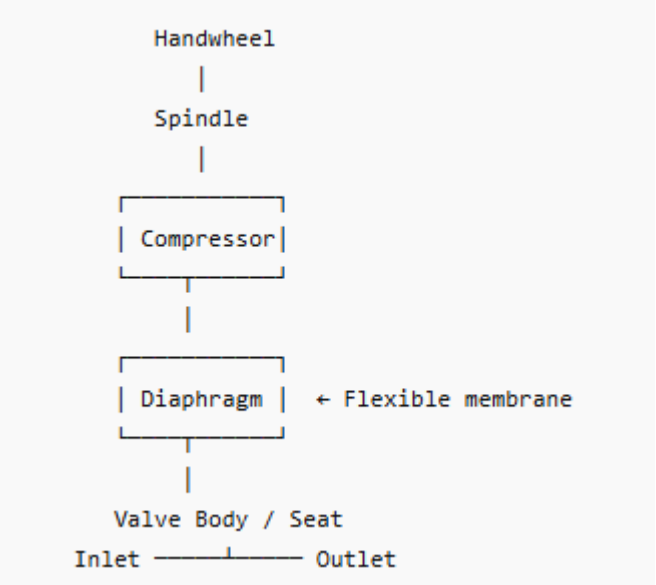
1. (a) Sketch a flexible diaphragm valve. (6)

(b) Describe how the diaphragm is replaced, stating the precautions that should be taken. (4)



Main components to label:

- Handwheel
- Spindle
- Compressor (pressure plate)
- Flexible diaphragm
- Valve body
- Valve seat
- Inlet and outlet

Description:

Turning the **handwheel** moves the **spindle**, which presses the **compressor** onto the flexible **diaphragm**. The diaphragm deflects downward to **seal against the valve seat**, stopping flow. When lifted, flow is allowed through the valve. The diaphragm isolates the working fluid from the moving parts.

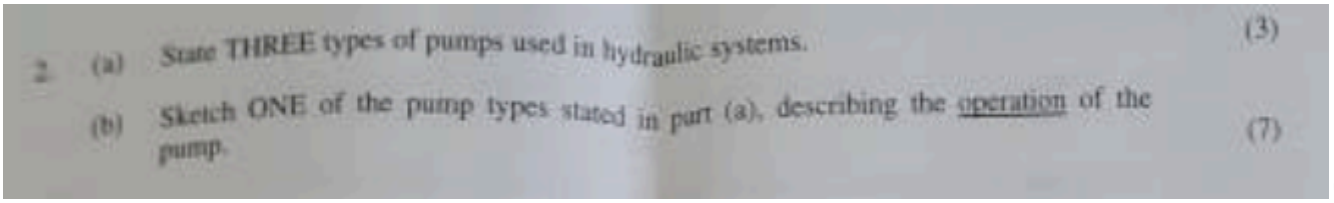
(b) Replacement of diaphragm and precautions (4 marks)

Procedure:

1. **Isolate the valve** and relieve all pressure from the system.
2. **Remove the valve bonnet/cover** and expose the diaphragm.
3. **Detach and remove the old diaphragm** from the compressor.
4. **Fit new diaphragm**, ensuring correct alignment.
5. Reassemble valve and **test for leaks and correct operation**.

Precautions:

- Ensure system is **fully depressurised and drained**.
- Use correct **replacement diaphragm material** (compatible with fluid).
- Maintain **cleanliness** to avoid contamination.
- Tighten bolts evenly to prevent **damage or leakage**.

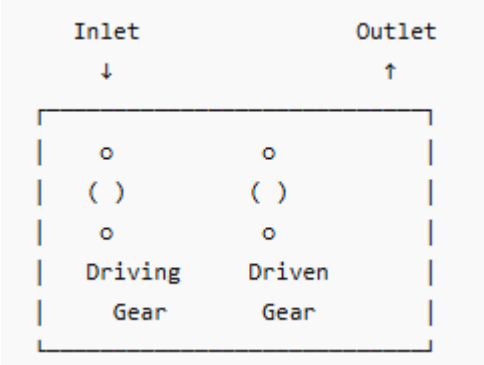

2 (a) State THREE types of pumps used in hydraulic systems. (3)

(b) Sketch ONE of the pump types stated in part (a), describing the operation of the pump. (7)

(a)

THREE types of pumps used in hydraulic systems (3 marks)

1. **Gear pump**
2. **Vane pump**
3. **Piston pump** (axial or radial)



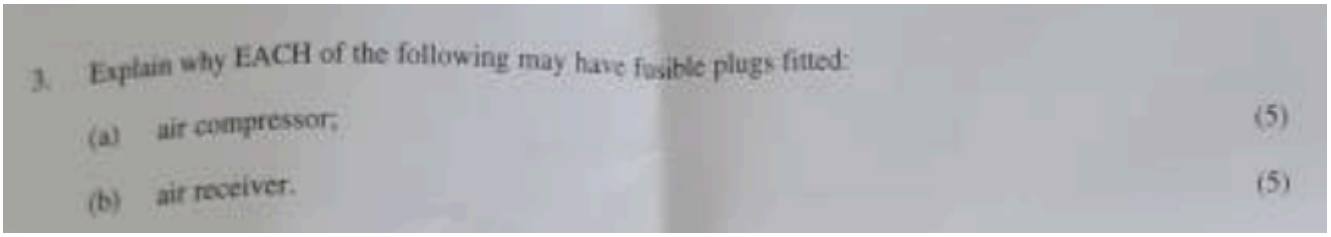
Gear Pump

Labels to include:

- Driving gear
- Driven gear
- Pump casing
- Inlet port
- Outlet port

Operation:

A gear pump consists of two meshing gears rotating inside a casing. As the gears rotate, fluid is drawn into the **inlet side** where the gear teeth separate, creating a low-pressure area. The fluid is trapped between the gear teeth and the casing and carried around the outside of the gears. At the **outlet side**, the gears mesh again, forcing the fluid out at high pressure. The meshing of gears prevents fluid from flowing back, ensuring a continuous flow.


3. Explain why EACH of the following may have fusible plugs fitted:
(a) air compressor; (5)
(b) air receiver. (5)

(a)

Air compressor (5 marks)

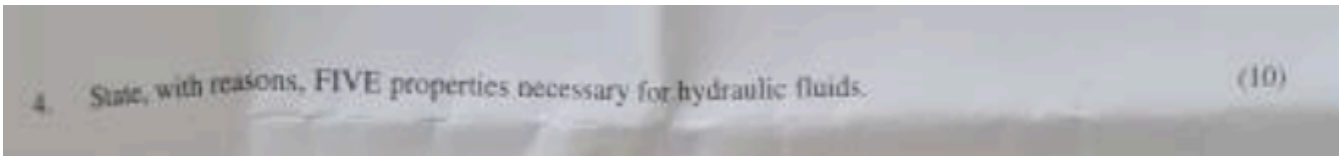
Fusible plugs are fitted to an air compressor to **prevent overheating and fire/explosion risks**. If the compressor overheats (e.g. due to poor lubrication or cooling failure), the fusible plug melts at a preset temperature, allowing compressed air and hot gases to escape. This **reduces pressure and temperature**, preventing ignition of oil vapour or carbon deposits in the compressor and avoiding a possible explosion.

(b) Air receiver (5 marks)

Fusible plugs are fitted to air receivers as a **safety device in case of external fire**. If the receiver is exposed to high temperatures, the fusible plug melts, releasing the compressed air inside. This prevents a dangerous **pressure build-up due to heating**, which could otherwise lead to a catastrophic explosion of the receiver.

Fusible plug = melts with heat → releases pressure → prevents explosion

- Compressor → protects from **internal overheating/fire**
- Receiver → protects from **external fire heating**


4. State, with reasons, FIVE properties necessary for hydraulic fluids. (10)

FIVE properties necessary for hydraulic fluids (with reasons) (10 marks)

1. **Suitable viscosity (correct thickness)**
   → Ensures effective lubrication and sealing while still allowing easy flow through the system.
2. **Good lubricating properties**
   → Reduces friction and wear between moving components such as pumps and valves.
3. **High thermal stability**
   → Prevents breakdown of the fluid at high operating temperatures.
4. **Corrosion resistance**
   → Protects system components from rust and chemical attack.

5. **Low compressibility**
   → Ensures efficient transmission of power without loss due to fluid compression.

Other acceptable points (if needed):

- **Oxidation resistance** → prevents sludge formation
- **Anti-foaming properties** → avoids air entrainment
- **Demulsibility** → ability to separate from water

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5. List ALL the necessary checks of the steering gear before a vessel leaves port. (10)

Necessary checks of the steering gear before leaving port (10 marks)

1. **Check operation of main steering gear**
   → Ensure rudder moves smoothly from hard-over to hard-over.
2. **Test auxiliary steering gear**
   → Confirm it is fully operational in case of main system failure.
3. **Check remote control from bridge**
   → Verify correct response to helm orders.
4. **Test local/manual control**
   → Ensure steering can be controlled from steering gear compartment.
5. **Check communication systems**
   → Confirm reliable communication between bridge and steering gear room.
6. **Check rudder angle indicators**
   → Ensure they are accurate and functioning on bridge and locally.
7. **Inspect hydraulic system**
   → Check oil levels, leaks, and system pressure.
8. **Check pumps and power units**
   → Ensure all steering gear pumps are operational and available.
9. **Test emergency power supply**
   → Verify steering gear works on emergency power.
10. **Check alarms and safety devices**
    → Confirm low oil level, power failure, and other alarms are functional.

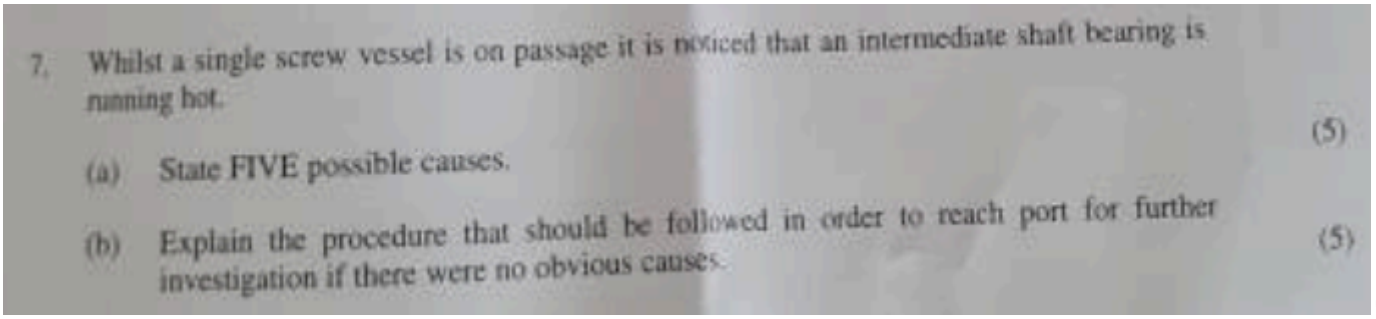
6. (a) State SIX advantages of controllabe pitch propellers. (6)
   (b) State FOUR disadvantages of controllable pitch propellers. (4)

(a) SIX advantages of controllable pitch propellers (6 marks)

1. **Improved manoeuvrability**
   → Pitch can be changed without reversing engine rotation.
2. **Rapid response to speed changes**
   → Immediate adjustment of thrust.
3. **Efficient operation over a wide range of speeds**
   → Pitch optimisation improves fuel efficiency.
4. **Constant engine speed operation possible**
   → Useful for generators and shaft-driven equipment.
5. **Quick astern thrust without stopping engine**
   → Enhances safety during manoeuvring.
6. **Reduced engine wear**
   → Fewer starts/stops and smoother operation.

(b) FOUR disadvantages of controllable pitch propellers (4 marks)

1. **More complex construction**
   → Increased number of moving parts.
2. **Higher initial cost**
   → More expensive than fixed pitch propellers.
3. **Greater maintenance requirements**
   → Hydraulic systems and mechanisms require upkeep.
4. **Risk of failure in pitch control system**
   → Could lead to loss of propulsion control.



7. Whilst a single screw vessel is on passage it is noticed that an intermediate shaft bearing is running hot.

(a) State FIVE possible causes. (5)

(b) Explain the procedure that should be followed in order to reach port for further investigation if there were no obvious causes. (5)

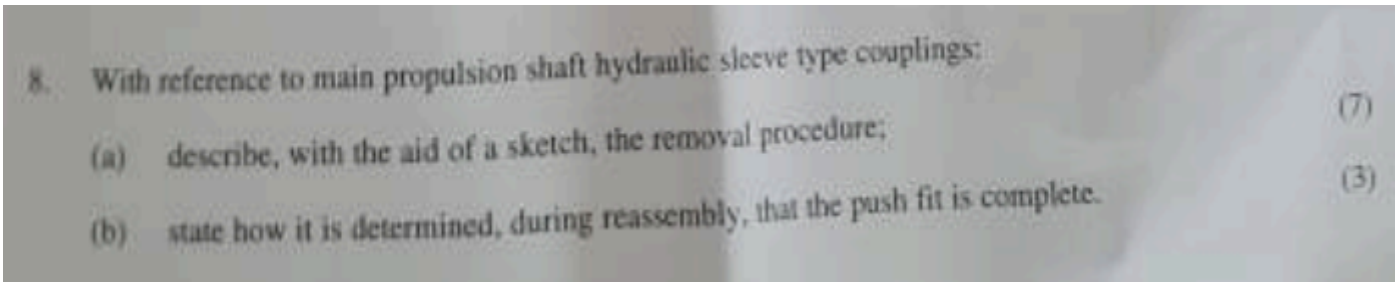
(a) FIVE possible causes of a hot intermediate shaft bearing (5 marks)

1. **Insufficient lubrication** (low oil level or failed lubrication system).
2. **Misalignment of shafting** causing uneven load on the bearing.
3. **Bearing wear or damage** (worn white metal or scoring).
4. **Excessive load** (e.g. propeller fouling or heavy sea conditions).
5. **Contaminated lubricating oil** (water or debris reducing effectiveness).

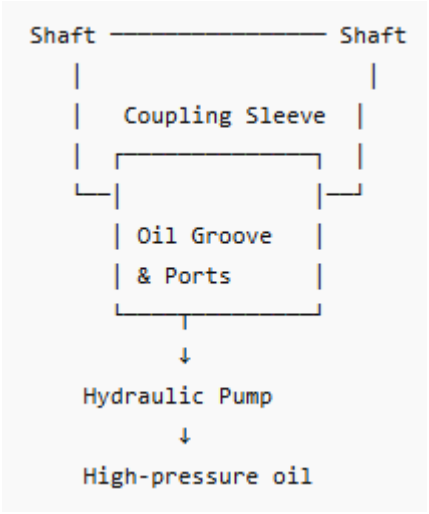
(b) Procedure to reach port safely if no obvious cause (5 marks)

1. **Reduce engine speed/load**
   → Minimises heat generation and prevents further damage.

2. **Increase monitoring**
   → Regularly check bearing temperature and condition.
3. **Ensure adequate lubrication**
   → Check oil supply and, if possible, increase lubrication.
4. **Avoid sudden manoeuvres**
   → Maintain steady running conditions to reduce stress.
5. **Prepare for emergency**
   → Be ready to stop engine if temperature rises dangerously; inform bridge and plan for reduced-speed passage.


8. With reference to main propulsion shaft hydraulic sleeve type couplings:
(a) describe, with the aid of a sketch, the removal procedure; (7)
(b) state how it is determined, during reassembly, that the push fit is complete. (3)

(a) Removal of a hydraulic sleeve type coupling (7 marks)



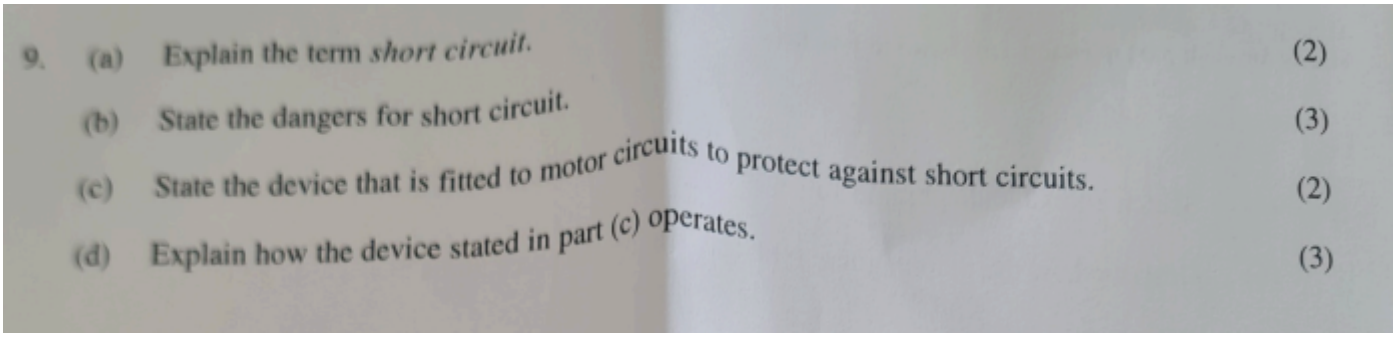
Procedure:

1. **Stop and isolate the shafting system** and ensure it cannot rotate.
2. **Remove coupling bolts and locking arrangements**.
3. Connect a **high-pressure hydraulic pump** to the oil injection ports in the coupling.
4. **Inject high-pressure oil** between the shaft and coupling sleeve.
   → This reduces friction by creating an oil film and expands the sleeve slightly.
5. Apply **axial force (jacking or withdrawal gear)** to slide the coupling off the shaft.
6. Continue oil injection and withdrawal until the coupling is **fully removed**.
7. Carefully support and lift away the coupling.

(b) How to determine push fit is complete (3 marks)

- **Correct axial position achieved** (measured against specified reference marks).

- **Specified hydraulic pressure reached and maintained** during fitting.
- **No further movement occurs** when pressure is applied, confirming full seating.



9. (a) Explain the term *short circuit.* (2)

(b) State the dangers for short circuit. (3)

(c) State the device that is fitted to motor circuits to protect against short circuits. (2)

(d) Explain how the device stated in part (c) operates. (3)

(a) Short circuit (2 marks)

A short circuit is a fault where **current flows along an unintended low-resistance path**, bypassing the normal load, resulting in a **sudden and excessive current flow**.

(b) Dangers of a short circuit (3 marks)

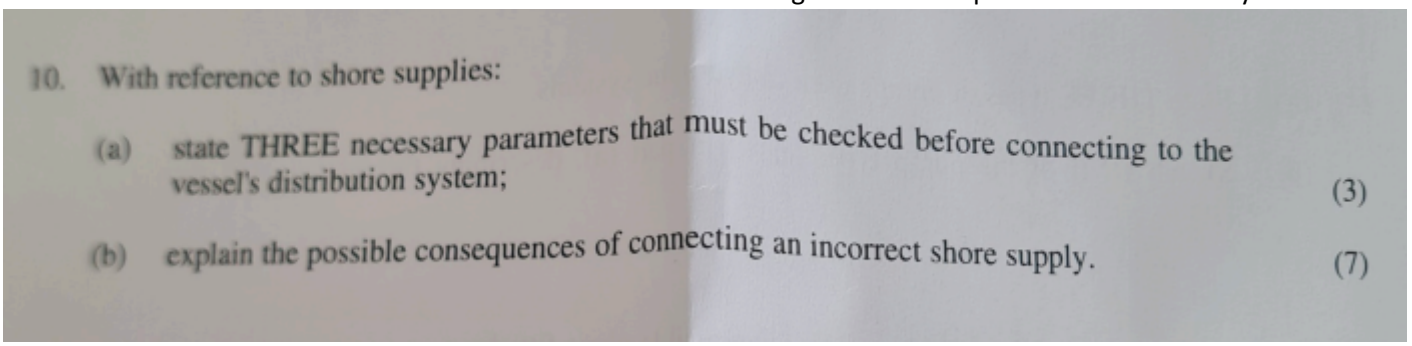
- **Overheating of cables and equipment** → insulation damage.
- **Fire risk** due to excessive current and heat.
- **Damage to electrical components** and possible system failure.

(c) Device used to protect against short circuits (2 marks)

- **Circuit breaker** (or fuse).

(d) How the device operates (3 marks)

A **circuit breaker** detects excessive current flow and automatically **trips**, opening the circuit and stopping current flow. This is usually achieved by **thermal (overheating) and/or magnetic (instantaneous high current) mechanisms**, which respond to abnormal current levels and disconnect the supply to protect the system.



10. With reference to shore supplies:

(a) state THREE necessary parameters that must be checked before connecting to the vessel's distribution system; (3)

(b) explain the possible consequences of connecting an incorrect shore supply. (7)

(a) THREE parameters to check before connecting shore supply (3 marks)

1. **Voltage**
   → Must match the vessel's system voltage.
2. **Frequency**
   → Must be the same (e.g. 50 Hz or 60 Hz).
3. **Phase sequence (phase rotation)**
   → Must be correct to ensure proper motor rotation.

(b) Consequences of connecting an incorrect shore supply (7 marks)

1. **Electrical equipment damage**
   → Overvoltage or undervoltage can damage motors and electronics.
2. **Incorrect motor rotation**
   → Wrong phase sequence can cause pumps and machinery to run in reverse.
3. **Overheating of equipment**
   → Frequency mismatch can cause excessive current and overheating.
4. **Failure of sensitive equipment**
   → Control systems and electronics may malfunction or fail.
5. **Protection devices may trip**
   → Causing loss of power and operational issues.
6. **Reduced efficiency or malfunction**
   → Systems may not operate as designed.
7. **Safety hazards**
   → Risk of fire, electrical faults, or injury to personnel.