Perfect 👍
You want a **full cheat sheet summary** that goes across **all 18 sections**, not compressed to one page.
Think of this as a **final revision sheet** → bullet points, quick code snippets, and diagrams where useful.

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# 🚀 Node.js Full Notes Summary Cheat Sheet

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## 1. Introduction to Node.js

- Built on **Chrome V8 Engine** (C++ binding).
- **Single-threaded, non-blocking I/O**, ideal for I/O-heavy apps.
- Use cases: APIs, real-time apps, microservices, CLI tools.

📌 **Difference vs PHP (Laravel):**

- PHP → multi-threaded, blocking I/O.
- Node.js → async, event loop-driven.

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## 2. Node.js Architecture

- **Event loop** manages concurrency.
- **libuv** → handles I/O in background threads.
- Flow: Request → Event Queue → Event Loop → Worker Pool → Callback.

🖼 Diagram (simplified):

```
Request → Event Queue → Event Loop → (async I/O handled by libuv threads) →
Callback Execution
```

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## 3. Core Modules

- `fs` → File system.
- `http`/`https` → Create servers.
- `path` → Path utilities.
- `os` → System info.
- `events` → Custom event emitter.
- `stream` & `buffer` → Handle large/chunked data.

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## 4. Package Management

- `npm` (default) vs `yarn`.

- `package.json` → dependencies, scripts.
- `package-lock.json` → locks exact versions.
- **Semver**:
    - `^1.2.3` → latest minor/patch.
    - `~1.2.3` → latest patch.

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## 5. Asynchronous Programming

- **Callbacks** → lead to “callback hell.”
- **Promises** → cleaner async chaining.
- **Async/Await** → synchronous-like async flow.
- Always handle errors with `try/catch` or `.catch()`.

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## 6. Express.js

- Minimal web framework.
- Middleware system → request/response cycle.
- Example:

```
const express = require("express");
const app = express();
app.get("/", (req, res) => res.send("Hello World"));
```

- Error handler: `app.use((err,req,res,next)=>{...})`.

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## 7. Database Integration

- **SQL** → MySQL, PostgreSQL with Knex/Sequelize.
- **NoSQL** → MongoDB with Mongoose.
- Best Practices:
    - Indexing.
    - Connection pooling.
    - Avoid N+1 queries (`populate` in Mongo, joins in SQL).

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## 8. Authentication & Security

- **JWT** → Stateless token-based auth.
- **OAuth2** → Third-party login.

- Secure Practices:
  - Sanitize inputs.
  - Use `helmet`, `express-rate-limit`.
  - Always prefer HTTPS.
  - Prevent **XSS**, **CSRF**, **SQL injection**.

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## 9. Node.js Design Patterns

- **Singleton** → Shared instance (DB connection).
- **Factory** → Create objects dynamically.
- **Middleware Pattern** → Express pipeline.
- **Observer Pattern** → `EventEmitter`.

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## 10. Scaling & Performance

- **Clustering** → Spawn workers across CPU cores.
- **Worker Threads** → CPU-intensive tasks.
- **Caching** → Redis, Memcached.
- **Load balancing** → Nginx, HAProxy.

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## 11. Testing

- **Unit tests** → Mocha/Jest.
- **Integration tests** → Supertest for API.
- **Best practices:**
  - Small, isolated tests.
  - Mock external services.

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## 12. Error Handling & Debugging

- Use `try/catch` for async/await.
- Central error middleware in Express.
- **Logging:** Winston, Morgan.
- **Debugging:** Node Inspector (`node --inspect`).

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## 13. RESTful APIs

- CRUD with Express.
- API versioning: `/api/v1/users`.
- Documentation: Swagger/Postman.

Example:

```
app.post("/users", (req,res)=>{...});
```

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## 14. Event-Driven Programming

- Core idea of Node.js.
- `EventEmitter`:

```
const EventEmitter = require("events");
const emitter = new EventEmitter();
emitter.on("data", d => console.log(d));
emitter.emit("data", "Hello");
```

- Basis for real-time apps (Socket.io).

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## 15. Microservices & Message Queues

- Microservices = small, independent services.
- Communication via REST, gRPC, or MQ.
- **Message Queues**:
  - RabbitMQ (AMQP).
  - Kafka (high throughput).
  - Redis Pub/Sub (lightweight).
- Best for async tasks: emails, notifications, logs.

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## 16. Performance Optimization

- Use **async APIs** (`fs.promises`).
- Caching with Redis.
- DB optimizations (indexes, pooling).
- Use **streams** for large files.
- Minimize Express middleware.
- Compression (`compression` middleware).
- **Clustering + Load balancing**.
- Monitor: PM2, Node Clinic, New Relic.

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## 17. Deployment & DevOps

- **PM2** → process manager, clustering, logs.
- **Docker** → containerize apps.
- **CI/CD** → GitHub Actions, Jenkins, GitLab CI.
- Logging & monitoring with ELK stack / Grafana.

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## 18. GraphQL

- Alternative to REST → query only what you need.
- **Apollo Server** for Node.js.
- Supports Queries, Mutations, Subscriptions (real-time).

Example:

```
const { ApolloServer, gql } = require("apollo-server");
const typeDefs = gql`type Query { hello: String }`;
const resolvers = { Query: { hello: () => "Hi" }};
new ApolloServer({ typeDefs, resolvers }).listen();
```

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## Interview Hot Questions

- How does the **event loop** work?
- Difference between **process vs thread**?
- What are **streams**? Why use them?
- How to **scale Node.js** apps?
- What's **callback hell** and how to fix it?
- JWT vs Session authentication?
- How to secure a Node.js app?

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✅ With this **cheat sheet**, you can quickly revise **all 18 topics** before an interview.

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Would you like me to also create a **visual diagram summary (mind map / flow)** across these 18 topics for quick recall, or keep it text-only?