Solutions

2.1

- $200^3 = 8 \times 10^6$ keys ✓.

2.2

- $8^3 = 512 \geq 500$: height 3 ✓.

2.3

- Table + 4 trees = 5 structure writes ✓.

3.1

- $128^3 \approx 2.1 \times 10^6 < 2 \times 10^7$ is not enough; $128^4 \approx 2.7 \times 10^8$ covers it – height 4 ✓.
- Reads per lookup: 4 node reads ✓.
- Full scan: 2×10^7 row reads ✓.
- Write amplification: $1 + 4 = 5$ structures per insert ✓.
- Plan without index: `SCAN table`; with the key index: `SEARCH … USING INDEX … (key=?)` ✓.

3.2

- The plain equality `title = 'Databases'` uses the index ✓.
- `UPPER(title) = …` computes over the column: the stored sorted keys are not the values being compared – the engine scans ✓.
- Rule: a function over an indexed column defeats a plain index ✓.
- An expression index on `UPPER(title)` serves it – one more tree to maintain on every write, the same loan at higher interest ✓.