Question 1: Logging (Part 2) ....[110 points]

(i) **[10 points]** **Write-Ahead Logging:**
Explain the WAL protocol.

(ii) **[10 points]** **Write-Ahead Logging:**
Explain the buffer pool policies underlying shadow paging.

(iii) **[10 points]** **Write-Ahead Logging:**
List the contents of log entry in a write-ahead log.

(iv) **[10 points]** **Write-Ahead Logging:**
Explain the group commit optimization.

(v) **[10 points]** **Write-Ahead Logging:**
When should the DBMS write dirty pages to disk?

(vi) **[10 points]** **Write-Ahead Logging:**
Explain the limitations of WAL with deferred updates.

(vii) **[10 points]** **Buffer Pool Policies:**
Compare the runtime performance: (1) NO-STEAL and FORCE and (2) STEAL and NO-FORCE.

(viii) **[10 points]** **Buffer Pool Policies:**
Compare the recovery performance: (1) NO-STEAL and FORCE and (2) STEAL and NO-FORCE.

(ix) **[10 points]** **Logging Schemes:**
Distinguish between: (1) physical, (2) logical, and (3) physiological logging schemes.

(x) **[10 points]** **Early Lock Release:**
Explain the benefits of the early lock release optimization.

(xi) **[10 points]** **Checkpointing:**
Explain the purpose of checkpointing.