Exercise 1 – Disk Management with LVM

Tasks to Perform on AlmaLinux:

1. Add **three SATA** drives to your AlmaLinux virtual machine (**5 GB** each).
2. Open a Shell terminal and type the **sudo -su** command to work with the **root** account.
3. Check that all three disks are added.

```
root@server07 ~ $ lsblk
NAME   MAJ:MIN RM SIZE RO TYPE MOUNTPOINTS
sda      8:0    0  60G  0 disk
├─sda1   8:1    0   2M  0 part
├─sda2   8:2    0   1G  0 part /boot
├─sda3   8:3    0   8G  0 part /var
├─sda4   8:4    0   1K  0 part
├─sda5   8:5    0   7G  0 part /home
├─sda6   8:6    0   4G  0 part [SWAP]
└─sda7   8:7    0  40G  0 part /
sdb      8:16   0   5G  0 disk
sdc      8:32   0   5G  0 disk
sdd      8:48   0   5G  0 disk
root@server07 ~ $
```

4. For each disk, create a **physical volume** (total of **3 PV**).
5. Check that the three physical volumes are created correctly.

```
root@server07 ~ $ pvcreate /dev/sdb /dev/sdc /dev/sdd
  Physical volume "/dev/sdb" successfully created.
  Physical volume "/dev/sdc" successfully created.
  Physical volume "/dev/sdd" successfully created.
  Creating devices file /etc/lvm/devices/system.devices
root@server07 ~ $ pvs
  PV         VG Fmt  Attr PSize PFree
  /dev/sdb      lvm2 ---  5.00g 5.00g
  /dev/sdc      lvm2 ---  5.00g 5.00g
  /dev/sdd      lvm2 ---  5.00g 5.00g
root@server07 ~ $
```

```
root@server07 ~ $ pvdisplay
  "/dev/sdb" is a new physical volume of "5.00 GiB"
  --- NEW Physical volume ---
  PV Name               /dev/sdb
  VG Name
  PV Size               5.00 GiB
  Allocatable           NO
  PE Size               0
  Total PE              0
  Free PE               0
  Allocated PE          0
  PV UUID               yDfdhh-n99g-5TIj-DkcO-pZds-iN2W-RtwXhp

  "/dev/sdc" is a new physical volume of "5.00 GiB"
  --- NEW Physical volume ---
  PV Name               /dev/sdc
  VG Name
  PV Size               5.00 GiB
  Allocatable           NO
  PE Size               0
  Total PE              0
  Free PE               0
  Allocated PE          0
  PV UUID               UPWqaC-gzRz-xSUl-BFWp-1py7-JOZG-MjR3Ml
```

```
  "/dev/sdd" is a new physical volume of "5.00 GiB"
  --- NEW Physical volume ---
  PV Name               /dev/sdd
  VG Name
  PV Size               5.00 GiB
  Allocatable           NO
  PE Size               0
  Total PE              0
  Free PE               0
  Allocated PE          0
  PV UUID               ZD3ONO-CRag-bttg-ulvS-E2du-Tw2z-0ZmBT3

root@server07 ~ $
```

6. Create a **Volume Group** using **only two physical volumes**, and name it **LAB4_VG**.

7. Verify that the volume group **LAB4_VG** is created.

```
root@server07 ~ $ vgcreate LAB4_VG /dev/sdb /dev/sdc
  Volume group "LAB4_VG" successfully created
root@server07 ~ $ vgs
  VG      #PV #LV #SN Attr   VSize VFree
  LAB4_VG   2   0   0 wz--n- 9.99g 9.99g
root@server07 ~ $ vgdisplay LAB4_VG
  --- Volume group ---
  VG Name               LAB4_VG
  System ID
  Format                lvm2
  Metadata Areas        2
  Metadata Sequence No  1
  VG Access             read/write
  VG Status             resizable
  MAX LV                0
  Cur LV                0
  Open LV               0
  Max PV                0
  Cur PV                2
  Act PV                2
  VG Size               9.99 GiB
  PE Size               4.00 MiB
  Total PE              2558
  Alloc PE / Size       0 / 0
  Free  PE / Size       2558 / 9.99 GiB
  VG UUID               9fomiN-Zqf2-5hhv-kHR7-jsrc-nUJK-QRI2CQ
```

8. In the new volume group, create these **two logical volumes**:

Name	Size
LV1	6 GB
LV2	3 GB

9. Check that the two logical volumes are created correctly.

```
root@server07 ~ $ lvcreate -L 6G -n LV1 LAB4_VG
  Logical volume "LV1" created.
root@server07 ~ $ lvcreate -L 3G -n LV2 LAB4_VG
  Logical volume "LV2" created.
root@server07 ~ $ lvs
  LV   VG      Attr       LSize Pool Origin Data%  Meta%  Move Log Cpy%Sync Convert
  LV1  LAB4_VG -wi-a----- 6.00g
  LV2  LAB4_VG -wi-a----- 3.00g
```

```
root@server07 ~ $ lvdisplay
  --- Logical volume ---
  LV Path                /dev/LAB4_VG/LV1
  LV Name                LV1
  VG Name                LAB4_VG
  LV UUID                2r2XBk-rDsQ-AB21-R7wc-c5ar-Vvl5-WEBqyr
  LV Write Access        read/write
  LV Creation host, time server07, 2025-03-29 13:23:52 -0400
  LV Status              available
  # open                 0
  LV Size                6.00 GiB
  Current LE             1536
  Segments               2
  Allocation             inherit
  Read ahead sectors     auto
  - currently set to     256
  Block device           253:0

  --- Logical volume ---
  LV Path                /dev/LAB4_VG/LV2
  LV Name                LV2
  VG Name                LAB4_VG
  LV UUID                XGMWJL-Rqnp-TN3N-gIcT-5moU-FGge-qFXZXZ
  LV Write Access        read/write
  LV Creation host, time server07, 2025-03-29 13:24:38 -0400
  LV Status              available
  # open                 0
  LV Size                3.00 GiB
  Current LE             768
```

10. Format **LV1** and **LV2** as **ext4.**

```
root@server07 ~ $ mkfs.ext4 /dev/LAB4_VG/LV1
mke2fs 1.46.5 (30-Dec-2021)
Creating filesystem with 1572864 4k blocks and 393216 inodes
Filesystem UUID: f2798047-1e18-4ef8-90f4-3dacea88ff42
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912, 819200, 884736

Allocating group tables: done
Writing inode tables: done
Creating journal (16384 blocks): done
Writing superblocks and filesystem accounting information: done

root@server07 ~ $ mkfs.ext4 /dev/LAB4_VG/LV2
mke2fs 1.46.5 (30-Dec-2021)
Creating filesystem with 786432 4k blocks and 196608 inodes
Filesystem UUID: 2ddbaa57-a004-4b21-9b5e-491b94250279
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912

Allocating group tables: done
Writing inode tables: done
Creating journal (16384 blocks): done
Writing superblocks and filesystem accounting information: done
```

11. Check that the LV1 and LV2 are properly formatted.

```
root@server07 ~ $ lsblk -f
NAME          FSTYPE      FSVER    LABEL UUID                                   FSAVAIL FSUSE% MOUNTPOINTS
sda
├─sda1
├─sda2        xfs                      e2a2a810-5eee-40db-9e03-1060581893ff    514.6M    46% /boot
├─sda3        xfs                      0573d09b-6afb-438e-b5c0-76dd94bf6845      7.2G     9% /var
├─sda4
├─sda5        xfs                      3a0ad093-7f68-4289-84c0-d252e1c84244      6.8G     1% /home
├─sda6        swap        1            6d92f581-372c-43b9-9d5d-c7579d06f171                  [SWAP]
└─sda7        xfs                      ea08ae8b-6d56-48e6-ad9f-712be8ca5828     34.9G    13% /
sdb           LVM2_member LVM2 001     yDfdhh-n99g-5TIj-DkcO-pZds-iN2W-RtwXhp
└─LAB4_VG-LV1 ext4        1.0          f2798047-1e18-4ef8-90f4-3dacea88ff42
sdc           LVM2_member LVM2 001     UPWqaC-gzRz-xSUl-BFWp-1py7-JOZG-MjR3Ml
├─LAB4_VG-LV1 ext4        1.0          f2798047-1e18-4ef8-90f4-3dacea88ff42
└─LAB4_VG-LV2 ext4        1.0          2ddbaa57-a004-4b21-9b5e-491b94250279
sdd           LVM2_member LVM2 001     ZD3ONO-CRag-bttg-ulvS-E2du-Tw2z-0ZmBT3
root@server07 ~ $
```

```
root@server07 ~ $ blkid | grep LAB4_VG
/dev/mapper/LAB4_VG-LV2: UUID="2ddbaa57-a004-4b21-9b5e-491b94250279" TYPE="ext4"
/dev/mapper/LAB4_VG-LV1: UUID="f2798047-1e18-4ef8-90f4-3dacea88ff42" TYPE="ext4"
root@server07 ~ $
```

12. Create the **/Docs** directory.

13. Create the **/home/*<your_user>*/volume** directory**.**

14. Mount **LV1** in **/Docs**

15. Mount **LV2** in **/home/*<your_user>*/volume.**

16. Check that the two logical volumes **LV1** and **LV2** are mounted correctly.

```
root@server07 ~ $ mkdir /Docs
root@server07 ~ $ mkdir /home/gkeymole/volume
root@server07 ~ $ mount /dev/LAB4_VG/LV1 /Docs
root@server07 ~ $ mount /dev/LAB4_VG/LV2 /home/gkeymole/volume
root@server07 ~ $ df -h
Filesystem                Size  Used Avail Use% Mounted on
devtmpfs                  4.0M     0  4.0M   0% /dev
tmpfs                     1.8G     0  1.8G   0% /dev/shm
tmpfs                     726M  9.7M  716M   2% /run
/dev/sda7                  40G  5.1G   35G  13% /
/dev/sda2                 960M  446M  515M  47% /boot
/dev/sda3                 8.0G  721M  7.3G   9% /var
/dev/sda5                 7.0G  102M  6.9G   2% /home
tmpfs                     363M  104K  363M   1% /run/user/1000
/dev/mapper/LAB4_VG-LV1   5.9G   24K  5.6G   1% /Docs
/dev/mapper/LAB4_VG-LV2   2.9G   24K  2.8G   1% /home/gkeymole/volume
root@server07 ~ $
```

```
root@server07 ~ $ df -Th
Filesystem              Type      Size  Used Avail Use% Mounted on
devtmpfs                devtmpfs  4.0M     0  4.0M   0% /dev
tmpfs                   tmpfs     1.8G     0  1.8G   0% /dev/shm
tmpfs                   tmpfs     726M  9.7M  716M   2% /run
/dev/sda7               xfs        40G  5.1G   35G  13% /
/dev/sda2               xfs       960M  446M  515M  47% /boot
/dev/sda3               xfs       8.0G  721M  7.3G   9% /var
/dev/sda5               xfs       7.0G  102M  6.9G   2% /home
tmpfs                   tmpfs     363M  104K  363M   1% /run/user/1000
/dev/mapper/LAB4_VG-LV1 ext4      5.9G   24K  5.6G   1% /Docs
/dev/mapper/LAB4_VG-LV2 ext4      2.9G   24K  2.8G   1% /home/gkeymole/volume
root@server07 ~ $
```

17. Add the **3rd physical disk** to the **LAB4_VG volume group.**

18. Extend the size of the **LV1** by **5 GB** more, for a total size of **11 GB.**

```
root@server07 ~ $ vgextend LAB4_VG /dev/sdd
  Volume group "LAB4_VG" successfully extended
root@server07 ~ $ lvextend -L +5G /dev/LAB4_VG/LV1
  Size of logical volume LAB4_VG/LV1 changed from 6.00 GiB (1536 extents) to 11.00 GiB (2816 extents).
  Logical volume LAB4_VG/LV1 successfully resized.
root@server07 ~ $
```

19. Decrease the size of the **LV2** by **250 MB**.

```
root@server07 ~ $ umount /home/gkeymole/volume
root@server07 ~ $ lvresize --resizefs --size -250m /dev/LAB4_VG/LV2
  Rounding size to boundary between physical extents: 248.00 MiB.
  File system ext4 found on LAB4_VG/LV2.
  File system size (3.00 GiB) is larger than the requested size (<2.76 GiB).
  File system reduce is required using resize2fs.
  File system fsck will be run before reduce.
  Reducing file system ext4 to <2.76 GiB (2961178624 bytes) on LAB4_VG/LV2...
e2fsck /dev/LAB4_VG/LV2
/dev/LAB4_VG/LV2: 11/196608 files (0.0% non-contiguous), 31036/786432 blocks
e2fsck done
resize2fs /dev/LAB4_VG/LV2 2891776k
resize2fs 1.46.5 (30-Dec-2021)
Resizing the filesystem on /dev/LAB4_VG/LV2 to 722944 (4k) blocks.
The filesystem on /dev/LAB4_VG/LV2 is now 722944 (4k) blocks long.

resize2fs done
  Reduced file system ext4 on LAB4_VG/LV2.
  Size of logical volume LAB4_VG/LV2 changed from 3.00 GiB (768 extents) to <2.76 GiB (706 extents).
  Logical volume LAB4_VG/LV2 successfully resized.
root@server07 ~ $
```

20. Check that the size of the **LV1** and **LV2** have changed.

```
root@server07 ~ $ lsblk -f
NAME          FSTYPE      FSVER    LABEL UUID                                   FSAVAIL FSUSE% MOUNTPOINTS
sda
├─sda1
├─sda2        xfs                      e2a2a810-5eee-40db-9e03-1060581893ff    514.6M    46% /boot
├─sda3        xfs                      0573d09b-6afb-438e-b5c0-76dd94bf6845      7.2G     9% /var
├─sda4
├─sda5        xfs                      3a0ad093-7f68-4289-84c0-d252e1c84244      6.8G     1% /home
├─sda6        swap        1            6d92f581-372c-43b9-9d5d-c7579d06f171                   [SWAP]
└─sda7        xfs                      ea08ae8b-6d56-48e6-ad9f-712be8ca5828     34.9G    13% /
sdb           LVM2_member LVM2 001     yDfdhh-n99g-5TIj-DkcO-pZds-iN2W-RtwXhp
└─LAB4_VG-LV1 ext4        1.0          f2798047-1e18-4ef8-90f4-3dacea88ff42      5.5G     0% /Docs
sdc           LVM2_member LVM2 001     UPWqaC-gzRz-xSUl-BFWp-1py7-JOZG-MjR3Ml
├─LAB4_VG-LV1 ext4        1.0          f2798047-1e18-4ef8-90f4-3dacea88ff42      5.5G     0% /Docs
└─LAB4_VG-LV2 ext4        1.0          2ddbaa57-a004-4b21-9b5e-491b94250279
sdd           LVM2_member LVM2 001     ZD3ONO-CRag-bttg-ulvS-E2du-Tw2z-0ZmBT3
└─LAB4_VG-LV1 ext4        1.0          f2798047-1e18-4ef8-90f4-3dacea88ff42      5.5G     0% /Docs
root@server07 ~ $ lvs
  LV   VG      Attr       LSize  Pool Origin Data%  Meta%  Move Log Cpy%Sync Convert
  LV1  LAB4_VG -wi-ao---- 11.00g
  LV2  LAB4_VG -wi-a----- <2.76g
root@server07 ~ $
```

21. Delete the **LV2** logical volume**. *(Remember to unmount it the volume before).***

22. Check that the logical volume **LV2** has been deleted.

```
root@server07 ~ $ lvremove /dev/LAB4_VG/LV2
Do you really want to remove active logical volume LAB4_VG/LV2? [y/n]: y
  Logical volume "LV2" successfully removed.
root@server07 ~ $ lsblk
NAME          MAJ:MIN RM SIZE RO TYPE MOUNTPOINTS
sda             8:0    0  60G  0 disk
├─sda1          8:1    0   2M  0 part
├─sda2          8:2    0   1G  0 part /boot
├─sda3          8:3    0   8G  0 part /var
├─sda4          8:4    0   1K  0 part
├─sda5          8:5    0   7G  0 part /home
├─sda6          8:6    0   4G  0 part [SWAP]
└─sda7          8:7    0  40G  0 part /
sdb             8:16   0   5G  0 disk
└─LAB4_VG-LV1 253:0    0  11G  0 lvm  /Docs
sdc             8:32   0   5G  0 disk
└─LAB4_VG-LV1 253:0    0  11G  0 lvm  /Docs
sdd             8:48   0   5G  0 disk
└─LAB4_VG-LV1 253:0    0  11G  0 lvm  /Docs
```

23. Unmount the **/Docs** directory.

```
root@server07 ~ $ umount /Docs
root@server07 ~ $
```

Exercise 2 – Limiting Storage Space Usage with Quotas

Tasks to Perform on AlmaLinux:

1. Continue working using the **root** account.
2. Check that the **quota** system is installed on your machine

```
root@server07 ~ $ dnf list quota
Last metadata expiration check: 0:50:11 ago on Sat 29 Mar 2025 02:22:59 PM.
Installed Packages
quota.x86_64                                1:4.09-2.el9                                @anaconda
root@server07 ~ $
```

3. Activate the **quota** system on the logical volume **/dev/LAB4_VG/LV1:**

   mkfs.ext4 -O quota /dev/LAB4_VG/LV1

   mount /dev/LAB4_VG/LV1 /Docs

   quotaon /Docs

```
root@server07 ~ $ mkfs.ext4 -O quota /dev/LAB4_VG/LV1
mke2fs 1.46.5 (30-Dec-2021)
/dev/LAB4_VG/LV1 contains a ext4 file system
        last mounted on Sat Mar 29 13:35:37 2025
Proceed anyway? (y,N) y
Creating filesystem with 2883584 4k blocks and 720896 inodes
Filesystem UUID: 3403ce3a-a365-4649-aa30-add7d211ddec
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912, 819200, 884736, 1605632, 2654208

Allocating group tables: done
Writing inode tables: done
Creating journal (16384 blocks): done
Writing superblocks and filesystem accounting information: done

root@server07 ~ $ mount /dev/LAB4_VG/LV1 /Docs
root@server07 ~ $ quotaon /Docs
root@server07 ~ $
```

4. Create the user **antoine** with the password **alma.**

5. Assign **antoine** as owner of the folder **/Docs.**

```
root@server07 ~ $ useradd antoine
root@server07 ~ $ passwd alma
passwd: Unknown user name 'alma'.
root@server07 ~ $ passwd antoine
Changing password for user antoine.
New password:
BAD PASSWORD: The password is shorter than 8 characters
Retype new password:
passwd: all authentication tokens updated successfully.
root@server07 ~ $ chown antoine:antoine /Docs
root@server07 ~ $
```

6. Modify the quota of **antoine** on the **/Docs** directory with the following configuration:

```
Disk quotas for user antoine (uid 1001):
  Filesystem                   blocks       soft       hard     inodes     soft     hard
  /dev/mapper/LAB4_VG-LV1           4          0         50          0        0        0
```

soft Blocks	hard blocks	soft inode	hard Inode
0	**50**	0	**0**

7. Switch to user antoine: **su - antoine**

8. Try to copy the **/etc/services** file to **/Docs.**

```
root@server07 ~ $ su - antoine
[antoine@server07 ~]$ cp /etc/services /Docs
dm-0: write failed, user block limit reached.
cp: error writing '/Docs/services': Disk quota exceeded
[antoine@server07 ~]$
```

9. Can you do that? Why? **No, the copy failed because user antoine has reached their block quota limit. The system output says, that user cant write more data to /Docs because of the hard limit of 50 has been exceeded.**

10. List the **quota** used by the **antoine** user.

```
[antoine@server07 ~]$ quota
Disk quotas for user antoine (uid 1001):
     Filesystem  blocks   quota   limit   grace   files   quota   limit   grace
/dev/mapper/LAB4_VG-LV1
                    48       0      50              2       0       0
[antoine@server07 ~]$
```

11. Did he exceed his quota?

    If usage is near or equal to 50 blocks, then yes, the hard block quota is reached.

12. Return to your **root** session**: exit**

13. View a **quota usage report**.

```
root@server07 ~ $ repquota -a
*** Report for user quotas on device /dev/mapper/LAB4_VG-LV1
Block grace time: 7days; Inode grace time: 7days
                        Block limits                File limits
User            used    soft    hard  grace    used  soft  hard  grace
----------------------------------------------------------------------
root      --      16       0       0              1     0     0
antoine   --      48       0      50              2     0     0


root@server07 ~ $
```

14. Modify again the quota of **antoine** on the **/Docs** directory with the following configuration:

```
Disk quotas for user antoine (uid 1001):
  Filesystem                   blocks       soft       hard     inodes     soft     hard
  /dev/mapper/LAB4_VG-LV1          48          0          0          2        0        8
```

Soft Blocks	Strict blocks	Soft inode	Strict Inode
0	**0**	0	**8**

15. Switch to user antoine: **su - antoine**

16. Create **5 files** in **/Docs**.

```
root@server07 ~ $ edquota antoine
root@server07 ~ $ su - antoine
[antoine@server07 ~]$ touch /Docs/file{1..5}
[antoine@server07 ~]$
```

17. Can you do that? Why?

Yes, because the quota allows up to 8 inodes (files), and Antoine had only used 2 before. Now he's at 7 total inodes (2 old + 5 new).

18. Create **5 more files** in **/Docs**.

```
[antoine@server07 ~]$ touch /Docs/file{6..10}
dm-0: write failed, user file limit reached.
touch: cannot touch '/Docs/file7': Disk quota exceeded
touch: cannot touch '/Docs/file8': Disk quota exceeded
touch: cannot touch '/Docs/file9': Disk quota exceeded
touch: cannot touch '/Docs/file10': Disk quota exceeded
[antoine@server07 ~]$
```

19. Can you do that? Why?

No, you cannot create 5 more files in /Docs because the file (inode) quota limit of 8 has been reached for the user antoine. The error Disk quota exceeded confirms this.

20. List the **quota** used by the **antoine** user.

```
[antoine@server07 ~]$ quota
Disk quotas for user antoine (uid 1001):
     Filesystem  blocks   quota   limit   grace   files   quota   limit   grace
/dev/mapper/LAB4_VG-LV1
                    48       0       0              8*      0       8
```

21. Did **antoine** exceed his quota?

Yes, antoine exceeded his inode (file) quota. He has created 8 files, which is the maximum allowed by the hard limit. The * symbol next to the number confirms the quota has been exceeded.

22. Return to the **root** session.

23. View a quota usage report of your system.

```
root@server07 ~ $ repquota -a
*** Report for user quotas on device /dev/mapper/LAB4_VG-LV1
Block grace time: 7days; Inode grace time: 7days
                        Block limits                File limits
User            used    soft    hard  grace    used  soft  hard  grace
----------------------------------------------------------------------
root      --      16       0       0              1     0     0
antoine   --      48       0       0              8     0     8
```

Exercise 3 – Delete Logical Volumes

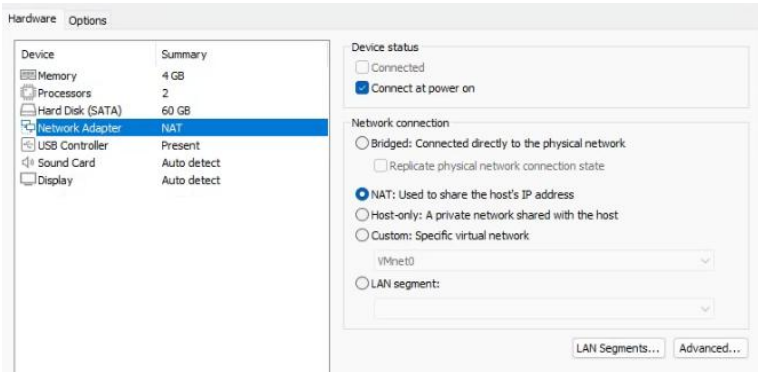
1. Unmount the **/Docs** directory.
2. Delete logical volume **LV1**.

```
root@server07 ~ $ umount /Docs
root@server07 ~ $ lvremove /dev/LAB4_VG/LV1
Do you really want to remove active logical volume LAB4_VG/LV1? [y/n]: y
  Logical volume "LV1" successfully removed.
root@server07 ~ $
```

3. Delete the volume group **LAB4_VG**.
4. Delete the **three physical volumes**.

```
root@server07 ~ $ vgremove LAB4_VG
  Volume group "LAB4_VG" successfully removed
root@server07 ~ $ pvremove /dev/sdb /dev/sdc /dev/sdd
  Labels on physical volume "/dev/sdb" successfully wiped.
  Labels on physical volume "/dev/sdc" successfully wiped.
  Labels on physical volume "/dev/sdd" successfully wiped.
root@server07 ~ $
```

5. Shut down the virtual machine and remove the **three new disks from the VM.**




```
gkeymole@server07 ~ $ lsblk
NAME   MAJ:MIN RM SIZE RO TYPE MOUNTPOINTS
sda      8:0    0  60G  0 disk
├─sda1   8:1    0   2M  0 part
├─sda2   8:2    0   1G  0 part /boot
├─sda3   8:3    0   8G  0 part /var
├─sda4   8:4    0   1K  0 part
├─sda5   8:5    0   7G  0 part /home
├─sda6   8:6    0   4G  0 part [SWAP]
└─sda7   8:7    0  40G  0 part /
gkeymole@server07 ~ $
```