Competency Framework for Marine Engineer Class 5

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Function: Diesel Engines and Systems

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Diesel engines **The components, function and care required**	**1.** Common systems and components	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Describes the cycle of events in both 2 and 4 stroke engines. Names principal engine components and can describe location and functions of these components. Is able to sketch the construction of these components.
	2. Fuel system		Describes and sketches a diesel supply system from fuel tank to injectors. Identifies key components and describes their purpose including filters, pumps and bleed points, for both common rail and jerk type systems. Describes: • The construction of system components. • The safety features of the fuel system. • The operation of the diesel injector, electronic and mechanical. • How fuel pumps are timed and calibrated. • The symptoms, causes of and remedies for typical fuel pump and injector defects. • Priming the diesel fuel system and removal of air. • The importance of maintaining a clean fuel supply. • The significance of fuel oil viscosity, relative density and flashpoint. • The dangers of fuel contamination and describes action to take to correct. • Modern high pressure fuel systems and associated safety issues.

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Diesel engines cont. **The components, function and care required**		Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	• How fuel consumption may be reduced in an emergency.
	3. Lubrication System		Describes and sketches the layout of a typical lubricating oil system including the flowpath. Identifies key components of a lubricating oil system and describes their purpose. Describes types of oil and testing of oil. Describes: • The construction of system components. • The purpose of lubricating oil and states its main desirable properties. • The dangers of lubricating oil contamination and describe action to take to correct. • Reasons for lubricating oil deterioration and how it may be detected, including fuel and water contamination. • The necessity for and maintenance of a clean oil supply. • Conducting a lubricating oil change. • The causes of abnormal oil pressure developing and state the emergency action which must be taken.
	4. Air system		Identifies key components and describes their purpose, including: filters, turbo charger, blowers, exhaust system and exhaust colour diagnosis. Demonstrates an understanding of the principles of supercharging diesel engines and the methods used.
	5. Cooling system		Describes and sketches a typical raw water system including flowpath. Describes and sketches a typical fresh water cooling system including flow path.

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Diesel engines cont. **The components, function and care required**	Cooling system cont.	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Identifies key components of both systems and describes their purpose including sacrificial anodes, anti-siphoning valves, heat exchangers and thermostats. Describes pump impeller replacement, thermostat checking and replacement, and the need for replacement of anodes. Describes likely faults with each of these systems, and actions to be taken in the event of failures including blockages. Describes: • The construction of individual components in cooling water systems. • The necessity for a header tank. • The system care and maintenance required including water testing and treatment. • The reasons an engine may overheat and the action to be taken.
	6. Electrical system		Describes and sketches basic D/C and A/C circuits including circuit protection, and states the hazards and safety features of both Describes safe electrical practices including isolation, lock outs and use of hand tools. Identifies key components and describes their purpose, including: batteries, starting systems, glow plugs, alternator, charging system, drive-belt adjustments, fuses and circuit breakers. Describes a simple ignition system for petrol engines and the methods of fault finding.

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Diesel engines cont. **The components, function and care required**	**7.** Starting systems	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Describes: • The electrical, hydraulic and air start systems found on a vessel. • The routine maintenance required by each system and problems which arise with each system. • The safety features of starting systems. • The reasons for failure to start and state actions to take to make emergency start arrangements. • The danger and means of avoidance of hydraulic effect when starting engines.
	8. Control systems		Identifies key components for automatic and remote control both on the bridge and in machinery spaces and describes their purpose. Describes: • Back-up control systems and manual overrides, and how to bring them into effect quickly when required. • Safety features including Alarms system interlocks. • The construction, operation and purpose of simple mechanical governors and over speed trips. Demonstrates an awareness of modern CPU based engine control systems and associated operating requirements.

Function: Vessel Structure and Systems

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Apply vessel principal structural member description and function to vessel operations including fishing vessels (adapted from IMO guidance)	**1.** Identify the principle structural members of a vessel	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Explains how the principal structural members of vessels are correctly identified taking into account the category of vessel concerned, including its design features and the construction materials.
	2. Identify the proper names of the various parts		Describes how the location and function of the various parts of vessels are identified in accordance with requirements for the safe operation of the vessel concerned.
	3. Identify damage control techniques		Explains how damage control techniques and procedures are identified, incorporating the vessel's contingency plan where appropriate.
Ship's machinery - components, function and care required	**1.** Propellers, shafting and stern glands		Identifies key components and describes their purpose, including: shaft, thrust arrangements, stern glands and flexible couplings. Describes and sketches the layout of the shaft system between engine and propeller including stern tube assembly. Describes: • The attention required by the shaft system before and during running. • The possible reasons for overheating of shaft bearings and remedial

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Ship's machinery - components, function and care required cont.		Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	action to be taken. • The necessity for, and construction of, the thrust bearing either integral with or independent of the gearbox. • The maintenance and attention required by the thrust bearing. • The operation of variable pitch propellers. Describes with the aid of sketches typical tail shaft sealing and lubrication arrangements.
	2. Gearboxes and clutches		Identifies key components and describes their purpose Describes: • The maintenance and attention required by gearboxes and clutches. • The operation of common gearbox types and explains any emergency running arrangements provided.
	3. Gearboxes and clutches cont.		• The need for reduction and reversing gearboxes. • The construction and operation of clutches. • The daily checks required. • Reasons for excessive vibration developing in the transmission system, and the action to be taken should this occur.
	4. Engine and thrust bearing mountings		• Identifies key components and describes their purpose
	5. Steering systems		• Describes and sketches simple mechanical and hydraulic steering systems • Describes:

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Ship's machinery - components, function and care required cont.		Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	• The checks made to these systems including emergency steering gear. • The arrangements provided for emergency steering. • What maintenance and attention is required by the steering gear. Describes and sketches a typical rudder assembly. • Describes and sketches how the mass of the rudder is supported and how its movement is limited.
	6. Compressed air and pressure vessels		Describes: • A typical compressed air system including starting and control air systems. • The operation and maintenance of air compressors. • The construction and maintenance of air receivers, fittings and safety devices.
Electrical system	*Compressed air and pressure vessels cont.*		Describes: • How batteries are installed, their routine maintenance and the precautions to be taken. • Common electrical faults, their causes and symptoms including monitoring for corrosion, moisture and defective connections. • Sketches a typical DC and AC supply and distribution system, and describes and explains the protection devices. • Emergency supply and distribution. • Switching arrangements for main propulsion and auxiliary machinery including standby and emergency equipment. • The basic operating principles of generators (AC and DC) and their maintenance requirements. • The routine electrical equipment maintenance which is required.

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		Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	The operation, limitations and cautions to be undertaken when using inverters safe electrical practices including the principles and use of Isolating transformers, Residual Current Devices, and certification and use of hand tools.
Hydraulic and pneumatic systems (adapted from IMO guidance)	Operate and maintain hydraulic and pneumatic systems		Describes: • How hydraulic and pneumatic systems are operated and maintained in accordance with operational guidelines and manufacturer's recommendations. • The use of main and standby hydraulic and pneumatic power and servo-mechanism units. The operation, calibration, testing, maintenance and cleanliness of the system.
Pumping systems (adapted from IMO guidance	Operate and maintain pumping systems (see also operate auxiliary equipment – bilge, ballast and fire systems)		Describes how pumps and piping systems are operated and maintained in accordance with operational requirements and specified procedures. Explains how discharges are monitored in accordance with requirements specified for the prevention of pollution. Demonstrates knowledge of the operation and maintenance of manual, plunger, centrifugal, geared and impeller operated pumps. Demonstrates knowledge of piping systems and pipe fittings including measurement, replacement and servicing.

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Refrigeration systems (adapted from IMO guidance)	Operate and maintain refrigeration systems	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Describes: • How refrigeration systems are operated and maintained in accordance with manufacturers' specifications and legal requirements. • Emergency evacuation and retrieval procedures for CFC gases are applied as specified. • The dangers of toxic gases emanating from refrigeration systems and holds are identified. The basic principles of a refrigeration system.
Catch handling equipment (adapted from IMO guidance	Operate and maintain catch handling equipment and deck machinery		Describes how catch handling equipment and deck machinery is operated and maintained in accordance with specified operational procedures and manufacturers' recommendations.

Function: Watchkeeping and Operation

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Operate vessel machinery	Machinery operating procedures are described	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Describes normal operational procedures for vessel's machinery as described in the Maritime Transport Operator Plan.
Operate and monitor a vessel's engines and auxiliary equipment	**1.** Load/check spares, fuel, lubricants and fresh water for intended voyage		Describes: • Preparation of a vessel in accordance with the vessel's MTOP, including knowledge of fuel and lubricant piping systems, cooling systems, valves, pumps and safety arrangements. • Loading of fuel and lubricants in accordance with the vessel's safety management plan. • Checking of spare parts and ensuring they are sufficient to cover emergencies and are in accordance with the vessel operating practices. • Filling fresh water tanks in accordance with the vessel operating practices. • Completing documentation in accordance with the vessel's MTOP.
	2. Pre-start checks of engines and auxiliary equipment		Describes completion of pre-start checks in accordance with the vessel's MTOP, including: • Propulsion engine/s, including: fuel, oil and cooling water header tank levels, valves, V-belts and hoses. • Auxiliary equipment including: generators, batteries, bilge pumps, strainers, bilge water levels and alarms, refrigeration, hydraulic system, fire-fighting system, electrical system (fuses/circuit breakers and

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Operate and monitor a vessel's engines and auxiliary equipment cont.		Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	switchboards).
	3. Start and monitor engines and auxiliary equipment		Describes how to start engines and auxiliary equipment and monitor gauges and instrument readings during warm-up in accordance with the manufacturer's operating instructions.
	4. Machinery safety equipment		Describes the purpose of: crankcase relief doors, bursting discs, oil mist detectors, engine shut-own devices (e.g. trips for low oil pressure, high water temperature). Describes the action to be taken in the event of engine alarms, trips or oil mist detectors operating.
	5. Test alarms and safety arrangements		Describes how to test alarms in accordance with the manufacturer's operating instructions.
	6. Emergency starting		Describes procedures in accordance with the vessel's MTOP.
	7. Shut-down of engines and auxiliary equipment		Explains how to follow procedures in accordance with the vessel's MTOP.
	8. Operate vessel's engines and equipment		Describes how to operate machinery to maintain maximum performance, observing safety precautions, in accordance with the manufacturer's operating instructions.
	9. Changes in operational performance		Demonstrates an understanding of vessel monitoring systems and an ability to read and interpret the information they provide.

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
		Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Explains how to monitor and adjust any changes in accordance with the vessel's MTOP, and identifies likely causes including: heavy weather, reduced visibility, fishing, towing, breakdowns, low fuel, propeller and hull damage.
Operate auxiliary equipment	**1.** Operate ancillary engine room equipment - bilge system		• Describes and sketches the layout of a typical bilge system. • Describes the principles of suction and the reasons for failure of the system. • Identifies the likely causes of a rise in bilge level and states the prevention measures to be taken. • States the reasons for bilge ventilation. • Describes the causes of back flooding and state the action to take if it occurs. • Describes the operation of a vessel bilge system including use of an oily water separator (see also Environmental protection).
	2. Operate ancillary engine room equipment - ballast system		• Describes ballasting or ballasting procedures including those with regard to maintaining vessel stability. • Describes precautions to be taken with regard to the environment when pumping out tanks or other spaces.
	3. Operate ancillary engine room equipment – auxiliary generator systems		• Describes the operation of generators with regard to bringing on and off-line with the switchboard, including manual and automatic paralleling. • Describes the safety features required of the system and precautions which need to be taken. • (see also Electrical system)
	4. Operate ancillary engine room equipment – fire system		• Describes and sketches the layout of a typical vessel fire main system. • Describes the operation, testing and maintenance required by a typical vessel fire main system. • Describes the operation and maintenance required of main and

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		Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	emergency fire pumps. • Describes and sketches types of fixed fire-fighting systems. • Describes the operation, testing and maintenance required by typical fixed fire-fighting systems.
Slipway	**1.** Prepare the vessel for the slip		• Describes the preparation that needs to be carried out before slipping the vessel, including preparing a list of repairs and survey work requirements, the dipping and sounding of tanks. • Describes the precautions to be taken to keep the vessel stable when going up and coming off the slipway including clear communication with the deck department.
	2. Slipway safety		• Describes the precautions to take to keep safe including: fire main connections, electrical connections, confined spaces, use of Personal Protective Equipment, and Material Safety Data Sheet.
	3. Survey requirements		• Describes the checks and maintenance that should be carried out when the vessel is on the slipway. • Describes the checks that are required by the Maritime Rules for the hull, through hull fittings, shafting and drive gear and steering gear.

Function: Maintenance Procedures

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Maintenance procedures for vessel's machinery	**1.** Demonstrate knowledge of the requirements under safety management for preventative maintenance and inspection of equipment	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination.	Demonstrates familiarity with checking and recording data and measurements in accordance with the vessel's Maintenance Plan, the vessel's Maritime Transport Operator Plan (MTOP), the manufacturer's recommended guidelines and accepted industry practice.
	2. Conduct planned maintenance		Describes how to carry out planned maintenance and inspection including: • Oil changes • Fuel filters • Bleeding air from fuel • Battery checks and top-up • Inspection of electrical switchboards, wiring, fuses and circuit breakers • Replacing drive belts
Apply theoretical engineering principles to vessel systems operation, including	Identify marine engineering terms applicable to vessel operating systems		Demonstrates adequate use of marine engineering terms to theoretically diagnose faults and develop solutions appropriate for vessel operating systems.

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fishing vessels (adapted from IMO Guidance)		Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination.	
Fault diagnosis **(adapted from IMO Guidance)**	**1.** Apply theoretical fault finding outcomes to maintain vessel operating systems		Explains how theoretical principles are applied to the development of maintenance schedules for vessel operating systems in accordance with operational requirements.
	2. Diagnose faults in mechanical and electrical systems		Describes how to diagnose faults including: • Mechanical systems – change in oil pressure, overheating, lack of fuel, discolouration of exhaust, uneven running, unusual noises, failure to operate, fault indicating light or alarm. • Electrical systems – failure to operate, fault indicating light or alarm.
Unscheduled maintenance	Perform unscheduled maintenance tasks		Describes procedures to perform unscheduled maintenance and repair tasks on mechanical and electrical systems in accordance with manufacturer's instructions and specified safety procedures including how to: • identify, remove, replace and test mechanical and electrical components requiring replacement; • carry out repairs to mechanical systems which allow the vessel to continue to operate without causing further damage to the vessel and/or its engines and equipment; and • perform any improvised repairs to rectify component failures where replacement or full repair is not possible, to ensure continued safety of the vessel, its crew and passengers, in accordance with the vessel's MTOP.
Procedure for	**1.** Select and		Describes how to select stores and spares for scheduled maintenance to

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
maintenance and repairs on a vessel's mechanical and electrical systems	prepare stores and spare parts	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination.	mechanical and electrical systems in accordance with manufacturers' instructions.
	2. Systems are tested		Describes the testing of systems before return to service in accordance with manufacturers' instructions.
	3. Complete documentation		Explains how to complete documentation, and file in accordance with the vessel's MTOP.
	4. Handle materials safely		Describes how to handle, store and secure maintenance materials and equipment in accordance with vessel's MTOP.

Function: Safety and Stability

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Safety awareness	System safety	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Lists Personal Protective Equipment to be used in the machinery space. Demonstrates awareness of engine room hazards. Describes hazard identification and onboard procedures for elimination, isolation and minimisation including, heat, pressures, slipping, moving machinery, guards, hand tools, common onboard chemicals for cleaning and maintenance. Defines confined/enclosed spaces and states the hazards, demonstrating appropriate awareness of the associated dangers. Describes the procedures for entering enclosed spaces including all precautions to be taken.
Safe working practices	**1.** Apply safe working practices (adapted from IMO Guidance)		Describes how safe working practices, contingency and emergency procedures are developed in accordance with the operational requirements of vessel operating systems.
	2. Safe working practices are demonstrated (adapted from IMO Guidance)		Demonstrates an understanding of the operation of a vessel's machinery while maintaining safe working practices and situational awareness.
	3. Safe working practices with lifting gear and		Describes: • The safety precautions to be taken when operating equipment: winches,

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	winches is described	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	windlass, lifting gear, ramps and davits. • Precautions to be taken before using lifting gear, including checking of lifting gear and load. • Procedures for safe use of lifting gear, including signals, entrapment and identification of site specific hazards. • Understands the requirements of Maritime Rule Part 49. • The layout of a typical trawl winch and outlines the maintenance required. • The safety devices fitted to typical trawl winches, including the provision made for overload.
Maintain vessel stability (adapted from IMO guidance)	**1.** Use stability data, stability and trim tables and pre-calculated operating conditions		Describes how stability data, stability and trim tables and pre-calculated operating conditions are used in accordance with specifications.
	2. Identify the significance of weathertight and watertight integrity		Explains the significance of weathertight and watertight integrity for the safe operation of vessels.
	3. Describes management of vessel's tanks with regard to stability		Describes the management of fuel, oil and water tanks. Explains how such tanks can affect ship stability.
	4. Identify the significance of		Explains the significance of free surface effect and how it may influence the

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
	free surface effect		safe operation of a vessel.
Apply safety and health procedures for vessel personnel (adapted from IMO guidance)	**1.** Apply safety and health precautions and procedures for vessel personnel on board	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	• Describes how safety precautions and procedures relating to the activities of vessel personnel working on deck and in machinery spaces are applied. • Describes how safety precautions relating to the use of protective clothing and equipment are applied as appropriate for the category of vessel concerned.
	2. Identify safety precautions associated with the operation of fishing gear		• Identifies safety precautions for fishing vessel personnel operating fishing gear as appropriate for the fishing method and category of fishing vessel concerned.
Principles and guidelines of the Code of Conduct for Responsible Fisheries (adapted from IMO guidance)	Explain the objectives of the Code of Conduct for Responsible Fisheries		Explains the objectives of the Code of Conduct for Responsible Fisheries in accordance with the guidelines of the code.
Apply fire prevention and fire-fighting techniques	Identify provisions concerning fire-fighting equipment, use of equipment and the application of fire safety		• Describes the procedures for identifying fire and explosion hazards, and the actions to take to prevent fire on the vessel. • Describes basic fire fighting techniques. • Describes the action that may be required as Engineer as part of the vessel Fire Party. • Identifies fire-fighting provisions appropriate for the category of vessel

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	procedures		concerned.
Respond to emergency situations involving vessel personnel (adapted from IMO guidance)	**1.** Follow emergency procedures specified in the vessel's contingency plans	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Describes how emergency situation responses appropriate for the vessel in which qualifying service has or is being gained are identified and followed in accordance with the vessel's contingency plan.
	2. Identify relevant emergency situation duties and responsibilities		Emergency duties and responsibilities are identified in accordance with contingency plans, including the appropriate action to be taken when observing or receiving distress signals.
	3. Identify appropriate action to be taken following a fire or collision		Identifies the appropriate actions to be taken following a fire or collision in accordance with the recommended procedures.
	4. Indicate procedures to be followed in abandoning the vessel		Describes procedures to be followed in abandoning the vessel.
Respond to vessel emergency situations (adapted from	Follow procedures for the temporary plugging of leaks		Demonstrates knowledge of the procedures to be followed to effect temporary repairs and the plugging of leaks, taking into consideration the structural material involved.

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
IMO guidance)		Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	
Operate and maintain emergency equipment	Follow procedures for the temporary plugging of leaks cont.		Demonstrates awareness of need for maintenance of emergency equipment in accordance with the specified requirements.

Function: Environment

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Environmental awareness	Environmental protection	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Describes with reference to the MARPOL Convention where appropriate: • The discharge of bilge water including proper use of an oily water separator. • Bunkering and fuel transfer procedures. • Bunkering a vessel without spill and according to the bunkering plan. • Oil Spill Contingency Plan. • Penalties associated with accidental discharge of fuels, oils and sewage from the vessel. • Procedures for the treatment and discharge of sewage, and black and grey water from the vessel. • Recording of fuel/oil/sewage movement on/off the vessel. • Explains how prevention of pollution from oil, smoke and garbage is achieved.
Prevent pollution of the marine environment by fishing vessels (adapted from IMO guidance)	Apply provisions of the International Convention for the Prevention of Pollution from Ships		Explains how the provision of the MARPOL Convention and the recommendations of the FAO Code of Conduct for Responsible Fisheries are applied to the operations of fishing vessels as appropriate to the operations of the category of fishing vessel concerned.

Competence	Knowledge, understanding and proficiency	Methods for demonstrating competence	Criteria for evaluating competence
Responsible harvesting practices (adapted from IMO guidance)	**1.** Describe the effects of discards and by-catch	Assessment of evidence obtained from approved training and approved in-service experience by way of written and oral examination	Describes the effects of discards and by-catch resulting from fishing operations as they relate to the fishery concerned and global fisheries.
	2. Identify the causes of habitat damage due to fishery operation		Identifies probable damage caused to fishery habitats through fishing activities according to the size and type of fishing operation concerned.
	3. Describe the purpose of marine reserves		Describes the purpose of establishing marine reserves in accordance with the objectives indicated by the Code of Conduct for Responsible Fisheries.
Responsible fishing gear/ selectivity (adapted from IMO guidance)	Explain the importance of fishing gear selectivity		Explains the importance of fishing gear selectivity in accordance with the ratio of by-catch to target species catch in local fisheries.