Q1:

Broadcast address = 42.1.63.255 ;
Max hosts = 16382

I.

Max hosts = $2^{h} - 2$

$2h - 2 = 16382$

$2h = 16384$

$\Rightarrow h = 14$

Host bits = 14 → Network bits = 32 − 14
= 18

Subnet mask = /18
or 255.255.192.0

II.

Broadcast address = 42.1.63.255
=00101010.00000001.00111111.11111111

With /18,
first 18 bits are network

First two octets: 42.1

Third octet: 00111111 → first 2 bits fixed by network mask
11000000→11 = 3

Network address = broadcast address − all host bits set to 0.

For /18:
- Host bits are last 14 bits (bits 19–32).
- Broadcast = all host bits = 1.
- Network = all host bits = 0.

So,
Broadcast = 42.1.63.255
Network = 42.1.0.0

III.

Main network: 42.1.0.0/18

- LAN A: 2000 hosts

Host bits needed: $2h - 2 > 2000$ → $2^{11} - 2 = 2046$
→ h=11; prefix = 32 − 11 = /21.

Subnet size= 2048 addresses.

First subnet: 42.1.0.0/21 (`42.1.0.0`−42.1.7.255).

$2^{10} - 2 = 1022 \rightarrow h=10$, prefix = /22.
Start from 42.1.8.0.
Subnet: 42.1.8.0/22 (`42.1.8.0`–`42.1.11.255`).

- LAN C: 512 hosts

$2^9 - 2 = 510$

Need 512 total IPs $\rightarrow 2^n = 512 \rightarrow n=9$ host bits $\rightarrow$ /23.
Start from 42.1.12.0
Subnet: 42.1.12.0/23(range:42.1.12.0-42.1.13.255`).

WAN links:

Each WAN needs 2 hosts $\rightarrow 2^2 - 2 = 2$ usable $\rightarrow$ /30.
- WAN1: 42.1.14.0/30 (range: 42.1.14.0–42.1.14.3)
- WAN2: `42.1.14.4/30` (range:42.1.14.4 –42.1.14.7)

Q2
I. NAT or PAT: This setup uses PAT (Port Address Translation because:
- There are 100+ internal devices (private IPs) but only 5 public IPs.
- All employees access internet simultaneously → multiple private IPs map to one public IP using different port numbers.
- Key indicators: many internal hosts, few public IPs, simultaneous access.
II. Director's speed issue:
To ensure directors get better speed during office time:
- Implement quality of service to prioritize traffic from directors' IPs/MACs.
- Set up a separate public IP for directors' traffic (dedicated line/IP) to avoid congestion with general staff traffic.

Q3:

Total Length = 5086 bytes
Header length= 5 x 4 = 20bytes
Data length=5086-20= 5066 bytes
MTU of link = 1244 bytes
Max data per fragment =1244 - 20 = 1224bytes

Each fragment data ≤ 1224, and except last must be multiple of 8.
Largest multiple of 8 ≤ 1224 = 1224.
Number of fragments = 5066 / 1224
1224x4 = 4896 (remaining 5066−4896=170)
So 4 full fragments + 1 last fragment =5 fragments.

II. Last fragment data = 170 bytes
Last fragment total length = 170 + 20 = 190bytes.
III.
Fragment offset counts in 8-byte units.
First 4 fragments carry 4 x 1224 = 4896 bytes
Offset = 4896 / 8 = 612.

IV.
All fragments of same original packet have same Identification value so receiver can reassemble them correctly.
V. If DF=1means "Do Not Fragment".
If packet size > MTU, router will discard packet and send an ICMP Destination Unreachable (Fragmentation needed message back to sender.

Q4

I. Recursive static route with AD 2
On R4:
ip route 'LAN1_network' 'mask' 'next_hop_IP' 'AD=2'
Example:
ip route 192.168.1.0 255.255.255.0 10.0.0.1 2
II. ip route 192.168.1.0 255.255.255.0 'exit_interface' 'higher_AD`
Example:
ip route 192.168.1.0 255.255.255.0 Serial0/0 3

Q5

Hello packets are used by Link State protocols (OSPF, IS-IS) to establish neighbor relationships.
Routers R1, R2, R3 (running Link State) will send hello packets to discover neighbors on same subnet.
Routing updates: Distance Vector (RIP) routers R1, R4, ISP will periodically send full routing tables to neighbors.

This is inefficient because:

- It consumes bandwidth even if no change in topology.
- Slow convergence compared to Link State.

Q7
I. ARP request MAC addresses
Source MAC = PC A's MAC address
Destination MAC = `FF:FF:FF:FF:FF:FF` (broadcast)
II. PCB compares target IP address in ARP request with its own IP. If match, it replies.
III.
Router R1 sees it's an ARP request for a host in another subnet (based on target IP), so it will **drop** the ARP request (does not forward ARP broadcasts across subnets).

Q8
I. Problem: DHCP requests are broadcast and don't cross routers by default. Distant subnet has no DHCP server/reachable relay.
II. Two solutions:
1. Configure a DHCP Relay Agent on the router of the new subnet.
2. Set up a local DHCP server in the new subnet.

Q9
Use `traceroute'. It shows each hop (router) between client and destination, with round-trip times.
If the trace stops at a certain hop or shows high latency there, the problem is at that network segment.