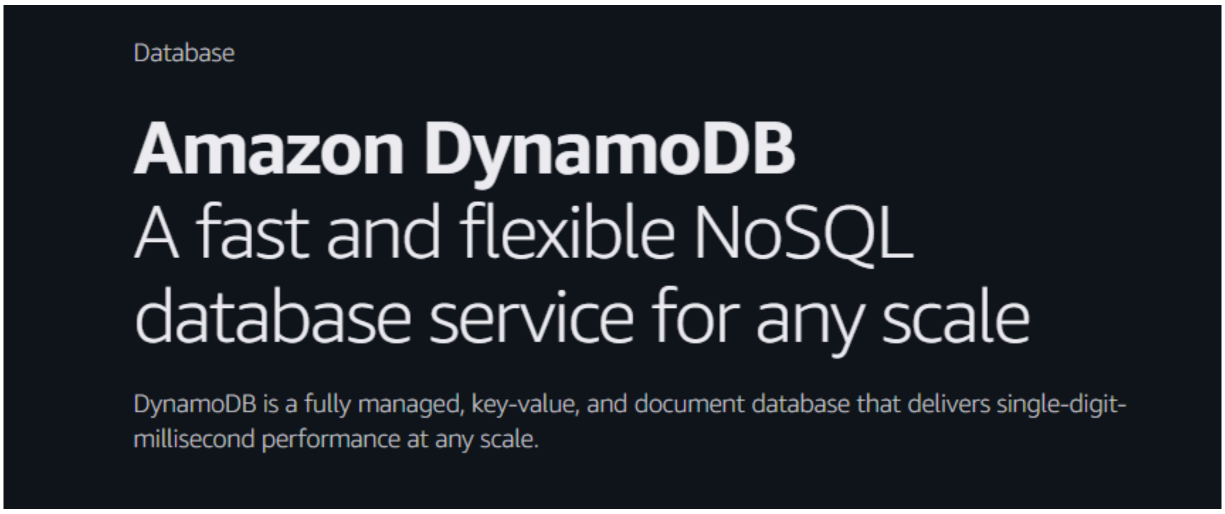
Amazon DynamoDB


Database

Amazon DynamoDB
A fast and flexible NoSQL database service for any scale

DynamoDB is a fully managed, key-value, and document database that delivers single-digit-millisecond performance at any scale.

Overview:

Amazon DynamoDB is a fully managed NoSQL database service provided by AWS, designed for fast and predictable performance with seamless scalability. It's commonly used for applications that require low-latency data access at any scale, like gaming, ad tech, IoT, mobile apps, etc.

Key Features of DynamoDB:

1. Fully Managed

- You don't need to manage infrastructure (no servers, no updates, no patching).
- AWS handles provisioning, patching, replication, fault tolerance, backups, etc.

2. High Performance at Scale

- Delivers single-digit millisecond latency for reads/writes—even at millions of requests per second.
- Consistent performance whether your table has 10 items or 10 million.

3. Automatic Scaling

- Supports Auto Scaling in provisioned mode.
- Automatically adjusts throughput based on usage patterns, ensuring performance and cost-efficiency.

4. Serverless + Pay-per-Use

- You don't provision servers—just use the table.
- With on-demand mode, you're billed only for the actual read/write requests.

5. Global Tables

- Multi-region replication with active-active writes across regions.
- Great for global applications needing low-latency access everywhere.

6. DAX (DynamoDB Accelerator)

- In-memory cache that sits in front of DynamoDB.
- Reduces read latency even further to microseconds.
- Fully managed, compatible with DynamoDB SDKs.

7. Fine-Grained Access Control

- Use IAM policies + Condition keys to control access at the item or attribute level.

Components of DynamoDB:

1. Tables

- A container for your data.
- You define a primary key (partition key or composite key) when creating a table.

2. Items

- Equivalent to a row in a relational database.
- Each item is a collection of attributes.
- Each item must have a primary key, but the rest of the attributes can vary from item to item (schema-less).

3. Attributes

- Equivalent to columns.
- Each attribute is a name–value pair.
- DynamoDB supports several data types:
  - Scalar types: String, Number, Boolean, Binary
  - Document types: List, Map
  - Set types: String Set, Number Set, Binary Set

4. Primary Key

- Uniquely identifies each item in the table.
- Two types:
  - Partition Key (simple key)
  - Partition Key + Sort Key (composite key)

5. Secondary Indexes

- Used to query the table in different ways, other than using the primary key.

a. Global Secondary Index (GSI)

- Can have different partition and sort keys than the base table.
- Can access any attribute, not just primary key.
- Can be created any time.

b. Local Secondary Index (LSI)

- Uses the same partition key as the base table but a different sort key.
- Can only be defined at table creation.

6. TTL (Time to Live)

- Automatically deletes expired items from your table.
- Helps with data retention and cost savings.

Read and Write Capacity Modes:

DynamoDB offers two capacity modes,

1. Provisioned Capacity:

- You manually define Read Capacity Units (RCUs) and Write Capacity Units (WCUs).
- Ideal for predictable workloads.
- Supports Auto Scaling to adjust capacity as needed.
- You pay for:
  - RCUs: 1 RCU = 1 strongly consistent read/sec for items up to 4KB.
  - WCUs: 1 WCU = 1 write/sec for items up to 1KB.

- **Example:**
  - You set 10 RCUs and 5 WCUs:
    - You can read 40KB of data/sec (10 RCUs × 4KB).
    - You can write 5KB of data/sec (5 WCUs × 1KB).

2. On-Demand Capacity:

- No need to provision capacity.
- DynamoDB auto-scales based on traffic.
- Ideal for unpredictable or spiky workloads.
- You only pay per read/write request.

When to Use What?

Use Case	Provisioned Mode	On-Demand Mode
Steady and predictable traffic	Yes	No
Spiky or unpredictable traffic	No	Yes
Cost control by limiting capacity	Yes	No
Minimal management effort	No	Yes

Primary Key:

The Primary Key is what DynamoDB uses to uniquely identify each item (row) in a table.

Unlike traditional relational databases where the primary key might be an auto-incremented ID, in DynamoDB, the Primary Key is mandatory and must be defined at the time of table creation. It determines how your data is stored and retrieved.

There are two types of primary keys:

1. Partition Key (Simple Primary Key):

Structure:

- Just one attribute (e.g., UserId, Email, etc.)

Behaviour:

- DynamoDB uses the Partition Key's value to compute a hash, which determines which partition (physical storage node) your item goes to.
- Each value of the partition key must be unique in the table.

Example:

Suppose you're storing users:

Partition Key (UserId)	Name	Email
101	Ajinkya	aj@example.com
102	Sneha	sneha@example.com

Here, UserId is the Partition Key, and every user has a unique value.

2. Partition Key + Sort Key (Composite Primary Key):

Structure:

- A Partition Key + a Sort Key.

Behaviour:

- All items with the same Partition Key are stored together in one partition.
- Items are sorted by the Sort Key within that partition.
- You can store multiple items with the same Partition Key as long as the Sort Key is different.

Example:

Suppose you're storing all tasks by users.

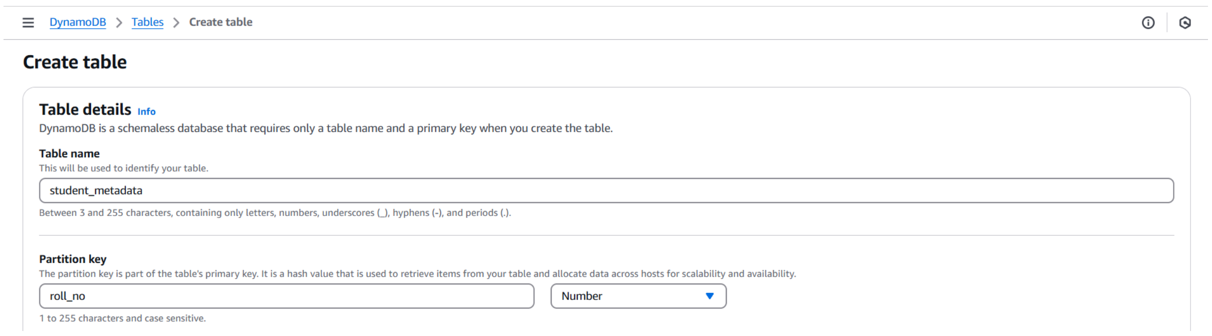
Partition Key (UserId)	**Sort Key (TaskId)**	**Task Name**	**Status**
101	task-1	Buy groceries	pending
101	task-2	Study DynamoDB	done
102	task-1	Workout	pending

- Here, the primary key is a combination of UserId (Partition Key) and TaskId (Sort Key).
- This allows multiple tasks for the same user, uniquely identified by the combination of both.

Practical-1:

Create a table in DynamoDB with only partition key.

- ➢ Open DynamoDB service from search bar and click on "Create table".
- ➢ Enter table name and partition key and keep sort key empty.



DynamoDB > Tables > Create table

Create table

Table details Info

DynamoDB is a schemaless database that requires only a table name and a primary key when you create the table.

Table name

This will be used to identify your table.

student_metadata

Between 3 and 255 characters, containing only letters, numbers, underscores (_), hyphens (-), and periods (.).

Partition key

The partition key is part of the table's primary key. It is a hash value that is used to retrieve items from your table and allocate data across hosts for scalability and availability.

roll_no | Number

1 to 255 characters and case sensitive.

- ➢ Keep table settings as default where we can see capacity mode is "On-Demand".

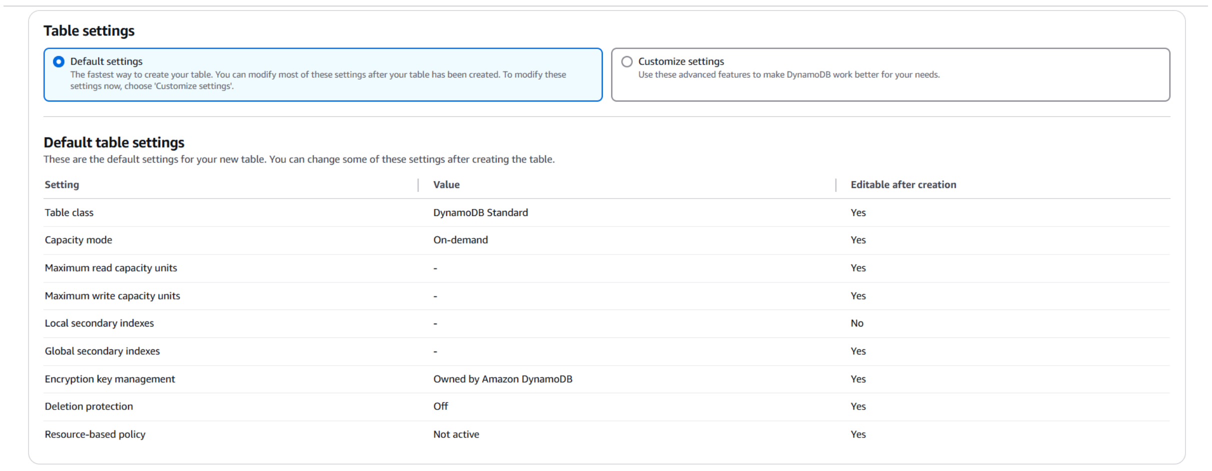


Table settings

● Default settings
The fastest way to create your table. You can modify most of these settings after your table has been created. To modify these settings now, choose 'Customize settings'.

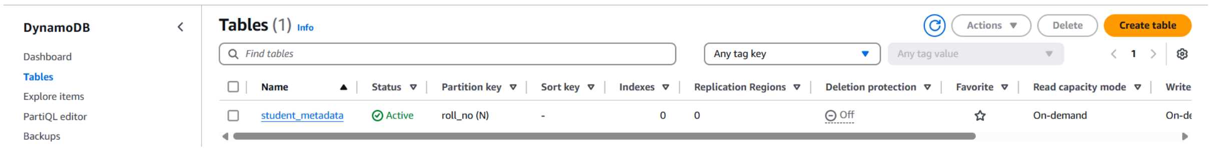
○ Customize settings
Use these advanced features to make DynamoDB work better for your needs.

Default table settings

These are the default settings for your new table. You can change some of these settings after creating the table.

Setting	Value	Editable after creation
Table class	DynamoDB Standard	Yes
Capacity mode	On-demand	Yes
Maximum read capacity units	-	Yes
Maximum write capacity units	-	Yes
Local secondary indexes	-	No
Global secondary indexes	-	Yes
Encryption key management	Owned by Amazon DynamoDB	Yes
Deletion protection	Off	Yes
Resource-based policy	Not active	Yes

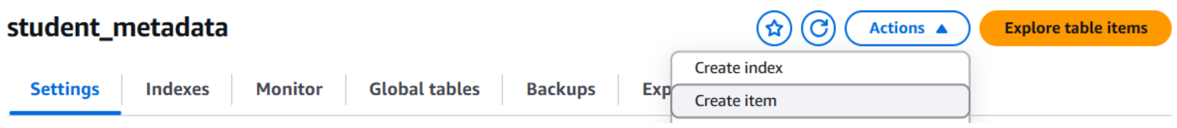
- ➢ Then click on 'create table' and wait for a while until the table is created.
- ➢ Once the status becomes "Active", click on table name to open details.



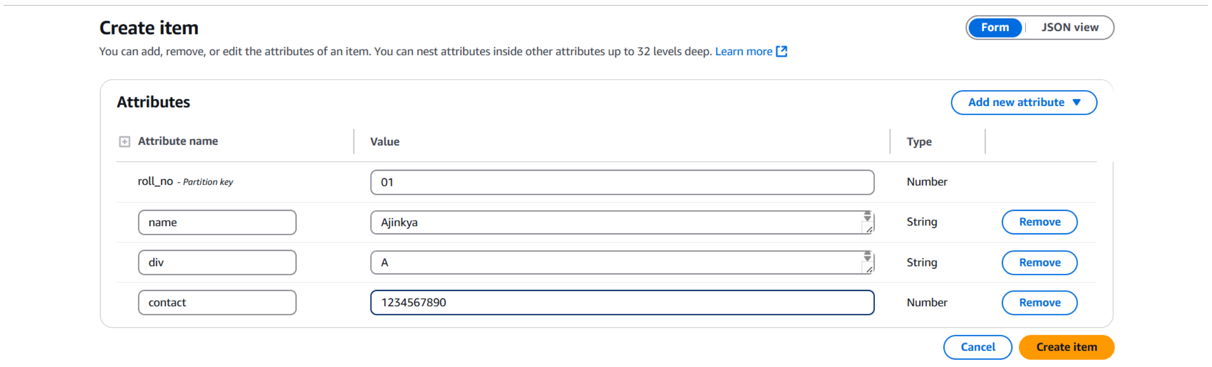
Tables (1) Info

Name	Status	Partition key	Sort key	Indexes	Replication Regions	Deletion protection	Favorite	Read capacity mode	Write
student_metadata	Active	roll_no (N)	-	0	0	Off	☆	On-demand	On-de

- ➢ Click on "Actions" and then "Create item".


student_metadata

➢ Create an item as shown in image and note one thing by default we need to mention our first attribute (roll_no) because its partition key which is compulsory.


Create item

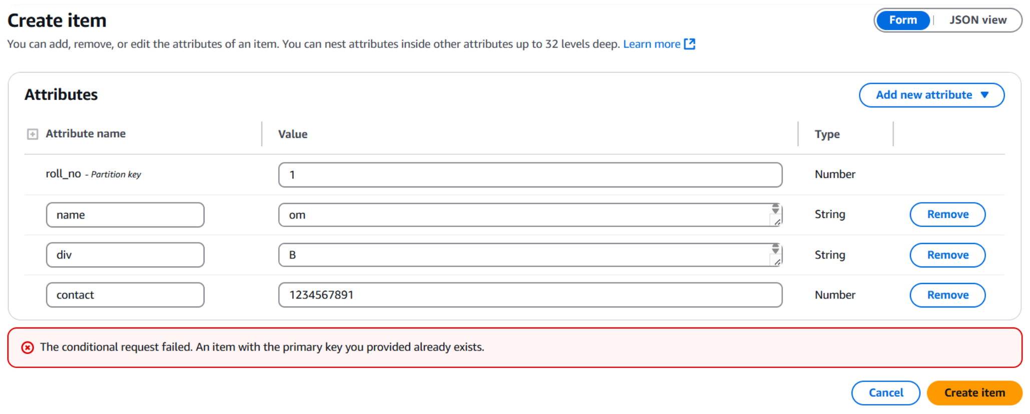
You can add, remove, or edit the attributes of an item. You can nest attributes inside other attributes up to 32 levels deep. Learn more

Attributes

Attribute name	Value	Type
roll_no - *Partition key*	01	Number
name	Ajinkya	String
div	A	String
contact	1234567890	Number

➢ Create a few items in this way.

➢ If we try to create another item with same partition key, it will return an error and the item will not be created.


Create item

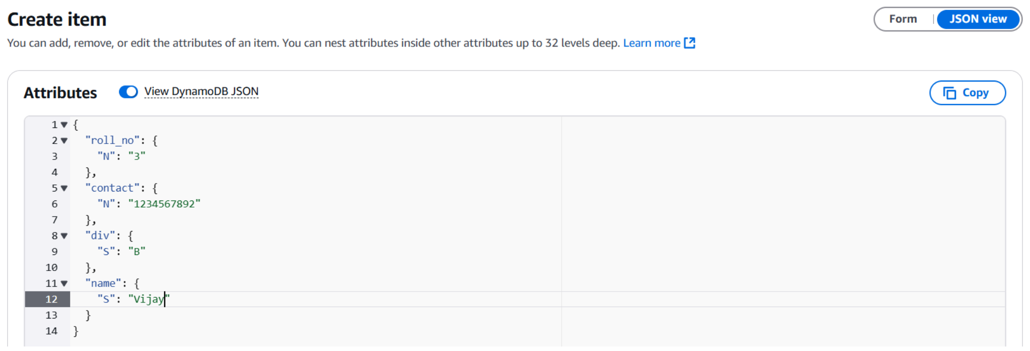
You can add, remove, or edit the attributes of an item. You can nest attributes inside other attributes up to 32 levels deep. Learn more

Attributes

Attribute name	Value	Type
roll_no - *Partition key*	1	Number
name	om	String
div	B	String
contact	1234567891	Number

The conditional request failed. An item with the primary key you provided already exists.

➢ We can create items using JSON too.

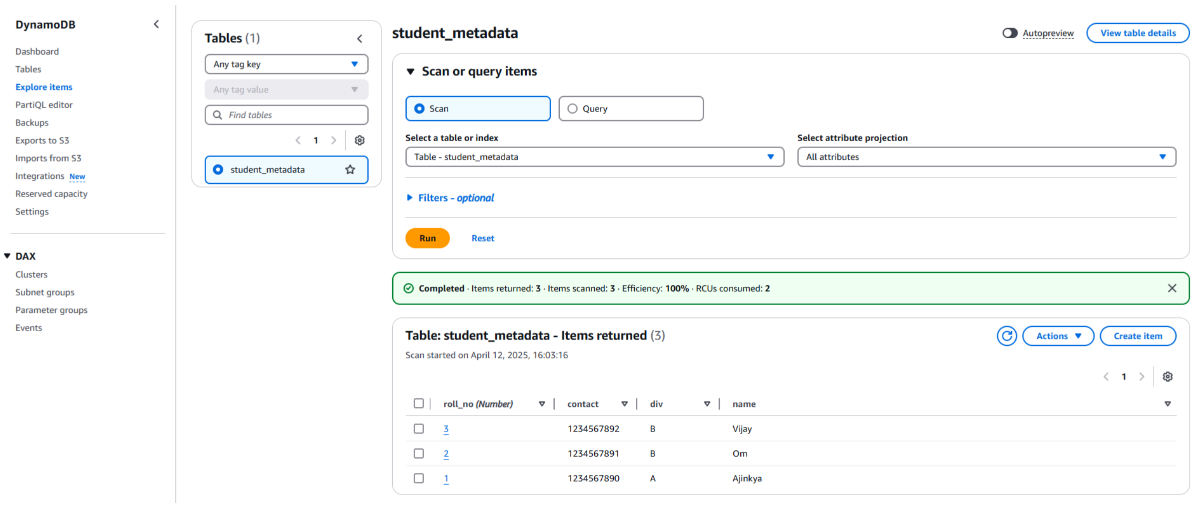

Create item

You can add, remove, or edit the attributes of an item. You can nest attributes inside other attributes up to 32 levels deep. Learn more

Attributes View DynamoDB JSON

```
{
  "roll_no": {
    "N": "3"
  },
  "contact": {
    "N": "1234567892"
  },
  "div": {
    "S": "B"
  },
  "name": {
    "S": "Vijay"
  }
}
```

- To view the items in the table we can go to "Explore items" section from where we can see the items by refreshing the table details using the spinning arrow. While doing that, notice a thing, a notification flashes something like "**Completed** · Items returned: **3** · Items scanned: **3** · Efficiency: **100%** · RCUs consumed: **2**".
- It states about RCUs consumed per read and items scanned.



student_metadata

Select a table or index: Table - student_metadata

Select attribute projection: All attributes

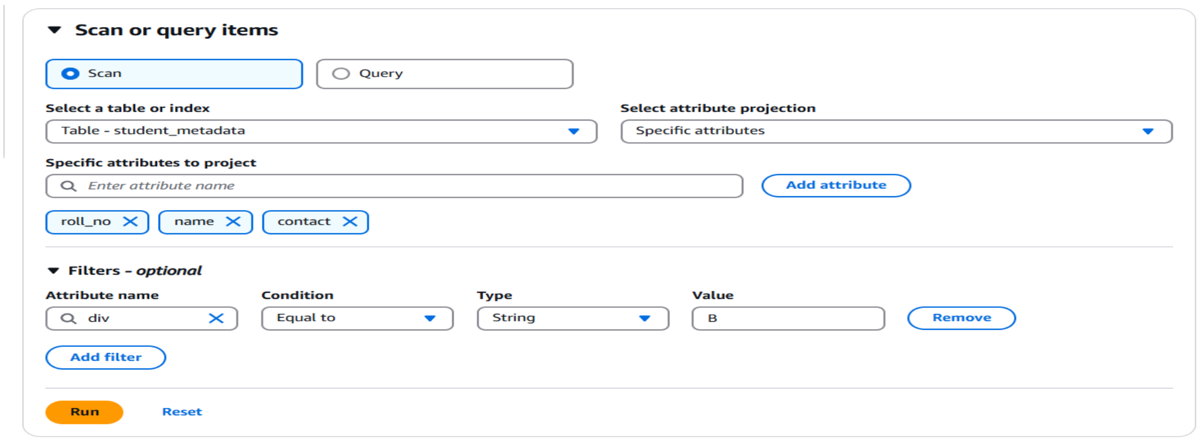
Completed · Items returned: 3 · Items scanned: 3 · Efficiency: 100% · RCUs consumed: 2

Table: student_metadata - Items returned (3)

Scan started on April 12, 2025, 16:03:16

roll_no (Number)	contact	div	name
3	1234567892	B	Vijay
2	1234567891	B	Om
1	1234567890	A	Ajinkya

- The same thing of scanning items can be done with/without filters using the "Scan" option available there.
- We will scan for specific attributes (roll_no, contact and name) with filter where div is B so it will return (by scanning) item details only with those attributes and "div" attribute won't be displayed.

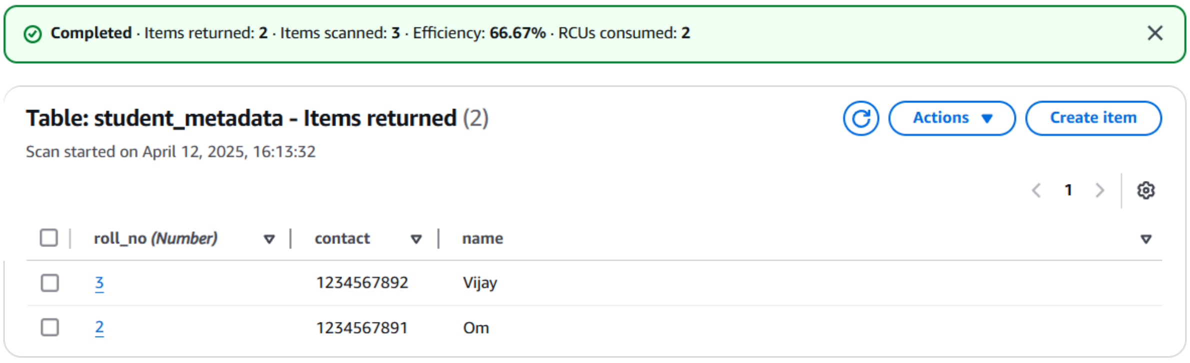


Select a table or index: Table - student_metadata

Select attribute projection: Specific attributes

Specific attributes to project: roll_no, name, contact

Attribute name	Condition	Type	Value
div	Equal to	String	B



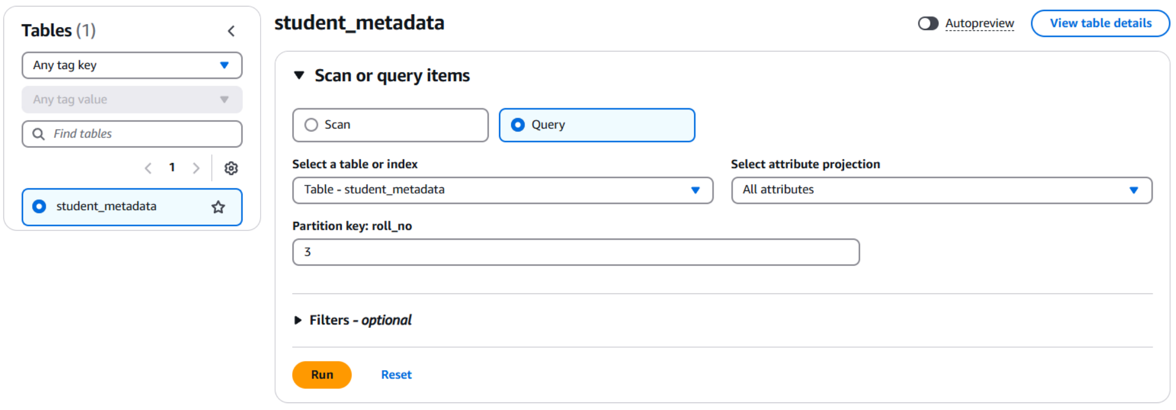
Completed · Items returned: 2 · Items scanned: 3 · Efficiency: 66.67% · RCUs consumed: 2

Table: student_metadata - Items returned (2)

Scan started on April 12, 2025, 16:13:32

roll_no (Number)	contact	name
3	1234567892	Vijay
2	1234567891	Om

➢ We can search for items using query section and entering the value of partition key.



student_metadata

Scan or query items

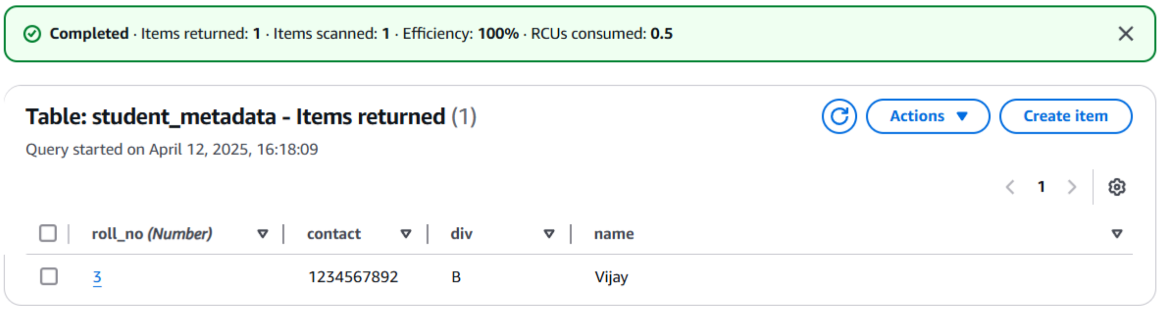
Scan [✓ Query]

Select a table or index: Table - student_metadata

Select attribute projection: All attributes

Partition key: roll_no: 3

➢ It will return the item that has the key.



Completed · Items returned: 1 · Items scanned: 1 · Efficiency: 100% · RCUs consumed: 0.5

Table: student_metadata - Items returned (1)

Query started on April 12, 2025, 16:18:09

roll_no (Number)	contact	div	name
3	1234567892	B	Vijay

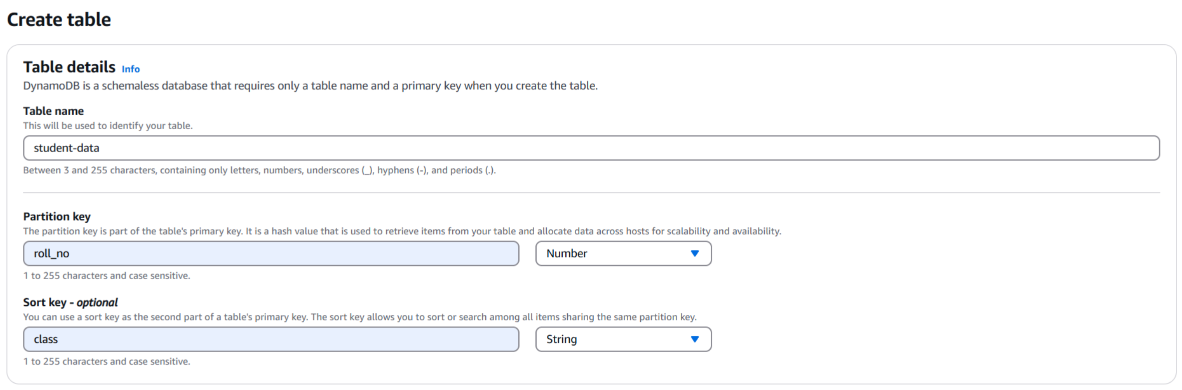
➢ We can run traditional queries in PartiQL editor to search for items too.

Practical-2:

Create a table in DynamoDB with composite key (partition key + sort key).

It will allow to create items with same partition key but sort key and partition key cannot be same for both the items.

- ➢ This time while creating table, enter both partition key and sort key and create the table.



Create table

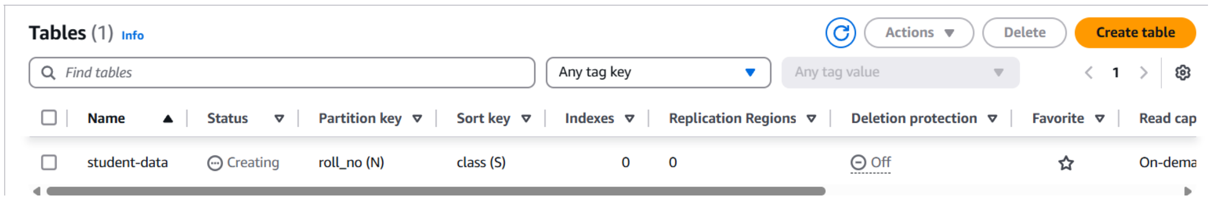
Table details Info
DynamoDB is a schemaless database that requires only a table name and a primary key when you create the table.

Table name
This will be used to identify your table.
student-data
Between 3 and 255 characters, containing only letters, numbers, underscores (_), hyphens (-), and periods (.).

Partition key
The partition key is part of the table's primary key. It is a hash value that is used to retrieve items from your table and allocate data across hosts for scalability and availability.
roll_no | Number
1 to 255 characters and case sensitive.

Sort key - *optional*
You can use a sort key as the second part of a table's primary key. The sort key allows you to sort or search among all items sharing the same partition key.
class | String
1 to 255 characters and case sensitive.

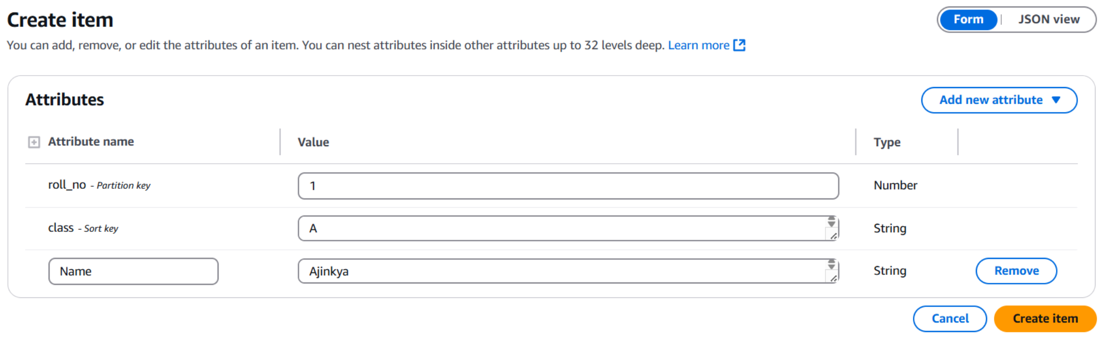
- ➢ On table list view als owe can see that sort key of string type (class (S) in my case) is mentioned.



Tables (1) Info

	Name	Status	Partition key	Sort key	Indexes	Replication Regions	Deletion protection	Favorite	Read cap
☐	student-data	Creating	roll_no (N)	class (S)	0	0	Off	☆	On-dema

- ➢ Create an item and this time while creating the item two attributes will be visible by default as partition key and sort key.



Create item

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Attributes

Attribute name	Value	Type	
roll_no - *Partition key*	1	Number	
class - *Sort key*	A	String	
Name	Ajinkya	String	Remove

➢ Try to create another item with same partition key but different sort key and it will get created.

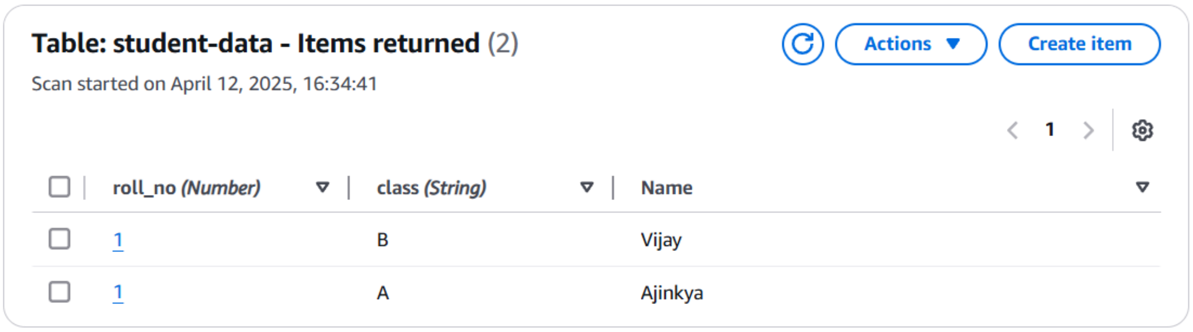
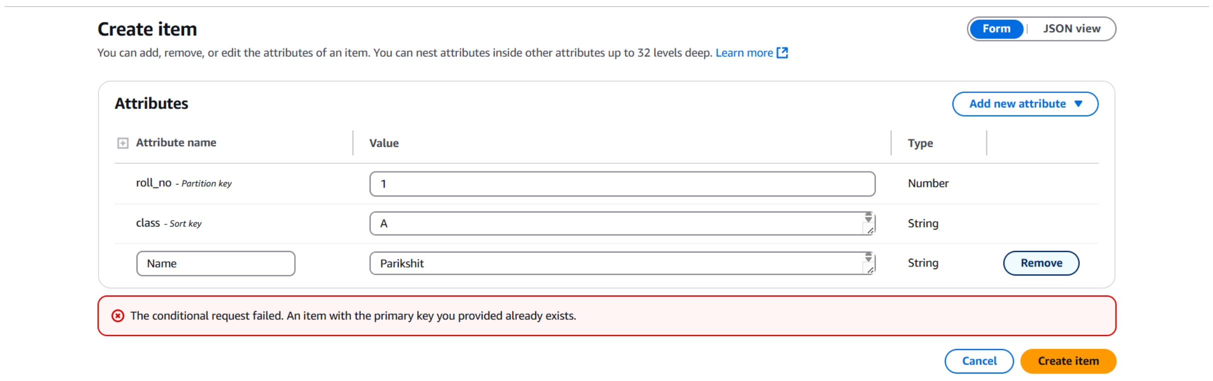


Table: student-data - Items returned (2)

Scan started on April 12, 2025, 16:34:41

roll_no (Number)	class (String)	Name
1	B	Vijay
1	A	Ajinkya

➢ But if we now try to create item with both the values same then it will generate an error and item won't be created.


Create item

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Attributes

Attribute name	Value	Type
roll_no - *Partition key*	1	Number
class - *Sort key*	A	String
Name	Parikshit	String

The conditional request failed. An item with the primary key you provided already exists.

Use Cases of DynamoDB:

1. User Profile Stores:

- **Use Case**: Store user data like name, email, preferences, settings.
- **Why DynamoDB?**

  Fast lookups, flexible schema, scalable for millions of users.
- **Example**: A social media app storing user profiles with UserId as the partition key.

2. Session Management:

- **Use Case**: Track active user sessions, login status, tokens.

Why DynamoDB?

Low-latency, TTL (Time-to-Live) support to auto-expire sessions.

- **Example**: A mobile app storing user sessions with TTL set to auto-delete after 1 hour.

3. E-Commerce Product Catalog:

- **Use Case**: Store and retrieve product info like price, stock, category.

Why DynamoDB?

Handles millions of products with fast filtering and access.

- **Example**: Category as Partition Key, ProductId as Sort Key to query all products in a category.

4. Shopping Cart / Order History:

- **Use Case**: Manage users' cart items or past orders.

Why DynamoDB?

Composite keys help store multiple orders/carts per user.

- **Example**: UserId as Partition Key, OrderId as Sort Key.

5. Real-Time Leaderboards / Gaming:

- **Use Case**: Track players' scores, rankings, match history.

Why DynamoDB?

Fast reads/writes, sort by score or time.

- **Example**: GameId as Partition Key, PlayerScore as Sort Key to rank players.

and many more.

Amazon DynamoDB is a fully managed NoSQL database service offered by AWS that provides consistent performance, seamless scalability, and serverless architecture. In this document, we explored DynamoDB's key features like auto-scaling, on-demand capacity, global tables, and fine-grained access control, all of which make it suitable for high-performance applications.

We examined the main components such as tables, items, attributes, and the importance of primary keys—both simple (partition key) and composite (partition + sort key). Through hands-on practicals, we created tables using both types of keys and understood how they control item uniqueness and querying behaviour.

Additionally, we explored DynamoDB's two capacity modes; Provisioned and On-Demand, highlighting when to use each based-on workload patterns

This practical and conceptual understanding builds a strong foundation for leveraging DynamoDB in real-world cloud-based applications.

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