Lab Exercise 14- Implementing Resource Quota in Kubernetes

Objective:

In Kubernetes, Resource Quotas are used to control the resource consumption of namespaces. They help in managing and enforcing limits on the usage of resources like CPU, memory, and the number of objects (e.g., Pods, Services) within a namespace. This exercise will guide you through creating and managing Resource Quotas to limit the resources used by applications in a specific namespace.

Step 1: Understand Resource Quotas

Resource Quotas allow you to:

- Limit the amount of CPU and memory a namespace can use.
- Control the number of certain types of resources (e.g., Pods, Services, PersistentVolumeClaims) in a namespace.
- Prevent a namespace from consuming more resources than allocated, ensuring fair usage across multiple teams or applications.

Step 2: Create a Namespace

First, create a namespace where you will apply the Resource Quota. This helps in isolating and controlling resource usage within that specific namespace.
Create a YAML file named **quota-namespace.yaml** with the following content:

```
apiVersion: v1
kind: Namespace
metadata:
  name: myns
```

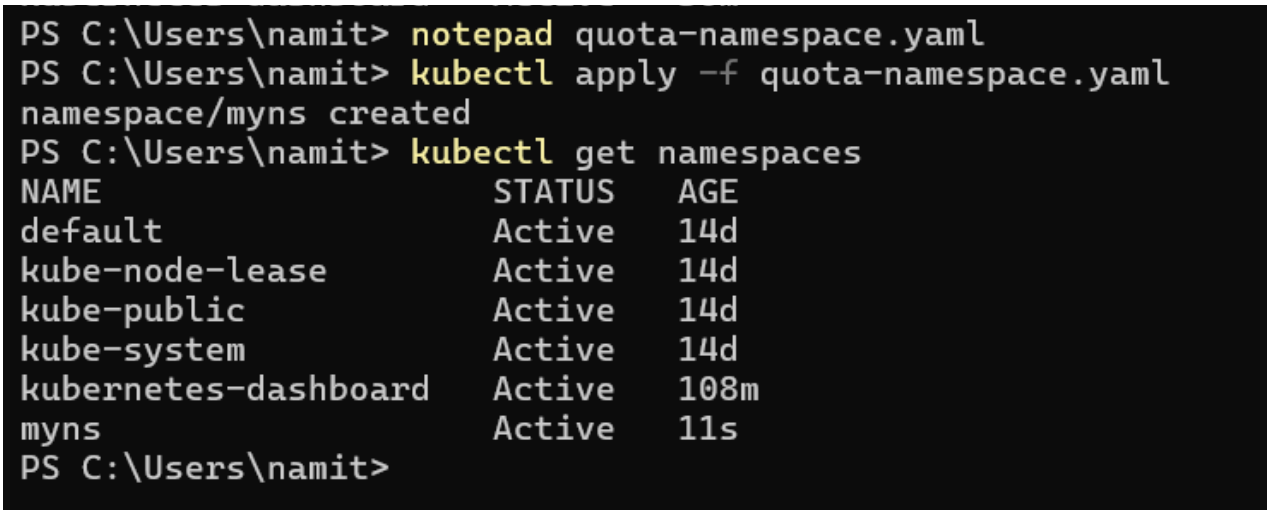
Apply the YAML to create the namespace:

```
kubectl apply -f quota-namespace.yaml
```

Verify that the namespace is created:

```
kubectl get namespaces
```

You should see quota-example listed in the output.



Step 3: Define a Resource Quota

Next, create a Resource Quota YAML file named **resource-quota.yaml** with the following content:

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: myns-quota    # The name of the Resource Quota.
  namespace: myns # The namespace to which the Resource Quota will apply.
spec:
  hard:               # The hard limits imposed by this Resource Quota.
    requests.cpu: "2"    # The total CPU resource requests allowed in the namespace (2 cores).
    requests.memory: "4Gi" # The total memory resource requests allowed in the namespace (4 GiB).
    limits.cpu: "4"      # The total CPU resource limits allowed in the namespace (4 cores).
    limits.memory: "8Gi" # The total memory resource limits allowed in the namespace (8 GiB).
    pods: "10"           # The total number of Pods allowed in the namespace.
    persistentvolumeclaims: "5" # The total number of PersistentVolumeClaims allowed in the namespace.
    configmaps: "10"     # The total number of ConfigMaps allowed in the namespace.
    services: "5"        # The total number of Services allowed in the namespace.
```

Step 4: Apply the Resource Quota

Apply the Resource Quota YAML to the namespace:

```
kubectl apply -f resource-quota.yaml
```

Verify that the Resource Quota is applied:

```
kubectl get resourcequota -n myns
```

```
PS C:\Users\namit> notepad resource-quota.yaml
PS C:\Users\namit> kubectl apply -f resource-quota.yaml
resourcequota/myns-quota created
PS C:\Users\namit> kubectl get resourcequota -n myns
NAME         AGE   REQUEST                                                                                 LIMIT
myns-quota   42s   configmaps: 1/10, persistentvolumeclaims: 0/5, pods: 0/10, requests.cpu: 0/2, requests.memory: 0/4Gi, services: 0/5   limits.cpu: 0/4, li
mits.memory: 0/8Gi
PS C:\Users\namit>
```

To see the details of the applied Resource Quota:

```
kubectl describe resourcequota myns-quota -n myns
```

```
PS C:\Users\namit> kubectl describe resourcequota myns-quota -n myns
Name:                   myns-quota
Namespace:              myns
Resource                Used  Hard
--------                ----  ----
configmaps              1     10
limits.cpu              0     4
limits.memory           0     8Gi
persistentvolumeclaims  0     5
pods                    0     10
requests.cpu            0     2
requests.memory         0     4Gi
services                0     5
PS C:\Users\namit>
```

Step 5: Test the Resource Quota

Let's create some resources in the quota-example namespace to see how the Resource Quota affects them.

Deploy a ReplicaSet with Resource Requests and Limits
Create a YAML file named **nginx-replicaset-quota.yaml** with the following content:

```
apiVersion: apps/v1
kind: ReplicaSet
metadata:
  name: nginx-replicaset
  namespace: myns
spec:
```

```
  replicas: 5           # Desired number of Pod replicas.
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - containerPort: 80
        resources:        # Define resource requests and limits.
          requests:
            memory: "100Mi"
            cpu: "100m"
          limits:
            memory: "200Mi"
            cpu: "200m"
```

Explanation:

This ReplicaSet requests a total of 500m CPU and 500Mi memory across 5 replicas.
It also limits each replica to use a maximum of 200m CPU and 200Mi memory.

Apply this YAML to create the ReplicaSet:

```
kubectl apply -f nginx-replicaset-quota.yaml
```

```
PS C:\Users\namit> notepad nginx-replicaset-quota.yaml
PS C:\Users\namit> kubectl apply -f nginx-replicaset-quota.yaml
replicaset.apps/nginx-replicaset created
PS C:\Users\namit>
```

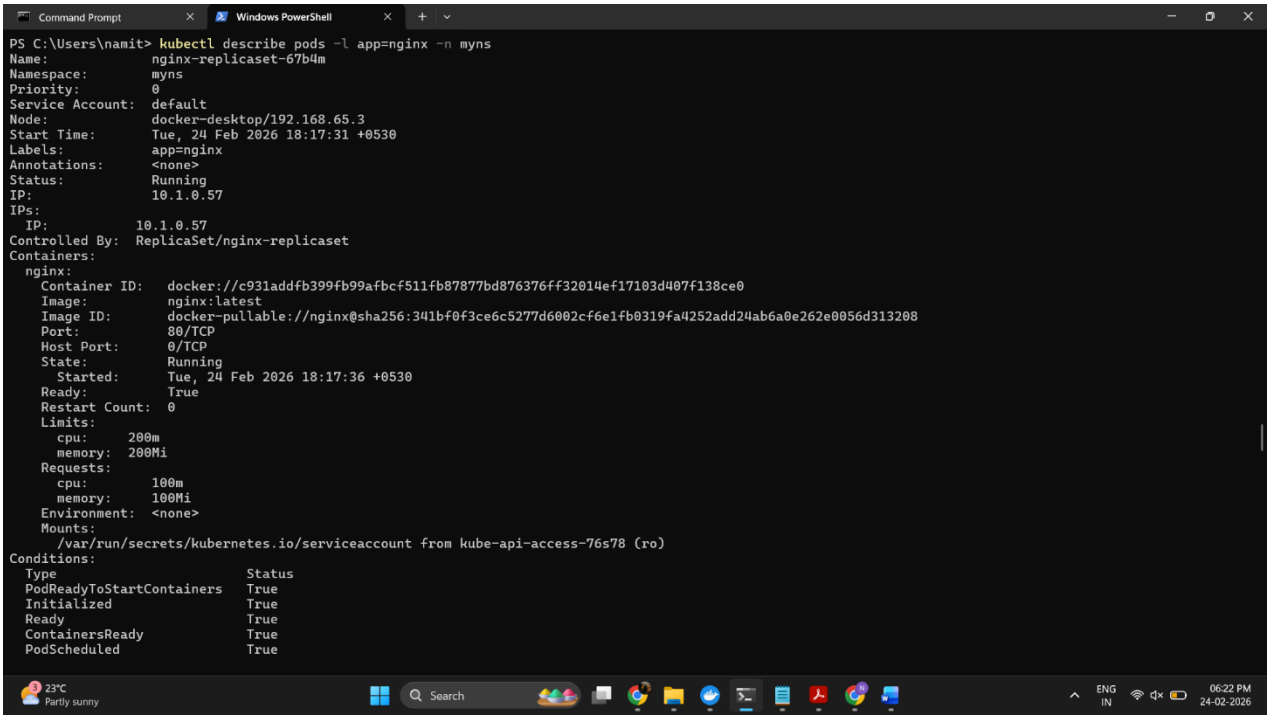
Check the status of the Pods and ensure they are created within the constraints of the Resource Quota:

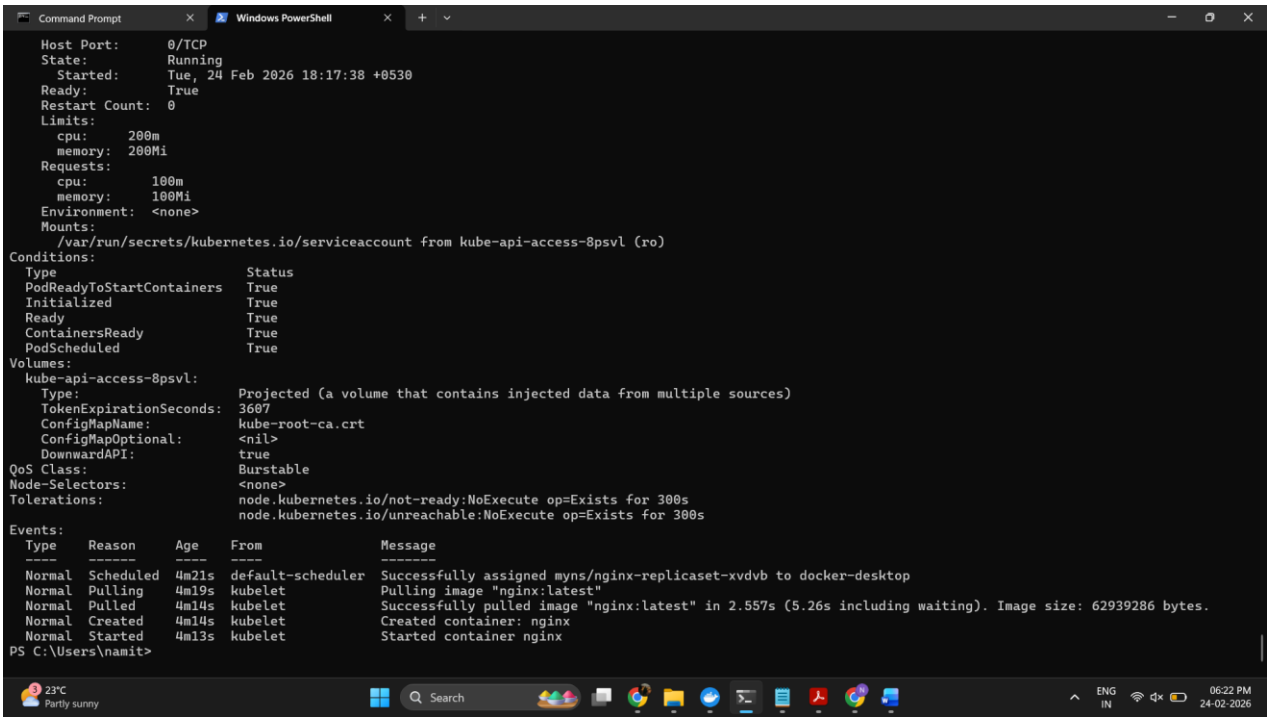
```
kubectl get pods -n myns
```

```
PS C:\Users\namit> kubectl get pods -n myns
NAME                    READY   STATUS    RESTARTS   AGE
nginx-replicaset-67b4m   1/1     Running   0          73s
nginx-replicaset-b76tj   1/1     Running   0          73s
nginx-replicaset-q96g5   1/1     Running   0          73s
nginx-replicaset-wgj45   1/1     Running   0          73s
nginx-replicaset-xvdvb   1/1     Running   0          73s
PS C:\Users\namit>
```

To describe the Pods and see their resource allocations:

```
kubectl describe pods -l app=nginx -n quota-example
```





Attempt to Exceed the Resource Quota

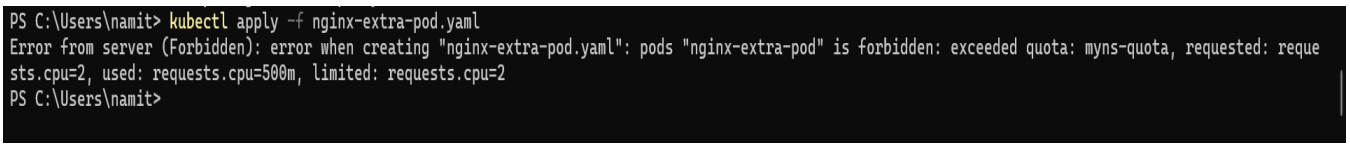
Try creating additional resources to see if they are rejected when exceeding the quota. For example, create more Pods or increase the CPU/memory requests to exceed the quota limits.

Create a YAML file named nginx-extra-pod.yaml with the following content:

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx-extra-pod
  namespace: myns
spec:
  containers:
  - name: nginx
    image: nginx:latest
    resources:
      requests:
        memory: "3Gi" # Requests a large amount of memory.
        cpu: "2"      # Requests a large amount of CPU.
      limits:
        memory: "4Gi"
        cpu: "2"
```

Apply this YAML to create the Pod:

```
kubectl apply -f nginx-extra-pod.yaml
```



This should fail due to exceeding the Resource Quota. Check the events to see the failure reason:

```
kubectl get events -n quota-example
```

Look for error messages indicating that the Pod creation was denied due to resource constraints.

```
PS C:\Users\namit>  kubectl get events -n myns
LAST SEEN   TYPE      REASON             OBJECT                          MESSAGE
18s         Normal    Scheduled          pod/nginx-replicaset-26zdk      Successfully assigned myns/nginx-replicaset-26zdk to docker-desktop
16s         Normal    Pulling            pod/nginx-replicaset-26zdk      Pulling image "nginx:latest"
20m         Normal    Scheduled          pod/nginx-replicaset-67b4m      Successfully assigned myns/nginx-replicaset-67b4m to docker-desktop
20m         Normal    Pulling            pod/nginx-replicaset-67b4m      Pulling image "nginx:latest"
20m         Normal    Pulled             pod/nginx-replicaset-67b4m      Successfully pulled image "nginx:latest" in 2.722s (2.722s including waiting). Image
size: 62939286 bytes.
20m         Normal    Created            pod/nginx-replicaset-67b4m      Created container: nginx
20m         Normal    Started            pod/nginx-replicaset-67b4m      Started container nginx
18s         Normal    Scheduled          pod/nginx-replicaset-75tjx      Successfully assigned myns/nginx-replicaset-75tjx to docker-desktop
16s         Normal    Pulling            pod/nginx-replicaset-75tjx      Pulling image "nginx:latest"
2s          Normal    Pulled             pod/nginx-replicaset-75tjx      Successfully pulled image "nginx:latest" in 3.192s (13.776s including waiting). Image
 size: 62939286 bytes.
2s          Normal    Created            pod/nginx-replicaset-75tjx      Created container: nginx
2s          Normal    Started            pod/nginx-replicaset-75tjx      Started container nginx
18s         Normal    Scheduled          pod/nginx-replicaset-7cj4z      Successfully assigned myns/nginx-replicaset-7cj4z to docker-desktop
16s         Normal    Pulling            pod/nginx-replicaset-7cj4z      Pulling image "nginx:latest"
9s          Normal    Pulled             pod/nginx-replicaset-7cj4z      Successfully pulled image "nginx:latest" in 2.969s (7.421s including waiting). Image
size: 62939286 bytes.
9s          Normal    Created            pod/nginx-replicaset-7cj4z      Created container: nginx
8s          Normal    Started            pod/nginx-replicaset-7cj4z      Started container nginx
20m         Normal    Scheduled          pod/nginx-replicaset-b76tj      Successfully assigned myns/nginx-replicaset-b76tj to docker-desktop
20m         Normal    Pulling            pod/nginx-replicaset-b76tj      Pulling image "nginx:latest"
19m         Normal    Pulled             pod/nginx-replicaset-b76tj      Successfully pulled image "nginx:latest" in 2.599s (10.501s including waiting). Image
 size: 62939286 bytes.
19m         Normal    Created            pod/nginx-replicaset-b76tj      Created container: nginx
19m         Normal    Started            pod/nginx-replicaset-b76tj      Started container nginx
20m         Normal    Scheduled          pod/nginx-replicaset-q96g5      Successfully assigned myns/nginx-replicaset-q96g5 to docker-desktop
20m         Normal    Pulling            pod/nginx-replicaset-q96g5      Pulling image "nginx:latest"
19m         Normal    Pulled             pod/nginx-replicaset-q96g5      Successfully pulled image "nginx:latest" in 2.76s (7.938s including waiting). Image s
ize: 62939286 bytes.
19m         Normal    Created            pod/nginx-replicaset-q96g5      Created container: nginx
19m         Normal    Started            pod/nginx-replicaset-q96g5      Started container nginx
18s         Normal    Scheduled          pod/nginx-replicaset-sn82c      Successfully assigned myns/nginx-replicaset-sn82c to docker-desktop
16s         Normal    Pulling            pod/nginx-replicaset-sn82c      Pulling image "nginx:latest"
12s         Normal    Pulled             pod/nginx-replicaset-sn82c      Successfully pulled image "nginx:latest" in 4.592s (4.592s including waiting). Image
size: 62939286 bytes.
12s         Normal    Created            pod/nginx-replicaset-sn82c      Created container: nginx
11s         Normal    Started            pod/nginx-replicaset-sn82c      Started container nginx
20m         Normal    Scheduled          pod/nginx-replicaset-wgj45      Successfully assigned myns/nginx-replicaset-wgj45 to docker-desktop
```

```
ize: 62939286 bytes.
20m         Normal    Created            pod/nginx-replicaset-xvdvb      Created container: nginx
20m         Normal    Started            pod/nginx-replicaset-xvdvb      Started container nginx
18s         Normal    Scheduled          pod/nginx-replicaset-zbq6w      Successfully assigned myns/nginx-replicaset-zbq6w to docker-desktop
16s         Normal    Pulling            pod/nginx-replicaset-zbq6w      Pulling image "nginx:latest"
6s          Normal    Pulled             pod/nginx-replicaset-zbq6w      Successfully pulled image "nginx:latest" in 3.27s (10.647s including waiting). Image
size: 62939286 bytes.
5s          Normal    Created            pod/nginx-replicaset-zbq6w      Created container: nginx
5s          Normal    Started            pod/nginx-replicaset-zbq6w      Started container nginx
20m         Warning   FailedCreate       replicaset/nginx-replicaset     Error creating: Unauthorized
20m         Normal    SuccessfulCreate   replicaset/nginx-replicaset     Created pod: nginx-replicaset-xvdvb
20m         Normal    SuccessfulCreate   replicaset/nginx-replicaset     Created pod: nginx-replicaset-67b4m
20m         Normal    SuccessfulCreate   replicaset/nginx-replicaset     Created pod: nginx-replicaset-q96g5
20m         Normal    SuccessfulCreate   replicaset/nginx-replicaset     Created pod: nginx-replicaset-wgj45
20m         Normal    SuccessfulCreate   replicaset/nginx-replicaset     Created pod: nginx-replicaset-b76tj
18s         Normal    SuccessfulCreate   replicaset/nginx-replicaset     Created pod: nginx-replicaset-sn82c
18s         Normal    SuccessfulCreate   replicaset/nginx-replicaset     Created pod: nginx-replicaset-7cj4z
18s         Normal    SuccessfulCreate   replicaset/nginx-replicaset     Created pod: nginx-replicaset-zbq6w
18s         Warning   FailedCreate       replicaset/nginx-replicaset     Error creating: pods "nginx-replicaset-f4c5d" is forbidden: exceeded quota: myns-quot
a, requested: pods=1, used: pods=10, limited: pods=10
18s         Warning   FailedCreate       replicaset/nginx-replicaset     Error creating: pods "nginx-replicaset-r8s7m" is forbidden: exceeded quota: myns-quot
a, requested: pods=1, used: pods=10, limited: pods=10
18s         Normal    SuccessfulCreate   replicaset/nginx-replicaset     Created pod: nginx-replicaset-26zdk
18s         Normal    SuccessfulCreate   replicaset/nginx-replicaset     Created pod: nginx-replicaset-75tjx
18s         Warning   FailedCreate       replicaset/nginx-replicaset     Error creating: pods "nginx-replicaset-kh9vg" is forbidden: exceeded quota: myns-quot
a, requested: pods=1, used: pods=10, limited: pods=10
18s         Warning   FailedCreate       replicaset/nginx-replicaset     Error creating: pods "nginx-replicaset-tgscs" is forbidden: exceeded quota: myns-quot
a, requested: pods=1, used: pods=10, limited: pods=10
18s         Warning   FailedCreate       replicaset/nginx-replicaset     Error creating: pods "nginx-replicaset-99bvs" is forbidden: exceeded quota: myns-quot
a, requested: pods=1, used: pods=10, limited: pods=10
18s         Warning   FailedCreate       replicaset/nginx-replicaset     Error creating: pods "nginx-replicaset-b9dpk" is forbidden: exceeded quota: myns-quot
a, requested: pods=1, used: pods=10, limited: pods=10
18s         Warning   FailedCreate       replicaset/nginx-replicaset     Error creating: pods "nginx-replicaset-bpns4" is forbidden: exceeded quota: myns-quot
a, requested: pods=1, used: pods=10, limited: pods=10
18s         Warning   FailedCreate       replicaset/nginx-replicaset     Error creating: pods "nginx-replicaset-qz5gk" is forbidden: exceeded quota: myns-quot
a, requested: pods=1, used: pods=10, limited: pods=10
17s         Warning   FailedCreate       replicaset/nginx-replicaset     Error creating: pods "nginx-replicaset-8w82w" is forbidden: exceeded quota: myns-quot
a, requested: pods=1, used: pods=10, limited: pods=10
1s          Warning   FailedCreate       replicaset/nginx-replicaset     (combined from similar events): Error creating: pods "nginx-replicaset-lpcrn" is forb
idden: exceeded quota: myns-quota, requested: pods=1, used: pods=10, limited: pods=10
PS C:\Users\namit>
```

Step 6: Clean Up Resources

To delete the resources you created:

```
kubectl delete -f nginx-replicaset-quota.yaml
kubectl delete -f nginx-extra-pod.yaml
kubectl delete -f resource-quota.yaml
kubectl delete namespace myns
```

```
PS C:\Users\namit> kubectl delete -f nginx-replicaset-quota.yaml
replicaset.apps "nginx-replicaset" deleted
PS C:\Users\namit> kubectl delete -f nginx-extra-pod.yaml
Error from server (NotFound): error when deleting "nginx-extra-pod.yaml": pods "nginx-extra-pod" not found
PS C:\Users\namit> kubectl delete -f resource-quota.yaml
resourcequota "myns-quota" deleted
PS C:\Users\namit> kubectl delete namespace myns
namespace "myns" deleted
PS C:\Users\namit>
```