1. Explain how the index structure for a Microsoft New Technology File System (NTFS) file can be more compact than the index structure for a UNIX Fast File System (FFS) file.

1. Small files can be completely stored in one MFT records.
2. NTFS uses extents rather than having to index individual disk blocks as done by FFS

2. Explain the statement that a copy-on-write file system optimize writes by transforming random I/O updates to sequential I/O updates.

COW file systems group updates (inode, free space map, indirect blocks, new data blocks) into a single contiguous write rather than randomly-located updates-in-place.

3. Explain how a copy-on-write file system makes the root inode copy-on-write.

Writes the new root inode in a circular buffer with a new version number and a checksum when the updates are completed.

4. Why does ZFS use an AVL tree for free space management instead of a bitmap?

It uses extents rather than blocks as the basis for representing free space. The AVL tree is used to allow fast selection of extent sizes.