

Kubernetes Lab Exercises

Exercise 1: Setting Up Your Kubernetes Cluster

Objective: Set up a local Kubernetes environment using Minikube and kubectl.

1. Install Minikube and kubectl.
2. Start a Minikube cluster with minikube start.
3. Use kubectl cluster-info to verify your cluster is running.
4. List all nodes using kubectl get nodes.

```
Administrator: Command Prompt
C:\Windows\System32>choco install kubernetes-cli
Chocolatey v2.4.3
Installing the following packages:
kubernetes-cli
By installing, you accept licenses for the packages.
Downloading package from source 'https://community.chocolatey.org/api/v2/'
Progress: Downloading kubernetes-cli 1.33.4... 100%

kubernetes-cli v1.33.4 [Approved]
kubernetes-cli package files install completed. Performing other installation steps.
The package kubernetes-cli wants to run 'chocolateyInstall.ps1'.
Note: If you don't run this script, the installation will fail.
Note: To confirm automatically next time, use '-y' or consider:
choco feature enable -n allowGlobalConfirmation
Do you want to run the script?([Y]es/[A]ll - yes to all/[N)o/[P]rint):
Timeout or your choice of '' is not a valid selection.
You must select an answer
Do you want to run the script?([Y]es/[A]ll - yes to all/[N)o/[P]rint): y

Extracting 64-bit C:\ProgramData\chocolatey\lib\kubernetes-cli\tools\kubernetes-client-windows-amd64.tar.gz to C:\ProgramData\chocolatey\lib\kubernetes-cli\tools...
C:\ProgramData\chocolatey\lib\kubernetes-cli\tools
Extracting 64-bit C:\ProgramData\chocolatey\lib\kubernetes-cli\tools\kubernetes-client-windows-amd64.tar to C:\ProgramData\chocolatey\lib\kubernetes-cli\tools...
C:\ProgramData\chocolatey\lib\kubernetes-cli\tools
ShimGen has successfully created a shim for kubectl-convert.exe
ShimGen has successfully created a shim for kubectl.exe
The install of kubernetes-cli was successful.
Deployed to 'C:\ProgramData\chocolatey\lib\kubernetes-cli\tools'

Chocolatey installed 1/1 packages.
See the log for details (C:\ProgramData\chocolatey\logs\chocolatey.log).

Enjoy using Chocolatey? Explore more amazing features to take your
experience to the next level at
https://chocolatey.org/compare

C:\Windows\System32>choco install minikube
Chocolatey v2.4.3
Installing the following packages:
minikube
By installing, you accept licenses for the packages.
Downloading package from source 'https://community.chocolatey.org/api/v2/'
Progress: Downloading Minikube 1.36.0... 100%

Minikube v1.36.0 [Approved]
Minikube package files install completed. Performing other installation steps.
ShimGen has successfully created a shim for minikube.exe
```

```
C:\Windows\System32>minikube start --driver=docker
* minikube v1.36.0 on Microsoft Windows 11 Home Single Language 10.0.26100.4946 Build 26100.4946
* Using the docker driver based on user configuration
* Using Docker Desktop driver with root privileges
* Starting "minikube" primary control-plane node in "minikube" cluster
* Pulling base image v0.0.47 ...
  > gcr.io/k8s-minikube/kicbase...: 502.26 MiB / 502.26 MiB 100.00% 1.16 Mi
* Creating docker container (CPUs=2, Memory=3900MB) ...
! Failing to connect to https://registry.k8s.io/ from inside the minikube container
* To pull new external images, you may need to configure a proxy: https://minikube.sigs.k8s.io/docs/reference/networking/proxy
* Preparing Kubernetes v1.33.1 on Docker 28.1.1 ...
  - Generating certificates and keys ...
  - Booting up control plane ...
  - Configuring RBAC rules ...
* Configuring bridge CNI (Container Networking Interface) ...
* Verifying Kubernetes components...
  - Using image gcr.io/k8s-minikube/storage-provisioner:v5
* Enabled addons: storage-provisioner, default-storageclass
* Done! kubectl is now configured to use "minikube" cluster and "default" namespace by default

C:\Windows\System32>
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C:\Windows\System32>
C:\Windows\System32>
C:\Windows\System32>
C:\Windows\System32>
C:\Windows\System32>
C:\Windows\System32>kubectl cluster-info
Kubernetes control plane is running at https://127.0.0.1:62194
CoreDNS is running at https://127.0.0.1:62194/api/v1/namespaces/kube-system/services/kube-dns:dns/proxy

To further debug and diagnose cluster problems, use 'kubectl cluster-info dump'.

C:\Windows\System32>kubectl get nodes
NAME      STATUS    ROLES     AGE   VERSION
minikube  Ready     control-plane  51s  v1.33.1
```

Exercise 2: Creating and Managing Pods

Objective: Learn how to create and manage Pods.

1. Create a simple pod using a predefined image like nginx
2. Check the pod status.
3. View pod logs
4. Expose the pod via a service

```
Administrator: Command Prompt - minikube service nginx-pod --url

C:\Windows\System32>kubectl run nginx-pod --image=nginx --restart=Never
pod/nginx-pod created

C:\Windows\System32>kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
nginx-pod  0/1     ContainerCreating   0          8s

C:\Windows\System32>kubectl get pods
NAME      READY   STATUS    RESTARTS   AGE
nginx-pod  1/1     Running   0          36s

C:\Windows\System32>kubectl logs nginx-pod
/docker-entrypoint.sh: /docker-entrypoint.d/ is not empty, will attempt to perform configuration
/docker-entrypoint.sh: Looking for shell scripts in /docker-entrypoint.d/
/docker-entrypoint.sh: Launching /docker-entrypoint.d/10-listen-on-ipv6-by-default.sh
10-listen-on-ipv6-by-default.sh: info: Getting the checksum of /etc/nginx/conf.d/default.conf
10-listen-on-ipv6-by-default.sh: info: Enabled listen on IPv6 in /etc/nginx/conf.d/default.conf
/docker-entrypoint.sh: Sourcing /docker-entrypoint.d/15-local-resolvers.envsh
/docker-entrypoint.sh: Launching /docker-entrypoint.d/20-envsubst-on-templates.sh
/docker-entrypoint.sh: Launching /docker-entrypoint.d/30-tune-worker-processes.sh
/docker-entrypoint.sh: Configuration complete; ready for start up
2025/08/27 17:46:40 [notice] 1#1: using the "epoll" event method
2025/08/27 17:46:40 [notice] 1#1: nginx/1.29.1
2025/08/27 17:46:40 [notice] 1#1: built by gcc 12.2.0 (Debian 12.2.0-14+deb12u1)
2025/08/27 17:46:40 [notice] 1#1: OS: Linux 6.6.87.2-microsoft-standard-WSL2
2025/08/27 17:46:40 [notice] 1#1: getrlimit(RLIMIT_NOFILE): 1048576:1048576
2025/08/27 17:46:40 [notice] 1#1: start worker processes
2025/08/27 17:46:40 [notice] 1#1: start worker process 29
2025/08/27 17:46:40 [notice] 1#1: start worker process 30
2025/08/27 17:46:40 [notice] 1#1: start worker process 31
2025/08/27 17:46:40 [notice] 1#1: start worker process 32
2025/08/27 17:46:40 [notice] 1#1: start worker process 33
2025/08/27 17:46:40 [notice] 1#1: start worker process 34
2025/08/27 17:46:40 [notice] 1#1: start worker process 35
2025/08/27 17:46:40 [notice] 1#1: start worker process 36
2025/08/27 17:46:40 [notice] 1#1: start worker process 37
2025/08/27 17:46:40 [notice] 1#1: start worker process 38
2025/08/27 17:46:40 [notice] 1#1: start worker process 39
2025/08/27 17:46:40 [notice] 1#1: start worker process 40
2025/08/27 17:46:40 [notice] 1#1: start worker process 41
2025/08/27 17:46:40 [notice] 1#1: start worker process 42
2025/08/27 17:46:40 [notice] 1#1: start worker process 43
2025/08/27 17:46:40 [notice] 1#1: start worker process 44

C:\Windows\System32>kubectl expose pod nginx-pod --type=NodePort --port=80
service/nginx-pod exposed

C:\Windows\System32>kubectl get svc

C:\Windows\System32>kubectl get svc
NAME      TYPE      CLUSTER-IP      EXTERNAL-IP      PORT(S)      AGE
kubernetes  ClusterIP  10.96.0.1      <none>        443/TCP      21m
nginx-pod   NodePort   10.100.78.24    <none>        80:31742/TCP  26s

C:\Windows\System32>minikube service nginx-pod --url
http://127.0.0.1:58417
! Because you are using a Docker driver on windows, the terminal needs to be open to run it.

C:\Windows\System32>kubectl delete pod nginx-pod
pod "nginx-pod" deleted
```

Exercise 3: Working with Deployments

Objective: Use Deployments for managing replicated Pods.

1. Create a deployment with using nginx image
2. Scale the deployment to 3 replicas
3. Verify the deployment
4. Update the deployment by changing the image(imperative way)

```
C:\Windows\System32>kubectl create deployment nginx-deployment --image=nginx
deployment.apps/nginx-deployment created

C:\Windows\System32>kubectl apply -f nginx-deployment.yaml
error: the path "nginx-deployment.yaml" does not exist

C:\Windows\System32>cd nginx

C:\Windows\System32\nginx>kubectl apply -f nginx-deployment.yaml
Warning: resource deployments/nginx-deployment is missing the kubectl.kubernetes.io/last-applied-configuration annotation which is required by kubectl apply. kubectl apply should only be used on resources created declaratively by either kubectl create --save-config or kubectl apply. The missing annotation will be patched automatically.
The Deployment "nginx-deployment" is invalid: spec.selector: Invalid value: v1.LabelSelector{MatchLabels:map[string]string{"app":"nginx"}, MatchExpressions:[]v1.LabelSelectorRequirement(nil)}: field is immutable

C:\Windows\System32\nginx>kubectl scale deployment nginx-deployment --replicas=3
deployment.apps/nginx-deployment scaled

C:\Windows\System32\nginx>kubectl get pods
NAME           READY   STATUS    RESTARTS   AGE
nginx-deployment-6cfb98644c-vgw9g  1/1     Running   0          12m
nginx-deployment-6cfb98644c-vw4rl  1/1     Running   0          5s
nginx-deployment-6cfb98644c-zxhj6  0/1     ContainerCreating   0          5s

C:\Windows\System32\nginx>

C:\Windows\System32\nginx>kubectl get pods
NAME           READY   STATUS    RESTARTS   AGE
nginx-deployment-6cfb98644c-vgw9g  1/1     Running   0          13m
nginx-deployment-6cfb98644c-vw4rl  1/1     Running   0          19s
nginx-deployment-6cfb98644c-zxhj6  1/1     Running   0          19s

C:\Windows\System32\nginx>kubectl get deployments
NAME        READY   UP-TO-DATE   AVAILABLE   AGE
nginx-deployment  3/3     3           3           13m

C:\Windows\System32\nginx>kubectl set image deployment/nginx-deployment nginx=nginx:1.19
deployment.apps/nginx-deployment image updated

C:\Windows\System32\nginx>kubectl rollout history deployment nginx-deployment
deployment.apps/nginx-deployment
REVISION  CHANGE-CAUSE
1          <none>
2          <none>

C:\Windows\System32\nginx>kubectl rollout undo deployment nginx-deployment
deployment.apps/nginx-deployment rolled back
```

Exercise 4: Services and Networking

Objective: Expose your app using Kubernetes services.

1. Expose your nginx deployment using a Service:
2. Create a service of type NodePort to make it accessible externally.
3. View the service details.
4. Test access to the nginx service through the browser.

```
C:\Windows\System32\nginx>kubectl expose deployment nginx-deployment --type=NodePort --port=80
service/nginx-deployment exposed

C:\Windows\System32\nginx>kubectl apply -f nginx-service.yaml
service/nginx-service created

C:\Windows\System32\nginx>kubectl get svc
NAME         TYPE      CLUSTER-IP   EXTERNAL-IP     PORT(S)        AGE
kubernetes   ClusterIP  10.96.0.1    <none>        443/TCP       57m
nginx-deployment   NodePort   10.105.7.48  <none>        80:31042/TCP  3m17s
nginx-pod     NodePort   10.100.78.24  <none>        80:31742/TCP  35m
nginx-service   NodePort   10.103.80.77  <none>        80:30080/TCP  47s

C:\Windows\System32\nginx>minikube service nginx-deployment --url
http://127.0.0.1:59065
! Because you are using a Docker driver on windows, the terminal needs to be open to run it.
```

Exercise 5: ConfigMaps and Secrets

Objective: Manage configurations using ConfigMaps and Secrets.

1. Create a ConfigMap using a key-value pair:
2. Mount the ConfigMap as environment variables in a pod.
3. Create a Secret:
4. Access the Secret in the pod via environment variables.

```
C:\Windows\System32\nginx>kubectl create configmap my-config --from-literal=APP_MODE=production --from-literal=APP_VERSION=1.0
configmap/my-config created

C:\Windows\System32\nginx>kubectl apply -f pod-with-secret.yaml
error: the path "pod-with-secret.yaml" does not exist

C:\Windows\System32\nginx>kubectl apply -f pod-with-config.yaml
pod/secret-pod created

C:\Windows\System32\nginx>kubectl create secret generic my-secret --from-literal=DB_USER=admin --from-literal=DB_PASS=pass123
secret/my-secret created

C:\Windows\System32\nginx>kubectl apply -f pod-with-secret.yaml
pod/secret-pod unchanged
```

Exercise 6: Persistent Volumes (PVs) and Persistent Volume Claims (PVCs)

Objective: Use PVs and PVCs for persistent data storage.

1. Create a Persistent Volume (PV) and a Persistent Volume Claim (PVC) in YAML.
2. Apply the YAML files to create the PV and PVC.
3. Create a pod that uses the PVC to mount the volume.
4. Write data to the volume and verify its persistence by restarting the pod.

```
C:\Windows\System32\nginx>kubectl apply -f pv.yaml
persistentvolume/my-pv created

C:\Windows\System32\nginx>kubectl apply -f pvc.yaml
persistentvolumeclaim/my-pvc created

C:\Windows\System32\nginx>kubectl apply -f pod-using-pvc.yaml
pod/pvc-pod created

C:\Windows\System32\nginx>kubectl delete pod pvc-pod
pod "pvc-pod" deleted

C:\Windows\System32\nginx>kubectl apply -f pod-using-pvc.yaml
pod/pvc-pod created

C:\Windows\System32\nginx>kubectl exec -it pvc-pod -- cat /usr/share/nginx/html/index.html
cat: /usr/share/nginx/html/index.html: No such file or directory
command terminated with exit code 1

C:\Windows\System32\nginx>kubectl exec -it pvc-pod -- /bin/sh
# echo "Hello from PVC" > /usr/share/nginx/html/index.html
cat /usr/share/nginx/html/index.html
exit
# Hello from PVC
#
C:\Windows\System32\nginx>kubectl delete pod pvc-pod
pod "pvc-pod" deleted

C:\Windows\System32\nginx>kubectl apply -f pod-using-pvc.yaml
pod/pvc-pod created

C:\Windows\System32\nginx>kubectl exec -it pvc-pod -- cat /usr/share/nginx/html/index.html
Hello from PVC
```

Exercise 7: StatefulSets

Objective: Use StatefulSets for managing stateful applications.

1. Deploy a StatefulSet with (create YAML for an app like MySQL).
2. View the StatefulSet.
3. Create a headless service for the StatefulSet and access the pod by its stable network identity.

```
C:\Windows\System32\nginx>kubectl apply -f mysql-statefulset.yaml
service/mysql created
statefulset.apps/mysql created

C:\Windows\System32\nginx>kubectl get statefulsets
NAME      READY   AGE
mysql     0/3     5s

C:\Windows\System32\nginx>kubectl get pods -l app=mysql
NAME      READY   STATUS            RESTARTS   AGE
mysql-0   0/1     ContainerCreating   0          6s

C:\Windows\System32\nginx>kubectl get statefulsets
NAME      READY   AGE
mysql     0/3     8s

C:\Windows\System32\nginx>kubectl get pods -l app=mysql
NAME      READY   STATUS            RESTARTS   AGE
mysql-0   0/1     ContainerCreating   0          8s

C:\Windows\System32\nginx>kubectl get statefulsets
NAME      READY   AGE
mysql     0/3     20s

C:\Windows\System32\nginx>kubectl get pods -l app=mysql
NAME      READY   STATUS            RESTARTS   AGE
mysql-0   0/1     ContainerCreating   0          20s

C:\Windows\System32\nginx>kubectl get svc mysql
NAME      TYPE        CLUSTER-IP    EXTERNAL-IP   PORT(S)      AGE
mysql    ClusterIP   None         <none>       3306/TCP   28s

C:\Windows\System32\nginx>kubectl get statefulsets
NAME      READY   AGE
mysql     0/3     45s

C:\Windows\System32\nginx>kubectl get pods -l app=mysql
NAME      READY   STATUS            RESTARTS   AGE
mysql-0   0/1     ContainerCreating   0          46s

C:\Windows\System32\nginx>kubectl get statefulsets
NAME      READY   AGE
mysql     3/3     77s

C:\Windows\System32\nginx>kubectl get pods -l app=mysql
NAME      READY   STATUS    RESTARTS   AGE
mysql-0   1/1     Running   0          77s
mysql-1   1/1     Running   0          26s
mysql-2   1/1     Running   0          24s
```

Exercise 8: Horizontal Pod Autoscaling (HPA)

Objective: Scale your application automatically based on metrics.

1. Create a deployment (e.g., a simple HTTP server).
2. Enable metrics server for autoscaling (e.g., Minikube).
3. Create an HPA to scale the deployment based on CPU utilization:
4. Test autoscaling by generating load on the deployment .

```
C:\Windows\System32\nginx>kubectl get hpa -w
NAME          REFERENCE          TARGETS          MINPODS   MAXPODS   REPLICAS   AGE
nginx-deployment  Deployment/nginx-deployment  cpu: <unknown>/50%  1         5         3          86s
nginx-deployment  Deployment/nginx-deployment  cpu: <unknown>/50%  1         5         3          94s
nginx-deployment  Deployment/nginx-deployment  cpu: <unknown>/50%  1         5         3          2m22s
nginx-deployment  Deployment/nginx-deployment  cpu: <unknown>/50%  1         5         3          2m53s
nginx-deployment  Deployment/nginx-deployment  cpu: <unknown>/50%  1         5         3          3m25s
nginx-deployment  Deployment/nginx-deployment  cpu: <unknown>/50%  1         5         3          4m11s
nginx-deployment  Deployment/nginx-deployment  cpu: <unknown>/50%  1         5         3          6m17s

C:\Windows\System32\nginx>kubectl get pods -w
NAME           READY   STATUS    RESTARTS   AGE
mysql-0        1/1     Running   0          14m
mysql-1        1/1     Running   0          13m
mysql-2        1/1     Running   0          13m
nginx-deployment-55659c995d-4mzr9  1/1     Running   0          72m
nginx-deployment-55659c995d-l6ndd   1/1     Running   0          72m
nginx-deployment-55659c995d-mngxl   1/1     Running   0          72m
pvc-pod        1/1     Running   0          19m
secret-pod     1/1     Running   0          38m
```

Exercise 9: Helm Basics

Objective: Use Helm to manage Kubernetes applications.

1. Install Helm on your local machine.
2. Add a Helm chart repository:
3. Install a package from the Helm chart repository, e.g., Nginx:
4. Verify the installation using

```
C:\Windows\System32\nginx>choco install kubernetes-helm
Chocolatey v2.4.3
Installing the following packages:
kubernetes-helm
By installing, you accept licenses for the packages.
Downloading package from source 'https://community.chocolatey.org/api/v2/'
Progress: Downloading kubernetes-helm 3.18.5... 100%

kubernetes-helm v3.18.5 [Approved]
kubernetes-helm package files install completed. Performing other installation steps.
The package kubernetes-helm wants to run 'chocolateyInstall.ps1'.
Note: If you don't run this script, the installation will fail.
Note: To confirm automatically next time, use '-y' or consider:
choco feature enable -n allowGlobalConfirmation
Do you want to run the script?([Y]es/[A]ll - yes to all/[N)o/[P]rint): y

Downloading kubernetes-helm 64 bit
  from 'https://get.helm.sh/helm-v3.18.5-windows-amd64.zip'
Progress: 100% - Completed download of C:\Users\alefi\AppData\Local\Temp\chocolatey\kubernetes-helm\3.18.5\helm-v3.18.5-windows-amd64.zip (17.59 MB).
Download of helm-v3.18.5-windows-amd64.zip (17.59 MB) completed.
Hashes match.
Extracting C:\Users\alefi\AppData\Local\Temp\chocolatey\kubernetes-helm\3.18.5\helm-v3.18.5-windows-amd64.zip to C:\ProgramData\chocolatey\lib\kubernetes-helm\tools...
C:\ProgramData\chocolatey\lib\kubernetes-helm\tools
ShimGen has successfully created a shim for helm.exe
The install of kubernetes-helm was successful.
Deployed to 'C:\ProgramData\chocolatey\lib\kubernetes-helm\tools'

Chocolatey installed 1/1 packages.
See the log for details (C:\ProgramData\chocolatey\logs\chocolatey.log).

C:\Windows\System32\nginx>helm version
version.BuildInfo{Version:"v3.18.5", GitCommit:"b78692c18f0fb38fe5ba4571a674de067a4c53a5", GitTreeState:"clean", GoVersion:"go1.24.5"}

C:\Windows\System32\nginx>helm repo add bitnami https://charts.bitnami.com/bitnami
"bitnami" has been added to your repositories

C:\Windows\System32\nginx>helm repo update
Hang tight while we grab the latest from your chart repositories...
...Successfully got an update from the "bitnami" chart repository
Update Complete. Happy Helming! ☺

C:\Windows\System32\nginx>helm install my-nginx bitnami/nginx
NAME: my-nginx
LAST DEPLOYED: Thu Aug 28 01:03:03 2025
NAMESPACE: default
STATUS: deployed
REVISION: 1
```

```
TEST SUITE: None
NOTES:
CHART NAME: nginx
CHART VERSION: 21.1.23
APP VERSION: 1.29.1
```

```
⚠️WARNING: Since August 28th, 2025, only a limited subset of images/charts are available for free.
Subscribe to Bitnami Secure Images to receive continued support and security updates.
More info at https://bitnami.com and https://github.com/bitnami/containers/issues/83267
```

```
** Please be patient while the chart is being deployed **
NGINX can be accessed through the following DNS name from within your cluster:
```

```
my-nginx.default.svc.cluster.local (port 80)
```

To access NGINX from outside the cluster, follow the steps below:

1. Get the NGINX URL by running these commands:

```
NOTE: It may take a few minutes for the LoadBalancer IP to be available.
Watch the status with: 'kubectl get svc --namespace default -w my-nginx'
```

```
export SERVICE_PORT=$(kubectl get --namespace default -o jsonpath=".spec.ports[0].port" services my-nginx)
export SERVICE_IP=$(kubectl get svc --namespace default my-nginx -o jsonpath='{.status.loadBalancer.ingress[0].ip}')
echo "http://${SERVICE_IP}:${SERVICE_PORT}"
```

```
WARNING: There are "resources" sections in the chart not set. Using "resourcesPreset" is not recommended for production. For production installations, please set the following values according to your workload needs:
```

- cloneStaticSiteFromGit.gitSync.resources
- resources

+info <https://kubernetes.io/docs/concepts/configuration/manage-resources-containers/>

```
C:\Windows\System32\nginx>helm list
NAME      NAMESPACE   REVISION    UPDATED           STATUS      CHART          APP VERSION
my-nginx  default     1          2025-08-28 01:03:03.9585618 +0530 IST  deployed    nginx-21.1.23  1.29.1
```

```
C:\Windows\System32\nginx>kubectl get pods
NAME                           READY   STATUS    RESTARTS   AGE
my-nginx-594d78ffc7-5fnml     0/1     Init:0/1  0          13s
mysql-0                         1/1     Running   0          17m
mysql-1                         1/1     Running   0          16m
mysql-2                         1/1     Running   0          16m
nginx-deployment-55659c995d-4mzr9  1/1     Running   0          75m
nginx-deployment-55659c995d-16ndd  1/1     Running   0          76m
nginx-deployment-55659c995d-mngx1  1/1     Running   0          75m
pvc-pod                         1/1     Running   0          23m
secret-pod                      1/1     Running   0          42m
```

```
C:\Windows\System32\nginx>kubectl get svc
NAME        TYPE        CLUSTER-IP   EXTERNAL-IP  PORT(S)          AGE
kubernetes  ClusterIP  10.96.0.1   <none>       443/TCP         122m
my-nginx    LoadBalancer 10.103.48.206  <pending>   80:30499/TCP,443:32652/TCP  13s
mysql       ClusterIP  None          <none>       3306/TCP        17m
nginx-deployment  NodePort  10.105.7.48  <none>       80:31042/TCP    68m
nginx-pod    NodePort  10.100.78.24  <none>       80:31742/TCP    101m
nginx-service  NodePort  10.103.80.77  <none>       80:30080/TCP    66m
```

Exercise 10: Debugging and Troubleshooting

Objective: Learn how to troubleshoot issues in Kubernetes.

1. Identify pod issues using describe command
2. Check the status of nodes and pods
3. View events related to the pod
4. View logs for troubleshooting(pods and deployment)

```
C:\Windows\System32\nginx>kubectl describe pod nginx-deployment-55659c995d-4mzr9
Name:           nginx-deployment-55659c995d-4mzr9
Namespace:      default
Priority:       0
Service Account: default
Node:          minikube/192.168.49.2
Start Time:    Wed, 27 Aug 2025 23:47:33 +0530
Labels:         app=nginx-deployment
                pod-template-hash=55659c995d
Annotations:   <none>
Status:        Running
IP:            10.244.0.12
IPs:
  IP:          10.244.0.12
Controlled By: ReplicaSet/nginx-deployment-55659c995d
Containers:
  nginx:
    Container ID:  docker://295563dc709afdd158ad2813fa5777fd5b9488cf95fa1dbb28b10a84f5a4e536
    Image:         nginx:1.19
    Image ID:     docker-pullable://nginx@sha256:df13abe416e37eb3db4722840dd479b00ba193ac6606e7902331dcea50f4f1f2
    Port:          <none>
    Host Port:    <none>
    State:        Running
      Started:   Wed, 27 Aug 2025 23:47:36 +0530
    Ready:        True
    Restart Count: 0
    Environment:  <none>
    Mounts:
      /var/run/secrets/kubernetes.io/serviceaccount from kube-api-access-2knw8 (ro)
Conditions:
  Type          Status
  PodReadyToStartContainers  True
  Initialized    True
  Ready          True
  ContainersReady  True
  PodScheduled   True
Volumes:
  kube-api-access-2knw8:
    Type:          Projected (a volume that contains injected data from multiple sources)
    TokenExpirationSeconds: 3607
    ConfigMapName:   kube-root-ca.crt
    Optional:       false
    DownwardAPI:    true
  QoS Class:      BestEffort
  Node-Selectors: <none>
  Tolerations:    node.kubernetes.io/not-ready:NoExecute op=Exists for 300s
                  node.kubernetes.io/unreachable:NoExecute op=Exists for 300s
Events:
```

```

Administrator: Command Prompt
QoS Class: BestEffort
Node-Selectors: <none>
Tolerations: node.kubernetes.io/not-ready:NoExecute op=Exists for 300s
node.kubernetes.io/unreachable:NoExecute op=Exists for 300s
Events: <none>

C:\Windows\System32\nginx>kubectl get nodes
NAME     STATUS   ROLES      AGE    VERSION
minikube Ready    control-plane   125m   v1.33.1

C:\Windows\System32\nginx>kubectl get pods -A -o wide
NAMESPACE NAME                                     READY   STATUS    RESTARTS   AGE   IP          NODE   NOMINATED NODE   RE
ADINNESS GATES
default   my-nginx-594d78ffc7-5fnml           1/1    Running   0          3m29s  10.244.0.23  minikube   <none>   <n
one>
default   mysql-0                            1/1    Running   0          20m    10.244.0.18  minikube   <none>   <n
one>
default   mysql-1                            1/1    Running   0          19m    10.244.0.19  minikube   <none>   <n
one>
default   mysql-2                            1/1    Running   0          19m    10.244.0.20  minikube   <none>   <n
one>
default   nginx-deployment-55659c995d-4mzr9  1/1    Running   0          79m    10.244.0.12  minikube   <none>   <n
one>
default   nginx-deployment-55659c995d-16ndd  1/1    Running   0          79m    10.244.0.8   minikube   <none>   <n
one>
default   nginx-deployment-55659c995d-mngxl  1/1    Running   0          78m    10.244.0.13  minikube   <none>   <n
one>
default   pvc-pod                           1/1    Running   0          26m    10.244.0.17  minikube   <none>   <n
one>
default   secret-pod                        1/1    Running   0          45m    10.244.0.14  minikube   <none>   <n
one>
kube-system coredns-674b8bbfcf-tf4m6        1/1    Running   0          125m   10.244.0.2   minikube   <none>   <n
one>
kube-system etcd-minikube                   1/1    Running   0          125m   192.168.49.2  minikube   <none>   <n
one>
kube-system kube-apiserver-minikube        1/1    Running   0          125m   192.168.49.2  minikube   <none>   <n
one>
kube-system kube-controller-manager-minikube 1/1    Running   0          125m   192.168.49.2  minikube   <none>   <n
one>
kube-system kube-proxy-n8fbn               1/1    Running   0          125m   192.168.49.2  minikube   <none>   <n
one>
kube-system kube-scheduler-minikube        1/1    Running   0          125m   192.168.49.2  minikube   <none>   <n
one>
kube-system metrics-server-7fbff699795-drhlt 1/1    Running   0          13m    10.244.0.21  minikube   <none>   <n
one>
kube-system storage-provisioner            1/1    Running   1 (125m ago) 125m   192.168.49.2  minikube   <none>   <n

C:\Windows\System32\nginx>
```

```

Administrator: Command Prompt
C:\Windows\System32\nginx>kubectl get events --sort-by=.metadata.creationTimestamp
LAST SEEN   TYPE    REASON          OBJECT                                MESSAGE
45m        Normal   Scheduled       pod/secret-pod
ult/secret-pod to minikube
45m        Normal   Pulling        pod/secret-pod
45m        Warning  Failed         pod/secret-pod
not found
45m        Normal   Pulled        pod/secret-pod
"nginx" in 2.084s (2.084s including waiting). Image size: 192385800 bytes.
45m        Normal   Pulled        pod/secret-pod
"nginx" in 2.024s (2.024s including waiting). Image size: 192385800 bytes.
45m        Normal   Pulled        pod/secret-pod
"nginx" in 2.063s (2.063s including waiting). Image size: 192385800 bytes.
45m        Normal   Created       pod/secret-pod
45m        Normal   Started       pod/secret-pod
28m        Normal   Scheduled     pod/pvc-pod
ult/pvc-pod to minikube
28m        Normal   ExternalProvisioning persistentvolumeclaim/my-pvc
created either by the external provisioner 'k8s.io/minikube-hostpath' or manually by the system administrator. If volume creation is delayed, please verify that the provisioner is running and correctly registered.
28m        Normal   Provisioning   persistentvolumeclaim/my-pvc
visioning volume for claim "default/my-pvc"
28m        Normal   ProvisioningSucceeded persistentvolumeclaim/my-pvc
olume pvc-736750e6-5212-40a7-a220-f54df84254d7
28m        Normal   Pulling        pod/pvc-pod
28m        Normal   Created       pod/pvc-pod
28m        Normal   Started       pod/pvc-pod
28m        Normal   Pulled        pod/pvc-pod
"nginx" in 2.102s (2.102s including waiting). Image size: 192385800 bytes.
28m        Normal   Killing       pod/pvc-pod
28m        Normal   Scheduled     pod/pvc-pod
ult/pvc-pod to minikube
28m        Normal   Pulling        pod/pvc-pod
28m        Normal   Created       pod/pvc-pod
28m        Normal   Pulled        pod/pvc-pod
"nginx" in 2.012s (2.012s including waiting). Image size: 192385800 bytes.
28m        Normal   Started       pod/pvc-pod
26m        Normal   Killing       pod/pvc-pod
26m        Normal   Scheduled     pod/pvc-pod
ult/pvc-pod to minikube
26m        Normal   Pulling        pod/pvc-pod
26m        Normal   Pulled        pod/pvc-pod
"nginx" in 2.052s (2.052s including waiting). Image size: 192385800 bytes.
26m        Normal   Created       pod/pvc-pod
26m        Normal   Started       pod/pvc-pod
21m        Warning  FailedScheduling pod/mysql-0
od has unbound immediate PersistentVolumeClaims. preemption: 0/1 nodes are available: 1 Preemption is not helpful for scheduling.
21m        Normal   SuccessfulCreate statefulset/mysql
ent-storage-mysql-0 Pod mysql-0 in StatefulSet mysql success
create Claim mysql-persist
```

```
Administrator: Command Prompt - X

layered, please verify that the provisioner is running and correctly registered.
21m Normal Provisioning persistentvolumeclaim/mysql-persistent-storage-mysql-0 External provisioner is pr
ovisioning volume for claim "default/mysql-persistent-storage-mysql-0"
21m Normal ProvisioningSucceeded persistentvolumeclaim/mysql-persistent-storage-mysql-0 Successfully provisioned v
olume pvc-423ae03c-8783-4a54-8df2-42557629ecf3
21m Normal Pulling pod/mysql-0 Pulling image "mysql:8.0"
20m Normal Pulled pod/mysql-0 Successfully pulled image
"mysql:8.0" in 47.594s (47.594s including waiting). Image size: 780948048 bytes.
20m Normal Created pod/mysql-0 Created container: mysql
20m Normal Started pod/mysql-0 Started container mysql
20m Normal SuccessfulCreate statefulset/mysql create Claim mysql-persist
ent-storage-mysql-1 Pod mysql-1 in StatefulSet mysql success
20m Warning FailedScheduling pod/mysql-1 0/1 nodes are available: p
od has unbound immediate PersistentVolumeClaims. preemption: 0/1 nodes are available: 1 Preemption is not helpful for scheduling.
20m Normal ProvisioningSucceeded persistentvolumeclaim/mysql-persistent-storage-mysql-1 Successfully provisioned v
olume pvc-aa439663-4283-4465-b9d7-fb3127d03eee
20m Normal Scheduled pod/mysql-1 Successfully assigned defa
ult/mysql-1 to minikube
20m Normal Provisioning persistentvolumeclaim/mysql-persistent-storage-mysql-1 External provisioner is pr
ovisioning volume for claim "default/mysql-persistent-storage-mysql-1"
20m Normal ExternalProvisioning persistentvolumeclaim/mysql-persistent-storage-mysql-1 Waiting for a volume to be
created either by the external provisioner 'k8s.io/minikube-hostpath' or manually by the system administrator. If volume creation is de
layed, please verify that the provisioner is running and correctly registered.
20m Normal SuccessfulCreate statefulset/mysql create Pod mysql-1 in Stat
efulSet mysql successful
20m Normal Created pod/mysql-1 Created container: mysql
20m Normal Pulled pod/mysql-1 Container image "mysql:8.0"
" already present on machine
20m Normal Started pod/mysql-1 Started container mysql
20m Normal ProvisioningSucceeded persistentvolumeclaim/mysql-persistent-storage-mysql-2 Successfully provisioned v
olume pvc-d3cb7f7f-7a0d-468e-a26a-538ea37a3f30
20m Normal SuccessfulCreate statefulset/mysql create Pod mysql-2 in Stat
efulSet mysql successful
20m Warning FailedScheduling pod/mysql-2 0/1 nodes are available: p
od has unbound immediate PersistentVolumeClaims. preemption: 0/1 nodes are available: 1 Preemption is not helpful for scheduling.
20m Normal Scheduled pod/mysql-2 Successfully assigned defa
ult/mysql-2 to minikube
20m Normal SuccessfulCreate statefulset/mysql create Claim mysql-persist
ent-storage-mysql-2 Pod mysql-2 in StatefulSet mysql success
20m Normal Provisioning persistentvolumeclaim/mysql-persistent-storage-mysql-2 External provisioner is pr
ovisioning volume for claim "default/mysql-persistent-storage-mysql-2"
20m Normal ExternalProvisioning persistentvolumeclaim/mysql-persistent-storage-mysql-2 Waiting for a volume to be
created either by the external provisioner 'k8s.io/minikube-hostpath' or manually by the system administrator. If volume creation is de
layed, please verify that the provisioner is running and correctly registered.
20m Normal Started pod/mysql-2 Started container mysql
20m Normal Created pod/mysql-2 Created container: mysql
20m Normal Pulled pod/mysql-2 Container image "mysql:8.0"
" already present on machine
13m Normal Scheduled pod/load-generator Successfully assigned defa
```

```
C:\Windows\System32\nginx>kubectl logs mysql-0
2025-08-27 19:16:40+00:00 [Note] [Entrypoint]: Entrypoint script for MySQL Server 8.0.43-1.el9 started.
2025-08-27 19:16:41+00:00 [Note] [Entrypoint]: Switching to dedicated user 'mysql'
2025-08-27 19:16:41+00:00 [Note] [Entrypoint]: Entrypoint script for MySQL Server 8.0.43-1.el9 started.
2025-08-27 19:16:41+00:00 [Note] [Entrypoint]: Initializing database files
2025-08-27T19:16:41.408811Z 0 [Warning] [MY-011068] [Server] The syntax '--skip-host-cache' is deprecated and will be removed in a future release. Please use SET GLOBAL host_cache_size=0 instead.
2025-08-27T19:16:41.408980Z 0 [System] [MY-013169] [Server] /usr/sbin/mysqld (mysqld 8.0.43) initializing of server in progress as process 81
2025-08-27T19:16:41.418847Z 1 [System] [MY-013576] [InnoDB] InnoDB initialization has started.
2025-08-27T19:16:42.413732Z 1 [System] [MY-013577] [InnoDB] InnoDB initialization has ended.
2025-08-27T19:16:44.988654Z 6 [Warning] [MY-010453] [Server] root@localhost is created with an empty password ! Please consider switching off the --initialize-insecure option.
2025-08-27 19:16:50+00:00 [Note] [Entrypoint]: Database files initialized
2025-08-27 19:16:50+00:00 [Note] [Entrypoint]: Starting temporary server
2025-08-27T19:16:50.605566Z 0 [Warning] [MY-011068] [Server] The syntax '--skip-host-cache' is deprecated and will be removed in a future release. Please use SET GLOBAL host_cache_size=0 instead.
2025-08-27T19:16:50.609876Z 0 [System] [MY-010116] [Server] /usr/sbin/mysqld (mysqld 8.0.43) starting as process 125
2025-08-27T19:16:50.633955Z 1 [System] [MY-013576] [InnoDB] InnoDB initialization has started.
2025-08-27T19:16:51.090728Z 1 [System] [MY-013577] [InnoDB] InnoDB initialization has ended.
2025-08-27T19:16:52.848770Z 0 [Warning] [MY-010068] [Server] CA certificate ca.pem is self signed.
2025-08-27T19:16:52.848835Z 0 [System] [MY-013602] [Server] Channel mysql_main configured to support TLS. Encrypted connections are now supported for this channel.
2025-08-27T19:16:52.853719Z 0 [Warning] [MY-011810] [Server] Insecure configuration for --pid-file: Location '/var/run/mysqld' in the path is accessible to all OS users. Consider choosing a different directory.
2025-08-27T19:16:52.872400Z 0 [System] [MY-011323] [Server] X Plugin ready for connections. Socket: /var/run/mysqld/mysqld.sock
2025-08-27T19:16:52.873119Z 0 [System] [MY-010931] [Server] /usr/sbin/mysqld: ready for connections. Version: '8.0.43' socket: '/var/run/mysqld/mysqld.sock' port: 0 MySQL Community Server - GPL.
2025-08-27 19:16:52+00:00 [Note] [Entrypoint]: Temporary server started.
'/var/lib/mysql/mysql.sock' -> '/var/run/mysqld/mysqld.sock'
Warning: Unable to load '/usr/share/zoneinfo/iso3166.tab' as time zone. Skipping it.
Warning: Unable to load '/usr/share/zoneinfo/leap-seconds.list' as time zone. Skipping it.
Warning: Unable to load '/usr/share/zoneinfo/leapsseconds' as time zone. Skipping it.
Warning: Unable to load '/usr/share/zoneinfo/tzdata.zi' as time zone. Skipping it.
Warning: Unable to load '/usr/share/zoneinfo/zone.tab' as time zone. Skipping it.
Warning: Unable to load '/usr/share/zoneinfo/zone1970.tab' as time zone. Skipping it.

2025-08-27 19:16:58+00:00 [Note] [Entrypoint]: Stopping temporary server
2025-08-27T19:16:58.226010Z 10 [System] [MY-013172] [Server] Received SHUTDOWN from user root. Shutting down mysqld (Version: 8.0.43).
2025-08-27T19:17:00.848143Z 0 [System] [MY-010910] [Server] /usr/sbin/mysqld: Shutdown complete (mysqld 8.0.43) MySQL Community Server - GPL.
2025-08-27 19:17:01+00:00 [Note] [Entrypoint]: Temporary server stopped

2025-08-27 19:17:01+00:00 [Note] [Entrypoint]: MySQL init process done. Ready for start up.

2025-08-27T19:17:01.575679Z 0 [Warning] [MY-011068] [Server] The syntax '--skip-host-cache' is deprecated and will be removed in a future release. Please use SET GLOBAL host_cache_size=0 instead.
2025-08-27T19:17:01.577925Z 0 [System] [MY-010116] [Server] /usr/sbin/mysqld (mysqld 8.0.43) starting as process 1
2025-08-27T19:17:01.605001Z 1 [System] [MY-013576] [InnoDB] InnoDB initialization has started.
```

```
C:\Windows\System32\nginx>kubectl logs deployment/my-nginx
Defaulted container "nginx" out of: nginx, preserve-logs-symlinks (init)
[38;5;6mnginx [38;5;5m19:33:28.56 [0m [38;5;2mINFO [0m ==>
[38;5;6mnginx [38;5;5m19:33:28.57 [0m [38;5;2mINFO [0m ==> [1mWelcome to the Bitnami nginx container! [0m
[38;5;6mnginx [38;5;5m19:33:28.57 [0m [38;5;2mINFO [0m ==> Subscribe to project updates by watching [1mhttps://github.com/bitnami/containers! [0m
[38;5;6mnginx [38;5;5m19:33:28.57 [0m [38;5;2mINFO [0m ==> [38;5;3mNOTICE: Starting August 28th, 2025, only a limited subset of images/charts will remain available for free. Backup will be available for some time at the 'Bitnami Legacy' repository. More info at https://github.com/bitnami/containers/issues/83267! [0m
[38;5;6mnginx [38;5;5m19:33:28.66 [0m [38;5;2mINFO [0m ==>
[38;5;6mnginx [38;5;5m19:33:28.67 [0m [38;5;2mINFO [0m ==> ** Starting NGINX setup **
[38;5;6mnginx [38;5;5m19:33:28.77 [0m [38;5;2mINFO [0m ==> Validating settings in NGINX_* env vars
[38;5;6mnginx [38;5;5m19:33:28.97 [0m [38;5;2mINFO [0m ==> No custom scripts in /docker-entrypoint-initdb.d
[38;5;6mnginx [38;5;5m19:33:29.06 [0m [38;5;2mINFO [0m ==> Initializing NGINX
realpath: /bitnami/nginx/conf/vhosts: No such file or directory
[38;5;6mnginx [38;5;5m19:33:29.46 [0m [38;5;2mINFO [0m ==> ** NGINX setup finished! **

[38;5;6mnginx [38;5;5m19:33:29.56 [0m [38;5;2mINFO [0m ==> ** Starting NGINX **
10.244.0.1 - - [27/Aug/2025:19:33:36 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:33:41 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:33:46 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:33:51 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:33:56 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:01 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:07 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:12 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:17 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:22 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:27 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:32 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:39 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:44 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:49 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:54 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:34:59 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:04 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:10 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:15 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:20 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:25 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:30 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:35 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:41 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:46 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:51 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:35:56 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:36:01 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:36:06 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
10.244.0.1 - - [27/Aug/2025:19:36:13 +0000] "GET / HTTP/1.1" 200 615 "-" "kube-probe/1.33" "-"
```