →
Answer:
Class A: 255.0.0.0

Class B: 255.255.0.0
Class C: 255.255.255.0

Part B – Subnetting Concepts & Calculations

11. What is subnetting and why is it used?

Answer: Subnetting is the process of dividing a larger network into smaller, more manageable subnetworks (subnets).
    Subnetting is used to improve the efficiency, security, and organization of a network by dividing a larger IP address space into smaller, more manageable segments called subnets. This allows network administrators to allocate IP addresses more precisely, reducing waste and ensuring each segment gets just the right number of addresses for its devices. It also helps control traffic flow by limiting broadcasts to smaller areas, which improves performance and simplifies troubleshooting. Additionally, subnetting enhances security by allowing different parts of a network to be isolated and controlled more easily, making it an essential tool for scalable and structured network design.

12. Given the IP address 192.168.1.0/24, how many total IP addresses are available?

Answer: /24 means that 24 bits are used for the network portion, leaving 8 bits for host addresses.
So, 2^8 = 256 total IPs in the range.

13. From question 12, how many usable host IPs are there?

Answer: 2^8 = 256 for the 8 bits left for hosts. But 2 addresses are reserved 192.168.1.0 for the network identifier and 192.168.1.255 for the broadcast address.
So, 256 − 2 = 254 usable IPs.

14. How many subnets can be created from a /24 network if you borrow 2 bits?

Answer: The original /24 network has 256 IPs. By borrowing 2 bits, we're creating 4 smaller subnetworks.

15. What will be the new subnet mask if you borrow 3 bits from a /24 network?

Answer: Original subnet mask: /24 → 255.255.255.0
Borrowed 3 bits: adds to the network portion → /27
Binary for the last octet:11100000 = 224
So, the new subnet mask is 255.255.255.224

16. Given IP: 192.168.10.0/26
- How many hosts per subnet?
- How many subnets can be created?

Answer: A. /26 means 32 – 26 = 6 bits for host addresses.

total IPs = 2^6 = 64

64-2 = 62 usable host addresses

So, 62 hosts per /26 subnet

B.
I. From a /24 block
Difference: 26 – 24 = 2 bits for subnetting

Possible subnets: 2^2 = 4

Each /26 block spans 64 IPs:

192.168.10.0/26

192.168.10.64/26

192.168.10.128/26

192.168.10.192/26

So, 4 subnets per /24

 17. Calculate the first and last usable IP address in the subnet 192.168.10.64/26.

Answer: CIDR Notation: /26
        Subnet Mask: 255.255.255.192
        Total IPs: 64 (that's 262^6, since 32 − 26 = 6 bits for hosts)
         Usable IPs: 62

    IPs reserved 1 for network address and 1 for broadcast address

    First Usable IP: 192.168.10.65

    Last Usable IP: 192.168.10.126

18. Identify the network address and broadcast address of 10.0.0.0/22.

Answer: The /22 network spans from 10.0.0.0 to 10.0.3.255.
    Network Address: 10.0.0.0. This is the starting IP of the block.
    Broadcast Address: 10.0.3.255. This is the highest IP in the range

19. Fill in the blanks:-
b.- CIDR /30 gives _____ usable IP addresses.
.- CIDR /28 supports _____ hosts per subnet.

Answer: A. 2
      B. 14

20. You are given the address block 172.16.0.0/20.
- How many subnets can be created if you want each subnet to support at most 510 hosts?
- What will be the subnet mask?

Answer: A. /20 CIDR means there are 32 - 20 = 12 bits available for host addresses. So, total number of IP addresses in this block: 2^{12} = 4096
number of subnets: 4096/512 = 8
B. 510 usable + 2 reserved. So, Subnet Mask: 255.255.254.0