Complete Notes: Introduction to Pods and YAML in Kubernetes (CKA 2024 Series #7) 🚀

🎯 Video Goals

- Understand **Pods** in Kubernetes and their creation methods.
- Grasp **YAML fundamentals** as used in Kubernetes resource configuration.
- Learn the difference between **imperative** and **declarative** approaches to managing resources.
- Get hands-on with creating, troubleshooting, and editing Pods.

1️⃣ How Does Kubernetes Work?

Diagram of Interaction:

```
User (kubectl)
      ⬇️
Kubernetes API Server (on Control Plane)
      ⬇️
Cluster Nodes (Worker/Pods)
```

- Users interact with clusters using `kubectl` (client utility).
- All requests (create, update, delete, get) go through the API Server.
- The API server controls Pods and other resources running on nodes.

2️⃣ Pod Creation: Imperative vs. Declarative

🏁 Imperative Approach (Direct Command)

- **Best for:** Quick tasks, troubleshooting, simple resources.
- **Command Example:**

```
kubectl run nginx-pod --image=nginx
```

  - Creates a Pod named `nginx-pod` with the `nginx` container.
  - Check Pod status with:

```
kubectl get pods
```

🚦 *Pod status "READY 1/1" means the Pod has one container, which is running.*

- **Key Point:** Imperative commands are fast but **not reusable**; not ideal for complex, production, or version-controlled deployments.

📜 Declarative Approach (YAML Configuration)

- **Best for:** Production, CI/CD pipelines, GitOps, reuse, complex resources.
- **You define the "desired state" in a YAML file and apply it to the cluster.**
- YAML is the preferred configuration format in Kubernetes (JSON is also supported, but rarely used).

Example: Minimal Pod YAML

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: nginx-pod
  labels:
    env: demo
    type: frontend
spec:
  containers:
    - name: nginx-container
      image: nginx
      ports:
        - containerPort: 80
```

- Save the file as `pod.yaml`, then create the Pod:

  ```
  kubectl create -f pod.yaml
  # or
  kubectl apply -f pod.yaml
  ```

  `apply` works for both creating and updating resources.

3️⃣ YAML Basics & Best Practices 📝

- **Comments:** Start with `#`

  ```
  # This is a YAML comment
  ```

- **Indentation:** Critical! Use **spaces**, not tabs. Typically 2 spaces per level.
- **Data Types:** Supports strings, ints, lists, dictionaries/maps, nested lists.

```
employee:
  name: Alice
  age: 30
  skills:
    - Python
    - Kubernetes
  address:
    old: "123 Old St"
    new: "456 New Ave"
```

- **Kubernetes File Structure:**
  - **Always 4 top-level fields:**
    - `apiVersion`
    - `kind`
    - `metadata`
    - `spec`
  - **Order & spelling are case-sensitive** (ex: `kind: Pod`, NOT `kind: pod`).

4️⃣ Useful Commands & Troubleshooting 🛠️

- **Delete a Pod**

```
kubectl delete pod nginx-pod
```

- **Describe a Pod (view events, errors, node info, etc.)**

```
kubectl describe pod nginx-pod
```

- **Edit a Pod directly (fix errors without editing YAML file)**

```
kubectl edit pod nginx-pod
# Opens pod spec in your default editor
```

- **Get extended Pod/node info**

```
kubectl get pods -o wide      # Shows node assignment, Pod IP, etc.
kubectl get nodes -o wide     # Shows kernel, OS, IP, etc.
```

- **Show labels on resource**

```
kubectl get pods nginx-pod --show-labels
```

- **Access Pod Shell**

```
kubectl exec -it nginx-pod -- sh
```

- **Check Pod logs**

```
kubectl logs nginx-pod
```

- **Troubleshoot image pull errors**
  - Misspelled or unauthorized images cause `ImagePullBackOff` errors.

5️⃣ Generating YAML Automatically (Pro-Tip) 🤖

You don't have to write YAML from scratch!

```
kubectl run nginx --image=nginx --dry-run=client -o yaml > my-nginx-pod.yaml
```

- `--dry-run=client`: Does not create resource
- `-o yaml`: Outputs YAML to the console
- `>`: Redirects output to a file

You can edit this file as needed and apply it:

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

Generate JSON if needed:

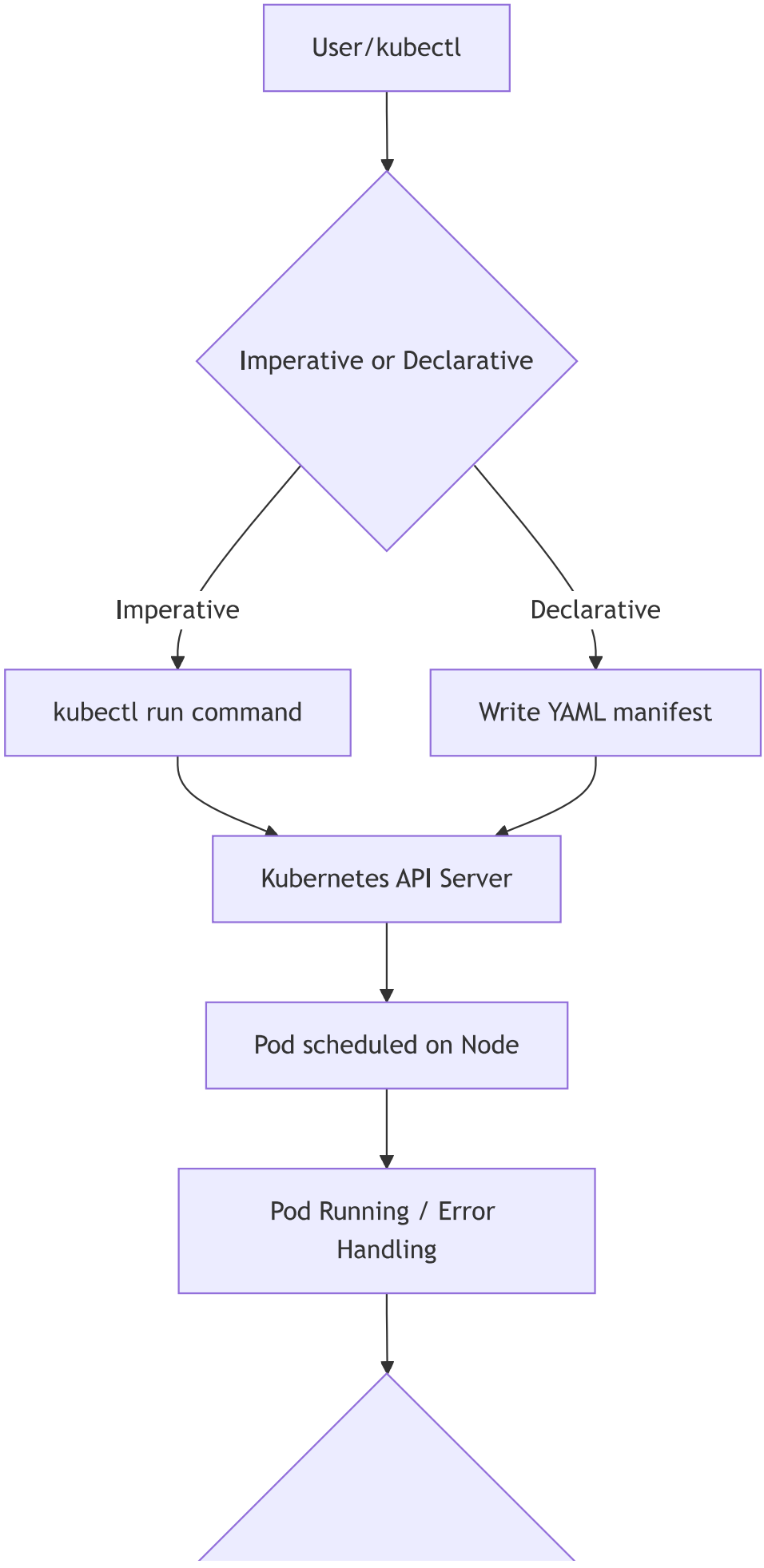
```
kubectl run nginx --image=nginx --dry-run=client -o json > pod.json
```

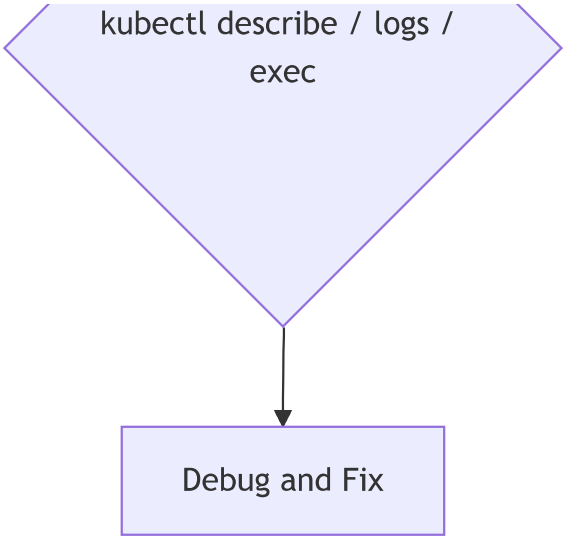
6️⃣ Assignment & Practice Tasks 💪

1. **Create a Pod imperatively**:
   `kubectl run nginx-pod --image=nginx`
2. **Generate YAML from imperative command**, modify Pod name, create new Pod with it.

3. **Troubleshoot YAML errors**:
    - Fix a deliberately misconfigured YAML, re-apply, verify Pod health.

7️⃣ Handy Flowchart: Pod Lifecycle in Kubernetes


User/kubectl
Imperative or Declarative
Imperative
Declarative
kubectl run command
Write YAML manifest
Kubernetes API Server
Pod scheduled on Node
Pod Running / Error Handling



🌟 Key Takeaways

- **Pods** are the smallest deployable object in Kubernetes.
- There are **two main methods** to create/manage resources: *imperative* (one-shot commands) and *declarative* (YAML/JSON manifests).
- **YAML** is essential in Kubernetes. Master its syntax, indentation, and conventions!
- Use `kubectl explain`, `kubectl describe`, and dry-run output for help and self-generation of manifests.
- Use **labels** to organize, search, and group resources.
- Always remember to **troubleshoot** using logs, describe, and edit operations.
- **Practice** with assignments to reinforce learning.

🚀 Mastering Pods in Kubernetes 🧱

✅ Task 1: Create an Nginx Pod Imperatively

💡 **Imperative commands** are used when you want to quickly spin up a pod without writing a YAML file.

```
kubectl run nginx --image=nginx
```

📝 This command tells Kubernetes to:

- Create a pod named `nginx`
- Use the Docker image `nginx`

🔍 Verify the pod:

```
kubectl get pods
```

✅ Task 2: Generate YAML from Pod & Reuse It

📄 Step 1: Export YAML from existing pod

```
kubectl get pod nginx -o yaml > nginx-pod.yaml
```

✍️ Step 2: Edit the YAML

Change the pod name from `nginx` → `nginx-new` in the `metadata.name` field.

```
metadata:
  name: nginx-new
```

Also, **remove** the following fields to avoid issues:

- `status:`
- `creationTimestamp:`
- `resourceVersion:`
- `uid:`
- `selfLink:`

🧪 Step 3: Create new pod using YAML

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

🔍 Verify:

```
kubectl get pods
```

You should now see:

```
nginx          Running
nginx-new      Running
```

🚨 Task 3: Apply Broken YAML & Fix Errors

📄 Faulty YAML:

```
apiVersion: v1
kind: Pod
metadata:
  labels:
    app: test
  name: redis
spec:
  containers:
  - image: rediss
    name: redis
```

⚠️ Apply it:

```
kubectl apply -f redis.yaml
```

❌ Error:

```
Failed to pull image "rediss": rpc error: code = Unknown desc = Error response from
daemon: pull access denied for rediss
```

🧠 Root Cause:

`rediss` is a **typo** – correct image name is `redis`.

🛠️ Fix:

Edit the YAML:

```
- image: redis
```

Then apply again:

```
kubectl apply -f redis.yaml
```

🎉 The pod should now be in **Running** state.

📘 Key Learnings

🔍 Concept	🧠 Takeaway
Imperative vs Declarative	Quick testing vs. long-term reusable config
Exporting YAML	Use `kubectl get -o yaml` to create templates
Editing YAML	Always remove metadata like `uid`, `resourceVersion`, etc.
Troubleshooting	Read error logs carefully, usually a typo or invalid config
Pod Debugging	Use `kubectl describe pod <name>` for deep insights

📚 References

- 📘 Kubernetes Official Docs – Pods
- 💉 `kubectl` CLI Reference: https://kubernetes.io/docs/reference/kubectl/
- 📦 Docker Hub: https://hub.docker.com/_/nginx
- 📦 Redis Docker Image: https://hub.docker.com/_/redis
