Formulas Used:

Offset bits = log2(page size in bytes)

Virtual Address (VA) bits = OS address size

Physical Address (PA) bits = log2(RAM size in bytes)

VPN bits = VA bits − Offset bits

PPN bits = PA bits − Offset bits

1) 32-bit OS, 4-KB pages, 1 GB RAM

- Page size = 4 KB = 4096 B = 2^12 -> Offset = 12
- VA = 32
- RAM = 1 GB = 2^30 B -> PA = 30
- VPN = VA − Offset = 32 − 12 = 20
- PPN = PA − Offset = 30 − 12 = 18

Answers:
a) VA: **32** b) PA: **30** c) VPN: **20** d) PPN: **18** e) Offset: **12**

2) 32-bit OS, 16-KB pages, 2 GB RAM

- Page size = 16 KB = 16384 B = 2^14 -> Offset = 14
- VA = 32
- RAM = 2 GB = 2^31 B -> PA = 31
- VPN = 32 − 14 = 18
- PPN = 31 − 14 = 17

Answers:
a) VA: **32** b) PA: **31** c) VPN: **18** d) PPN: **17** e) Offset: **14**

3) 64-bit OS, 16-KB pages, 16 GB RAM

- Page size = 16 KB = 2^14 -> Offset = 14
- VA = 64
- RAM = 16 GB = 2^34 B -> PA = 34
- VPN = 64 − 14 = 50
- PPN = 34 − 14 = 20

Answers:
a) VA: **64** b) PA: **34** c) VPN: **50** d) PPN: **20** e) Offset: **14**

All 15 numbers (in order a–e for each row)

1. 32, 30, 20, 18, 12
2. 32, 31, 18, 17, 14
3. 64, 34, 50, 20, 14