

- 
1. Explain EACH of the following:
- (a) Merchant Shipping Notices; (4)
  - (b) Marine Guidance Notes; (3)
  - (c) Marine Information Notes. (3)

## 1. Explain EACH of the following:

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### (a) Merchant Shipping Notices (MSNs) (4 marks)

**Merchant Shipping Notices (MSNs)** are official notices issued by the **Maritime and Coastguard Agency (MCA)** that contain **mandatory requirements** relating to merchant shipping legislation.

They are used to:

- Implement UK Merchant Shipping Regulations.
- Give details of statutory requirements.
- Explain how legislation should be complied with.
- Notify shipowners, masters, and seafarers of changes to legal requirements.

#### Exam Answer (4 marks)

Merchant Shipping Notices are statutory notices issued by the MCA that provide mandatory information and instructions relating to Merchant Shipping Regulations and legal requirements that must be complied with by the shipping industry.

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### (b) Marine Guidance Notes (MGNs) (3 marks)

**Marine Guidance Notes (MGNs)** provide **advice, guidance, and best practice recommendations** on a wide range of marine matters.

They are intended to:

- Explain the practical application of regulations.
- Offer guidance on safety and operational procedures.
- Promote good seamanship and industry best practice.

Unlike MSNs, MGNs are **not legally mandatory**, although they are strongly recommended.

#### Exam Answer (3 marks)

Marine Guidance Notes are issued by the MCA to provide advice and guidance on the interpretation and practical application of regulations and to promote best practice within the maritime industry.

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## (c) Marine Information Notes (MINs) (3 marks)

**Marine Information Notes (MINs)** are issued by the MCA to disseminate **general information** to the maritime industry.

They are used to:

- Announce new developments and initiatives.
- Draw attention to safety concerns and lessons learned from incidents.
- Provide information on consultations, training, examinations, and administrative matters.
- Give temporary information that may not justify the issue of an MSN or MGN.

MINs do **not contain mandatory requirements**.

### Exam Answer (3 marks)

Marine Information Notes provide general information to the maritime industry on current issues, safety matters, consultations, examinations, and administrative developments. They are informational only and do not impose statutory requirements.

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## Summary Table

| Notice Type                           | Purpose                                                  | Mandatory?                                                                                |
|---------------------------------------|----------------------------------------------------------|-------------------------------------------------------------------------------------------|
| <b>Merchant Shipping Notice (MSN)</b> | Statutory requirements and implementation of regulations |  Yes |
| <b>Marine Guidance Note (MGN)</b>     | Guidance and best practice advice                        |  No  |
| <b>Marine Information Note (MIN)</b>  | General information and announcements                    |  No  |

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## Complete Exam Answer (10 marks)

- (a) Merchant Shipping Notices are statutory notices issued by the MCA containing mandatory requirements and instructions relating to Merchant Shipping Regulations.
- (b) Marine Guidance Notes provide advice and guidance on the interpretation and practical application of regulations and promote best practice.
- (c) Marine Information Notes provide general information on safety matters, consultations, examinations, and other current developments affecting the maritime industry and do not contain mandatory requirements.

2. (a) State SEVEN checks that should be carried out before taking over the machinery space watch from another officer. (7)
- (b) State the circumstances under which it would be inappropriate for the officer in charge of an engineering watch to hand over responsibility to a relief. (3)

**2.**

### (a) State SEVEN checks that should be carried out before taking over the machinery space watch from another officer. (7 marks)

Before taking over an engineering watch, the relieving officer should ensure that they are fully informed of the condition of the machinery and any special circumstances affecting the watch. The following checks should be carried out:

#### 1. Main Propulsion Machinery Status

- Check the operating condition of the main engines and any control systems.
- Ascertain whether the vessel is operating under bridge control or engine-room control.

#### 2. Auxiliary Machinery Condition

- Confirm the condition and operation of generators, boilers, pumps, compressors, purifiers, and other essential auxiliary machinery.

#### 3. Tank Levels and Transfers

- Check the levels of:
  - fuel oil service tanks,
  - lubricating oil sumps,
  - jacket water expansion tanks,
  - bilge wells,
  - ballast and fresh water tanks.
- Determine whether any transfers are in progress.

#### 4. Defects and Machinery Under Repair

- Be informed of any defects, abnormal operating conditions, or equipment isolated for maintenance.
- Check the machinery defect book and outstanding work.

## 5. Standing Orders and Special Instructions

- Read and understand the Chief Engineer's standing orders and any special instructions for the watch.

## 6. Fire-Fighting and Safety Equipment Status

- Ensure that fire detection, fire pumps, emergency equipment, and safety systems are operational.
- Confirm the status of any permits to work in force.

## 7. Bilge and Pollution Prevention Arrangements

- Check bilge levels and the condition of oily water separator arrangements.
- Confirm that MARPOL requirements are being complied with.

## 8. Weather and Navigational Conditions

- Obtain information regarding expected weather, restricted waters, manoeuvring requirements, or any conditions affecting machinery operation.

## 9. Alarm and Monitoring Systems

- Check that alarms, remote indicators, and monitoring systems are functioning correctly.

### Exam Answer (7 marks)

Before taking over the watch, the relieving engineer should check the status of the main and auxiliary machinery, tank levels and transfers, outstanding defects and repairs, standing orders and special instructions, safety and fire-fighting equipment, bilge and pollution prevention arrangements, and any weather or navigational conditions affecting the operation of the machinery.

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## **(b) State the circumstances under which it would be inappropriate for the officer in charge of an engineering watch to hand over responsibility to a relief. (3 marks)**

The watch should **not** be handed over if:

### 1. The Relieving Officer Is Unfit for Duty

- The relieving officer appears to be under the influence of alcohol or drugs.
- They are suffering from illness, severe fatigue, or are otherwise incapable of carrying out their duties safely.

### 2. An Emergency Situation Exists

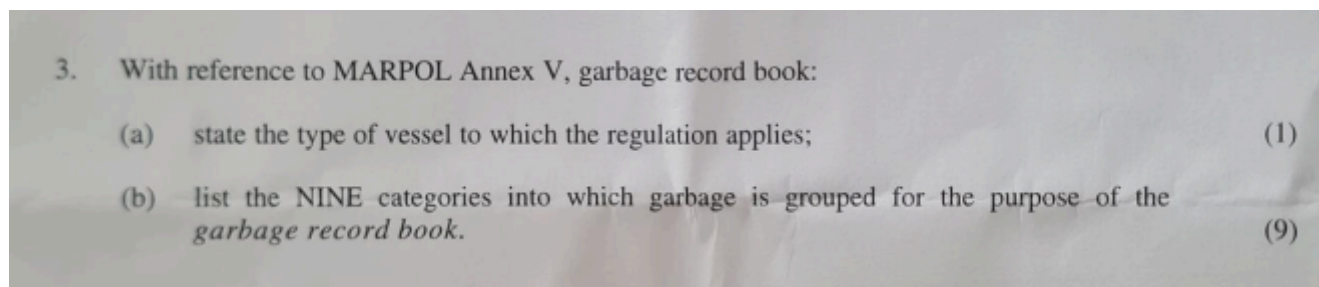
- There is a fire, flooding, machinery breakdown, blackout, or any other emergency in progress requiring the attention of the officer on watch.

### 3. Critical Operations Are in Progress

- The vessel is manoeuvring, entering or leaving port, operating in restricted waters, or undertaking operations that require continuity of supervision until safely completed.

#### Exam Answer (3 marks)

The engineering watch should not be handed over if the relieving officer is unfit for duty due to fatigue, illness, alcohol, or drugs; if an emergency situation exists; or while critical operations such as manoeuvring or major machinery operations are in progress.



3.

## With reference to MARPOL Annex V, Garbage Record Book:

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### (a) State the type of vessel to which the regulation applies. (1 mark)

Under **MARPOL Annex V**, a **Garbage Record Book** is required for:

**All ships of 100 gross tonnage and above, and every ship certified to carry 15 persons or more, engaged on international voyages.**

It is also required for **fixed or floating platforms** engaged in the exploration and exploitation of the seabed.

#### Exam Answer (1 mark)

The regulation applies to ships of **100 gross tonnage and above**, ships certified to carry **15 persons or more**, and fixed or floating offshore platforms.

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## **(b) List the NINE categories into which garbage is grouped for the purpose of the Garbage Record Book. (9 marks)**

For Garbage Record Book entries, MARPOL Annex V classifies garbage into the following **nine categories**:

| Category | Garbage Type |
|----------|--------------|
|----------|--------------|

|   |          |
|---|----------|
| A | Plastics |
|---|----------|

|   |             |
|---|-------------|
| B | Food wastes |
|---|-------------|

|   |                 |
|---|-----------------|
| C | Domestic wastes |
|---|-----------------|

|   |             |
|---|-------------|
| D | Cooking oil |
|---|-------------|

|   |                   |
|---|-------------------|
| E | Incinerator ashes |
|---|-------------------|

|   |                    |
|---|--------------------|
| F | Operational wastes |
|---|--------------------|

|   |                  |
|---|------------------|
| G | Animal carcasses |
|---|------------------|

|   |              |
|---|--------------|
| H | Fishing gear |
|---|--------------|

|   |                            |
|---|----------------------------|
| I | E-waste (electronic waste) |
|---|----------------------------|

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### **Brief Explanation of Each Category**

#### **A – Plastics**

- Includes synthetic ropes, fishing nets, plastic bags, and plastic packaging materials.

**B – Food Wastes**

- All spoiled or unspoiled food substances generated during normal shipboard operations.

**C – Domestic Wastes**

- Paper products, rags, glass, metal, bottles, crockery, and similar household-type wastes.

**D – Cooking Oil**

- Edible oils and fats generated from food preparation.

**E – Incinerator Ashes**

- Ashes resulting from the incineration of shipboard garbage.

**F – Operational Wastes**

- Cargo-associated waste, sweepings, maintenance waste, and similar materials generated during ship operations.

**G – Animal Carcasses**

- Bodies of animals carried as cargo that die during the voyage.

**H – Fishing Gear**

- Nets, lines, traps, and other fishing equipment.

**I – E-Waste**

- Electrical and electronic equipment and their components that are no longer usable.
- 

## Exam Answer (10 marks)

(a) A Garbage Record Book is required for ships of **100 GT and above**, ships certified to carry **15 persons or more**, and fixed or floating platforms.

(b) The nine garbage categories are:

1. Plastics
2. Food wastes
3. Domestic wastes
4. Cooking oil
5. Incinerator ashes
6. Operational wastes
7. Animal carcasses
8. Fishing gear
9. E-waste.

4. With reference to microbiological contamination of marine gas oil:
- (a) state the conditions that must be present for the microbes to live and multiply; (2)
  - (b) describe the effect of microbiological growth in the fuel; (2)
  - (c) explain how the contamination may be detected; (2)
  - (d) state how the risk of contamination may be reduced; (2)
  - (e) explain how the contamination may be removed. (2)

**4.**

## With reference to microbiological contamination of marine gas oil:

Microbiological contamination, often called "**diesel bug**," is caused by bacteria, fungi, and yeasts growing in the fuel system.

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### (a) State the conditions that must be present for the microbes to live and multiply. (2 marks)

Micro-organisms require the following conditions:

1. **The presence of water** in contact with the fuel (usually free water at the bottom of tanks).
2. **Suitable temperatures and nutrients**, with the fuel providing a food source and oxygen being available for aerobic organisms.

### Exam Answer (2 marks)

Microbes require **water and a source of nutrients (the fuel itself)**, together with favourable temperatures and suitable conditions for growth.

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### (b) Describe the effect of microbiological growth in the fuel. (2 marks)

Microbiological growth can:

1. **Produce sludge and slime**, blocking filters, strainers, fuel lines, and injectors.
2. **Cause corrosion** of tanks and pipework due to acidic by-products produced by the organisms.

Other effects include reduced engine reliability and fuel starvation.

### Exam Answer (2 marks)

Microbial growth produces sludge that blocks filters and fuel systems and generates corrosive substances that attack tanks and pipework.

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### (c) Explain how the contamination may be detected. (2 marks)

Contamination may be detected by:

1. **Visual inspection**, revealing black or brown slime, sludge, or deposits in filters, drain samples, and tank bottoms.
2. **Microbiological testing**, using dip slides, test kits, or laboratory analysis of fuel and water samples.

#### Exam Answer (2 marks)

The contamination may be detected by observing sludge or slime in filters and drain samples, or by using microbiological test kits and laboratory analysis.

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### (d) State how the risk of contamination may be reduced. (2 marks)

The risk can be reduced by:

1. **Regularly draining water** from storage and service tanks.
2. **Maintaining tanks in a clean condition and keeping them as dry as possible.**
3. Using approved **biocide treatments** where appropriate.
4. Avoiding long-term storage of fuel without monitoring.

#### Exam Answer (2 marks)

The risk is reduced by removing water from tanks, maintaining good housekeeping, cleaning tanks regularly, and using approved biocides when necessary.

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### (e) Explain how the contamination may be removed. (2 marks)

Contamination may be removed by:

1. **Cleaning the affected tanks and fuel system**, removing sludge and deposits.
2. **Treating the fuel with a suitable biocide** to kill the micro-organisms.
3. Replacing contaminated filters and draining accumulated water.

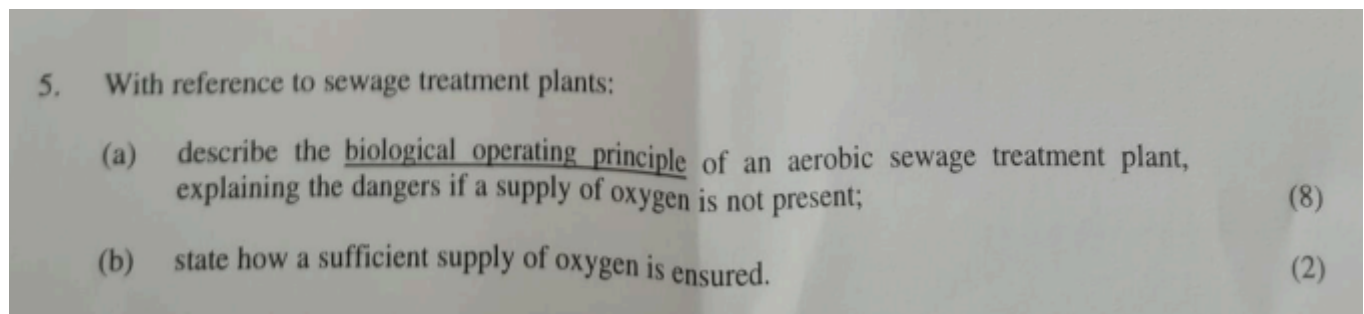
#### Exam Answer (2 marks)

The contamination is removed by cleaning the fuel system and tanks, removing sludge and water, replacing blocked filters, and treating the fuel with an approved biocide.

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# Complete Exam Answer (10 marks)

- (a) Microbes require the presence of water and suitable conditions, with the fuel acting as a nutrient source.
- (b) Their growth produces sludge that blocks filters and fuel lines and may cause corrosion through acidic by-products.
- (c) Contamination can be detected by visual inspection for slime and deposits or by microbiological test kits and laboratory analysis.
- (d) The risk is reduced by removing water from tanks, maintaining cleanliness, and using biocides where necessary.
- (e) Contamination is removed by cleaning tanks and fuel systems, replacing filters, draining water, and treating the fuel with an approved biocide.



## With reference to sewage treatment plants:

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**(a) Describe the biological operating principle of an aerobic sewage treatment plant, explaining the dangers if a supply of oxygen is not present. (8 marks)**

### Biological Operating Principle

An **aerobic sewage treatment plant** uses **aerobic micro-organisms (bacteria)** to break down and stabilise organic matter present in sewage.

The process operates as follows:

#### 1. Collection of Sewage

- Black water (from toilets) and, in some systems, grey water enter the treatment plant.
- The sewage flows into the **aeration chamber**.

## 2. Aeration Stage

- Air is continuously supplied to the sewage by blowers or compressors through diffusers.
- The oxygen supports the growth of **aerobic bacteria**.

## 3. Biological Oxidation

- The bacteria feed on the organic pollutants in the sewage.
- They convert complex organic matter into simpler, harmless substances by oxidation.

The end products are mainly:

- **Carbon dioxide (CO<sub>2</sub>)**
- **Water (H<sub>2</sub>O)**
- **Nitrates**
- **Biological sludge (biomass)**

## 4. Settlement Stage

- The mixed liquor passes to a **settling tank (clarifier)**.
- The activated sludge settles to the bottom.
- Some settled sludge is returned to maintain the bacterial population.
- Excess sludge is removed for disposal.

## 5. Disinfection Stage

- The clarified effluent is disinfected, commonly by chlorination, before discharge overboard in accordance with regulations.

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## Dangers if Oxygen Is Not Present

If an adequate oxygen supply is not maintained:

### (i) Anaerobic Conditions Develop

- Aerobic bacteria die or become inactive.
- Anaerobic bacteria multiply.

### (ii) Offensive Odours Are Produced

- Putrefaction occurs.
- Foul-smelling gases are generated.

### (iii) Dangerous Gases May Form

These include:

- **Hydrogen sulphide (H<sub>2</sub>S)** – toxic and corrosive.
- **Methane (CH<sub>4</sub>)** – highly flammable and explosive.
- **Ammonia (NH<sub>3</sub>)** – toxic and irritating.

- **Carbon dioxide (CO<sub>2</sub>)** – can contribute to oxygen deficiency.

#### (iv) Reduced Treatment Efficiency

- Organic matter is not fully broken down.
  - The discharged effluent quality deteriorates and may fail to comply with MARPOL requirements.
- 

### Exam Answer (8 marks)

An aerobic sewage treatment plant uses aerobic bacteria to decompose organic matter in sewage. Air is supplied continuously to an aeration chamber, allowing the bacteria to oxidise the sewage into carbon dioxide, water, nitrates, and biological sludge. The treated liquor then passes to a settling tank where sludge separates from the clarified effluent, which is subsequently disinfected before discharge. If oxygen is not supplied, anaerobic conditions develop, resulting in poor treatment efficiency and the production of dangerous gases such as hydrogen sulphide and methane.

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### (b) State how a sufficient supply of oxygen is ensured. (2 marks)

A sufficient oxygen supply is ensured by:

1. **Continuously aerating the sewage** using air blowers or compressors connected to diffusers within the aeration chamber.
  2. **Maintaining and monitoring the aeration equipment** to ensure the correct airflow and dissolved oxygen levels are provided.
- 

### Exam Answer (2 marks)

Adequate oxygen is ensured by continuously injecting air into the aeration chamber using blowers or compressors and maintaining the aeration system so that sufficient dissolved oxygen is available for the aerobic bacteria.

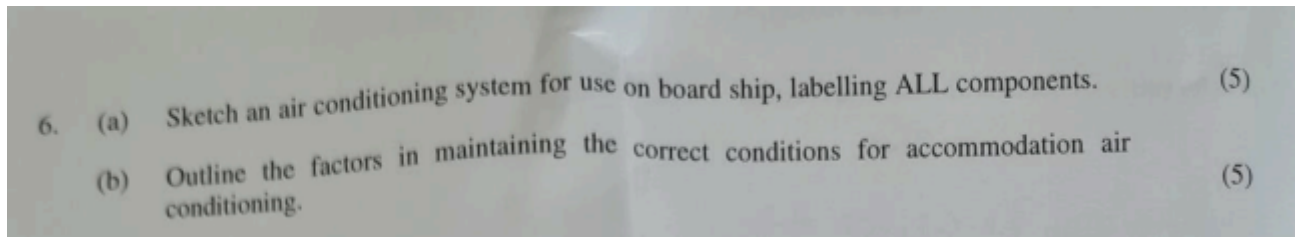
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### Complete Exam Answer (10 marks)

**(a)** An aerobic sewage treatment plant relies on aerobic bacteria to biologically oxidise organic matter in sewage. Air is continuously supplied to the aeration chamber, enabling the bacteria to convert the waste into stable products. The mixture then passes to a settling tank, and the treated effluent is disinfected before discharge. Without oxygen, anaerobic conditions develop, producing

foul odours and hazardous gases such as hydrogen sulphide and methane, while treatment efficiency is reduced.

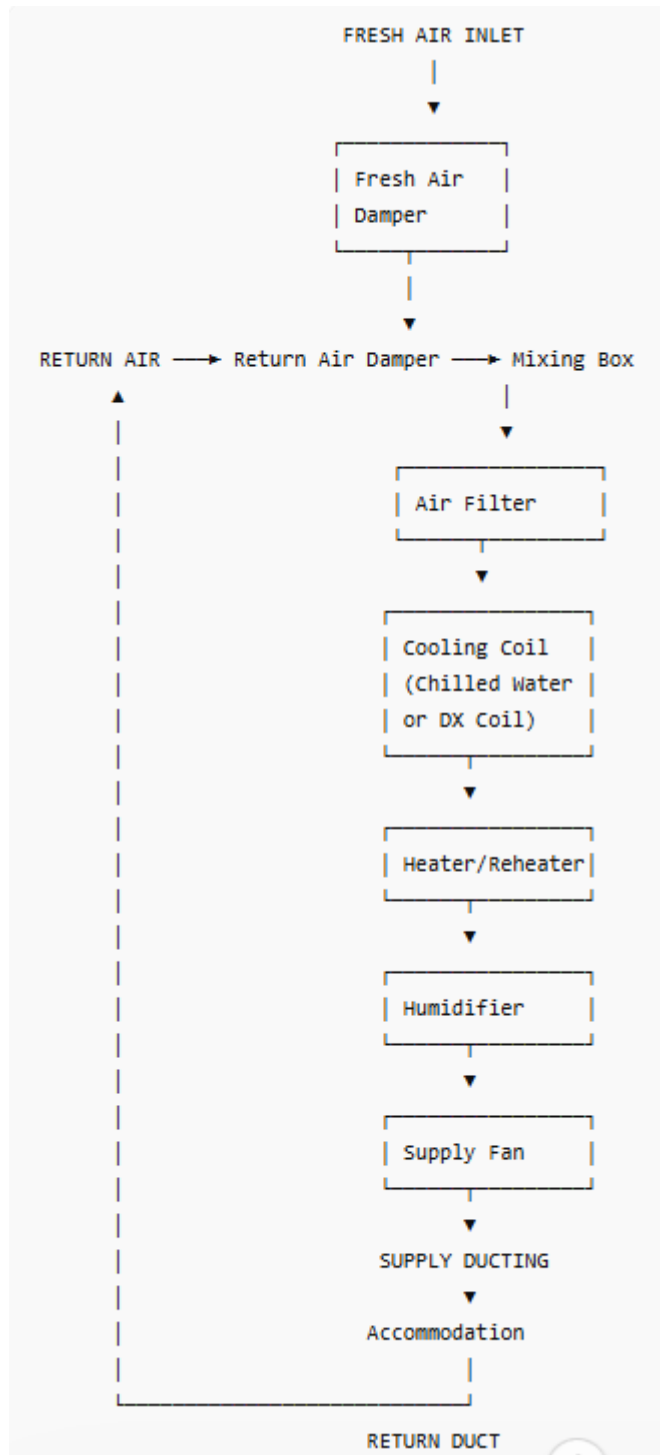
**(b)** Sufficient oxygen is ensured by the continuous operation of blowers or compressors supplying air through diffusers and by maintaining the aeration equipment to provide adequate airflow.



### **Sketch an air conditioning system for use on board ship, labelling ALL components. (5 marks)**

A typical marine air conditioning system consists of an air handling unit, supply and return ducts, cooling and heating arrangements, filters, and fans.

#### **Sketch**



## Main Components

- Fresh air intake and damper
- Return air damper
- Mixing box
- Air filters
- Cooling coil (direct expansion or chilled water)
- Heating/reheater coil
- Humidifier
- Supply fan (blower)
- Supply ducting
- Accommodation spaces
- Return ducting

## Exam Answer (5 marks)

A shipboard air conditioning system consists of a fresh air intake, return air mixing chamber, filters, cooling coil, reheater, humidifier, supply fan, supply ducting to accommodation spaces, and return ducting back to the air handling unit.

---

## (b) Outline the factors in maintaining the correct conditions for accommodation air conditioning. (5 marks)

The objective of accommodation air conditioning is to provide a comfortable and healthy environment for personnel.

The principal factors are:

### 1. Temperature Control

- The air temperature should be maintained within comfortable limits, typically around **21–24°C**.

### 2. Humidity Control

- Relative humidity should normally be maintained between **40–60%** to avoid excessive dryness or dampness.

### 3. Ventilation and Fresh Air Supply

- Adequate fresh air must be introduced to provide oxygen and remove odours, carbon dioxide, and contaminants.

### 4. Air Movement

- Sufficient air circulation should be provided without causing uncomfortable draughts.

### 5. Air Cleanliness

- Filters should remove dust, smoke, and other airborne particles to maintain good air quality.

### 6. Noise Control

- Fans and ducting should operate quietly to ensure occupant comfort.

### 7. Uniform Distribution

- Conditioned air should be evenly distributed throughout the accommodation spaces.

## Exam Answer (5 marks)

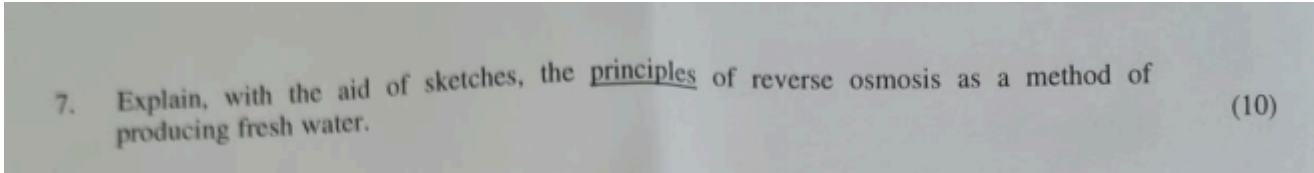
The correct accommodation conditions are maintained by controlling temperature, relative humidity, ventilation rate, air movement, and air cleanliness. Adequate fresh air, effective filtration, and even distribution of conditioned air should also be provided to ensure comfort and a healthy environment.

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## Complete Exam Answer (10 marks)

(a) A marine air conditioning system comprises a fresh air intake, return air mixing box, filters, cooling coil, reheater, humidifier, supply fan, and supply and return ducting serving the accommodation spaces.

(b) Correct accommodation conditions are maintained by controlling temperature, humidity, ventilation, air movement, and cleanliness, together with adequate fresh air supply and uniform air distribution.



7. Explain, with the aid of sketches, the principles of reverse osmosis as a method of producing fresh water. (10)

7.

## Explain, with the aid of sketches, the principles of reverse osmosis as a method of producing fresh water. (10 marks)

### Principle of Reverse Osmosis

**Reverse osmosis (RO)** is a process used to produce fresh water from seawater by forcing seawater at high pressure through a **semi-permeable membrane**.

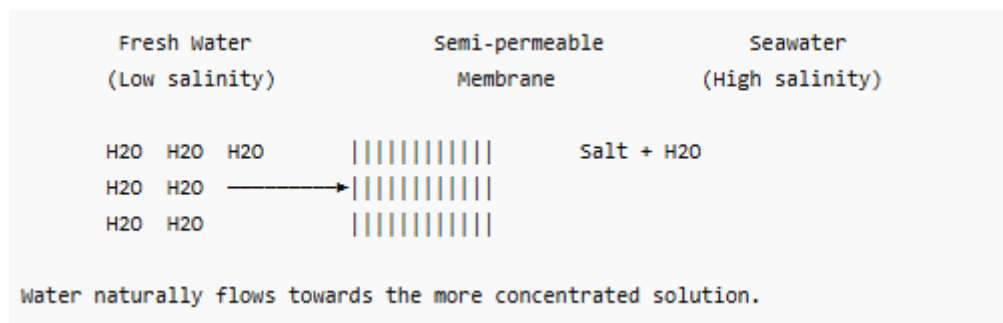
The membrane allows **water molecules to pass through** but prevents the passage of most dissolved salts, minerals, bacteria, and impurities.

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### (i) Normal Osmosis

In natural osmosis, water moves from a dilute solution to a concentrated solution through a semi-permeable membrane until equilibrium is reached.

### Sketch

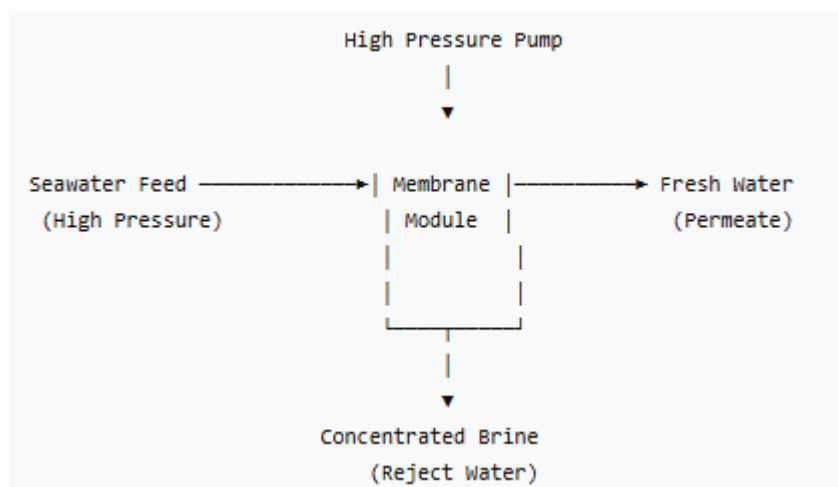


## (ii) Reverse Osmosis

If pressure greater than the **osmotic pressure** is applied to the seawater side, the natural process is reversed.

Fresh water is forced through the membrane while salts are retained.

### Sketch



## Main Components of an RO Plant

### 1. Seawater Supply Pump

- Draws seawater from the sea chest.

### 2. Pre-Filters

- Remove suspended solids and debris to protect the membranes.

### 3. High-Pressure Pump

- Raises the seawater pressure above the osmotic pressure.
- Typical operating pressures are approximately **50–70 bar** for seawater systems.

#### 4. Semi-Permeable Membrane Module

- Usually spiral-wound membranes.
- Allows only water molecules to pass through.

#### 5. Product Water (Permeate) Outlet

- Collects the fresh water produced.

#### 6. Brine Discharge

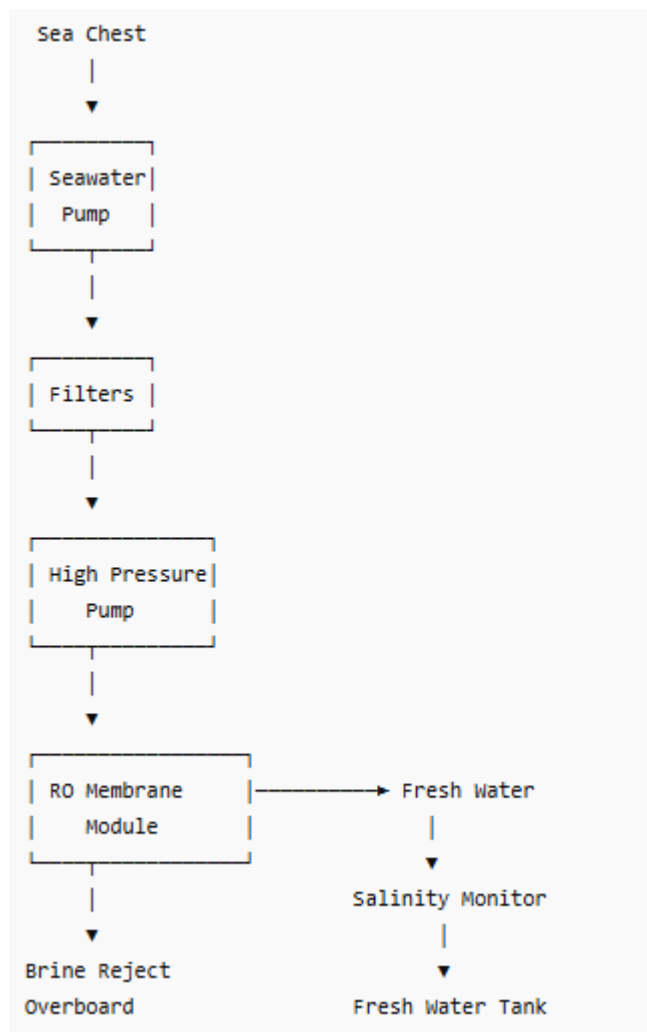
- Rejects concentrated salt solution overboard.

#### 7. Salinity Monitor

- Checks the quality of the product water.
- Diverts water to drain if salinity exceeds the acceptable limit.

#### 8. Fresh Water Storage Tank

- Stores acceptable product water.



## Advantages of Reverse Osmosis

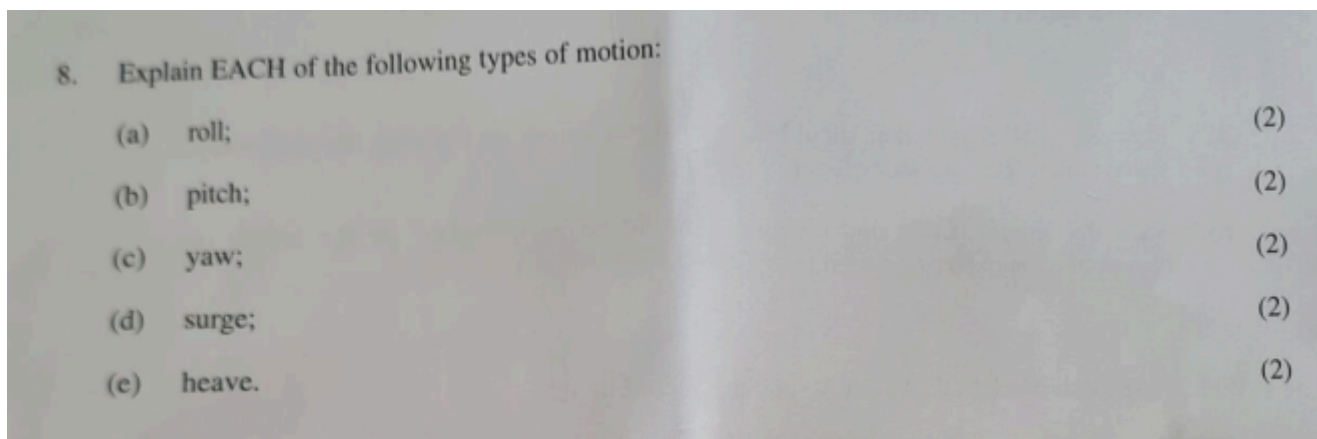
- Produces high-quality fresh water.
  - Does not require heating or evaporation.
  - Lower energy consumption than distillation plants.
  - Compact equipment with few moving parts.
  - Can operate continuously.
- 

## Disadvantages

- Membranes can foul or scale.
  - Requires effective pre-treatment and filtration.
  - Membranes require periodic cleaning and replacement.
  - Product output decreases if membranes become contaminated.
- 

## Exam Answer (10 marks)

Reverse osmosis produces fresh water by applying pressure greater than the osmotic pressure to seawater and forcing it through a semi-permeable membrane. The membrane permits water molecules to pass while rejecting dissolved salts and impurities. A typical plant consists of a seawater pump, filters, a high-pressure pump, membrane modules, a salinity monitor, a fresh water tank, and a brine discharge line. Fresh water (permeate) is collected for use, while the concentrated brine is discharged overboard. The process provides an efficient method of producing fresh water without the need for evaporation.



## 8. Explain EACH of the following types of motion:

A vessel at sea experiences various motions due to wave action and external forces. The following are five of the six degrees of freedom.

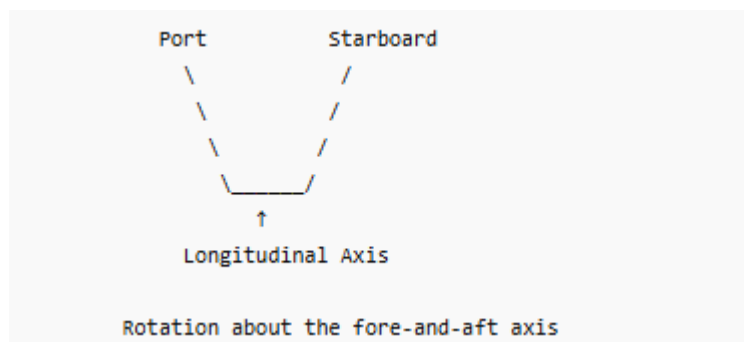
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## (a) Roll (2 marks)

**Roll** is the side-to-side rotational motion of a vessel about its **longitudinal (fore-and-aft) axis**.

- The ship tilts alternately to **port and starboard**.
- It is the motion most associated with passenger discomfort and cargo shifting.

### Sketch



### Exam Answer

Roll is the oscillating motion of a vessel from side to side about its longitudinal axis.

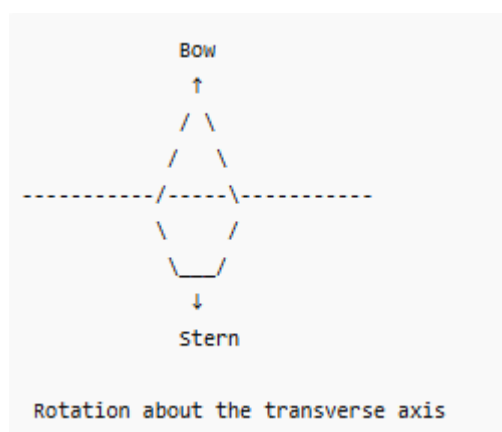
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## (b) Pitch (2 marks)

**Pitch** is the rotational motion of a vessel about its **transverse (athwartships) axis**.

- The **bow rises and falls** relative to the stern.
- It commonly occurs when the vessel encounters head or following seas.

### Sketch



**Exam Answer**

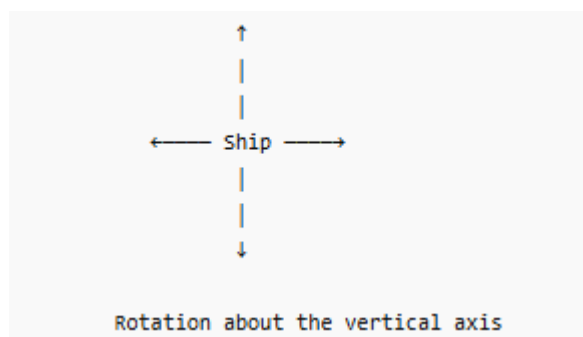
Pitch is the up-and-down rotational movement of the bow and stern about the vessel's transverse axis.

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**(c) Yaw (2 marks)**

**Yaw** is the rotational motion of a vessel about its **vertical axis**.

- The bow swings alternately to port and starboard.
- It causes the vessel to deviate from its intended course.

**Sketch****Exam Answer**

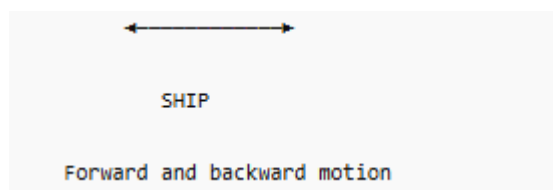
Yaw is the turning motion of a vessel about its vertical axis, causing the bow to swing from side to side.

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**(d) Surge (2 marks)**

**Surge** is the translational movement of a vessel **forwards and backwards** along its longitudinal axis.

- The entire vessel moves bodily ahead and astern.
- It is usually caused by wave action.

**Sketch****Exam Answer**

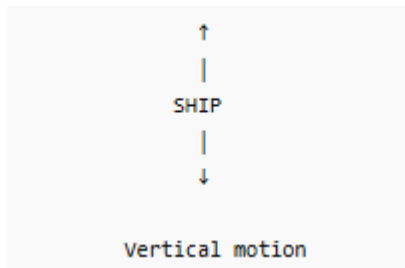
Surge is the longitudinal movement of the whole vessel forwards and backwards.

## (e) Heave (2 marks)

**Heave** is the vertical translational motion of a vessel.

- The entire vessel moves **up and down** without rotating.
- It occurs as the ship rises and falls with the waves.

### Sketch



### Exam Answer

Heave is the vertical movement of the entire vessel up and down.

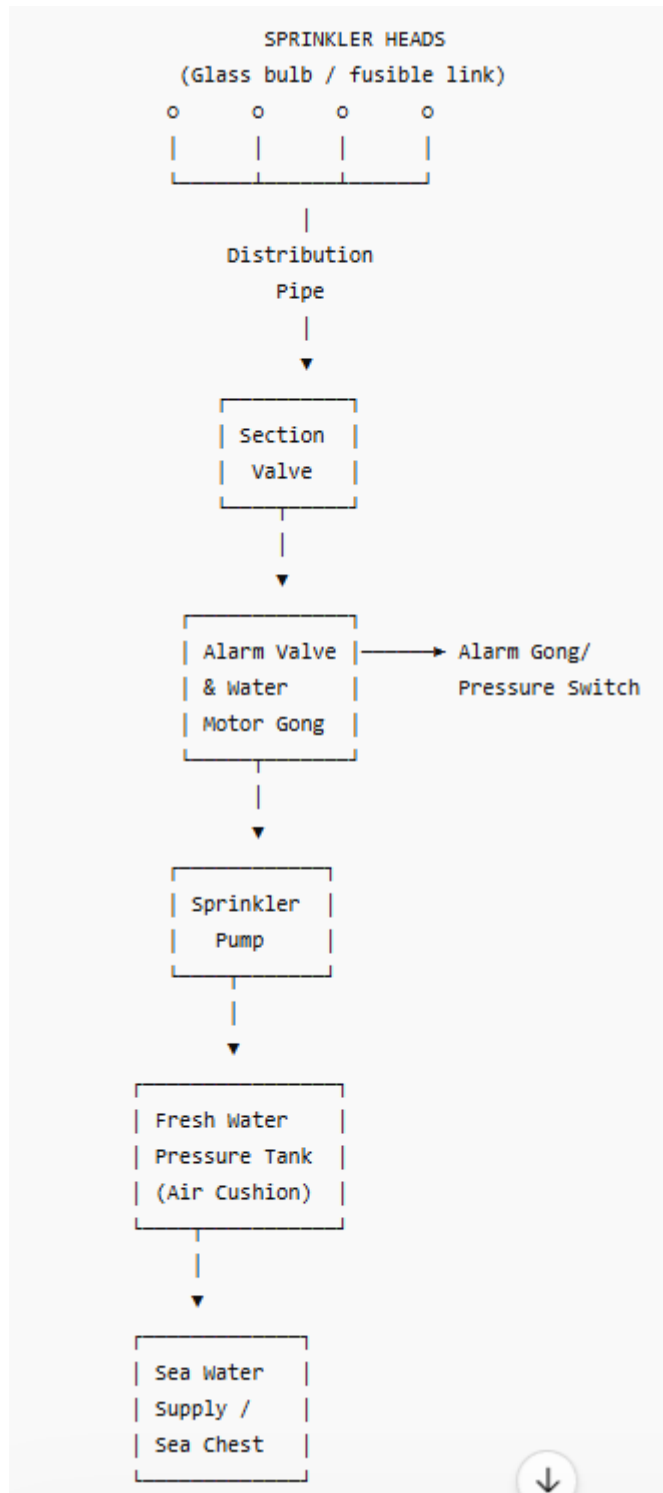
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## Complete Exam Answer (10 marks)

- (a) Roll – side-to-side rotation about the longitudinal axis.
- (b) Pitch – rotation of the bow and stern about the transverse axis.
- (c) Yaw – turning motion about the vertical axis.
- (d) Surge – forward and backward translational movement along the longitudinal axis.
- (e) Heave – vertical up-and-down translational movement of the vessel.

9. Sketch a line diagram of an automatic sprinkler system, labelling the MAIN components.

(10)



## Main Components

The main components of an automatic sprinkler system are:

1. **Sprinkler Heads**
  - Fitted throughout accommodation and service spaces.
  - Normally closed by a **glass bulb** or **fusible element**.
2. **Distribution Pipework**
  - Delivers water from the supply to the sprinkler heads.
3. **Section (Stop) Valve**
  - Allows sections of the system to be isolated for maintenance and testing.

**4. Alarm Valve**

- Detects water flow caused by an operating sprinkler head.
- Activates the alarm system.

**5. Water Motor Gong / Pressure Switch**

- Provides an audible and/or electrical alarm indicating sprinkler operation.

**6. Sprinkler Pump**

- Supplies water to the system automatically when pressure falls.

**7. Pressure Tank (Hydrophore Tank)**

- Contains fresh water under pressure with an air cushion.
- Provides an immediate water supply before the pump starts.

**8. Sea Water Supply (Sea Chest)**

- Supplies the sprinkler pump with water once the pressure tank is depleted.
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## Operation

### Normal Condition

- The system is maintained under pressure by the **fresh water pressure tank**.
- All sprinkler heads remain closed.

### Fire Condition

- Heat from a fire causes the glass bulb or fusible element in the nearest sprinkler head to rupture.
  - The affected sprinkler head opens and discharges water onto the fire.
  - The resulting pressure drop operates the **alarm valve** and sounds the alarm.
  - The pressure drop also causes the **sprinkler pump to start automatically**.
  - The pump initially draws from the pressure tank and subsequently from the sea supply.
  - Only the sprinkler heads exposed to sufficient heat operate.
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## Exam Answer (10 marks)

An automatic sprinkler system consists of sprinkler heads connected to distribution pipework supplied from a fresh water pressure tank. The system incorporates a section valve, alarm valve, water motor gong or pressure switch, and an automatically started sprinkler pump supplied from a sea chest. Under normal conditions the system remains pressurised. During a fire, heat opens the affected sprinkler head, causing a pressure drop that operates the alarm and starts the sprinkler pump, which supplies water to control the fire.

10. Describe the functions of a double bottom.

(10)

# 10. Describe the functions of a double bottom. (10 marks)

A **double bottom** consists of an inner bottom plating fitted above the outer shell plating of the ship, with the space between divided by floors and girders into watertight compartments.

It performs a number of important functions in a vessel.

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## 1. Protection Against Grounding Damage

- The double bottom provides an additional layer of protection if the vessel grounds or the outer shell plating is damaged.
- Damage may be confined to the outer bottom, reducing the risk of flooding into cargo spaces or machinery spaces.

### Exam Point

It provides protection against penetration of the hull due to grounding.

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## 2. Structural Strength

- It contributes significantly to the **longitudinal strength** of the vessel.
- The inner bottom, outer bottom, floors, and girders form a strong box girder structure.
- It also improves **transverse rigidity** of the hull.

### Exam Point

It strengthens the hull structure and contributes to the ship's longitudinal and transverse strength.

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## 3. Ballast Water Storage

- Double bottom tanks are commonly used to carry **ballast water**.
- Ballast improves:
  - stability,
  - trim,
  - propeller immersion,
  - hull stresses when cargo is absent.

### Exam Point

It provides ballast tank capacity for stability and trim control.

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## 4. Fuel Oil Storage

- Many ships use double bottom tanks for the storage of:
  - fuel oil,
  - diesel oil,
  - lubricating oil.

This makes efficient use of available space.

### Exam Point

It provides tank space for fuel and other liquids.

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## 5. Fresh Water Storage

- Some double bottom tanks may be allocated for:
  - fresh water,
  - feed water,
  - domestic water storage.

### Exam Point

It can provide storage for fresh water supplies.

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## 6. Reduction of Pollution Risk

- The additional barrier between tank contents and the sea reduces the likelihood of pollution following minor damage.
- Leakage from fuel tanks is less likely if only the outer bottom is breached.

### Exam Point

It reduces the risk of oil pollution following bottom damage.

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## 7. Distribution of Loads

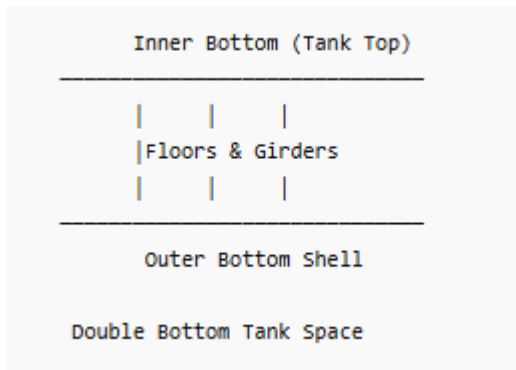
- The double bottom helps distribute concentrated loads from cargo, machinery, and tank contents over a wider area of the hull structure.
- It supports heavy machinery foundations.

### Exam Point

It spreads loads and supports machinery and cargo weights.

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## Sketch



## Exam Answer (10 marks)

A double bottom consists of an inner bottom and outer shell plating separated by floors and girders. Its functions are to provide protection against grounding damage, increase the longitudinal and transverse strength of the hull, provide ballast tank capacity, provide storage space for fuel and fresh water, reduce the risk of pollution following bottom damage, and distribute structural loads throughout the vessel. These functions improve the vessel's safety, strength, and operational efficiency.