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(07/2007)

THIRD-CLASS ENGINEER

SET OF SPECIMEN EXAMINATION QUESTIONS

2nd EDITION
JULY 2007



TC-1002463



Canada

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1. SCOPE AND APPLICATION

1.1 PURPOSE:

- (1) To provide information to seafarers and marine training institutions by outlining the guidance on the examination for obtaining the certificate of competency as Third-class Engineer, Motor Ship, and Third-class Engineer, Steamship.

1.2 SCOPE:

- (1) Recommended for all those seafarers who intend to write examinations for the certificate of competency as Third-class Engineer, Motor Ship and/or Third-class Engineer, Steamship.

1.3 EFFECTIVE DATE:

- (1) This document enters into force on July 1, 2007.

1.4 AUTHORITY:

- (1) The *Marine Personnel Regulations* (SOR/2007-115), made pursuant to the *Canada Shipping Act, 2001* (2001, c.26).

2. GENERAL INFORMATION

This guide is intended to provide information to the candidates for the Third-class Engineer, Motor Ship, and Third-class Engineer, Steamship certificates.

- (1) You must pass a written examination in each of the following subjects:
 - Applied Mathematics;
 - Applied Mechanics;
 - Thermodynamics;
 - Electrotechnology;
 - Engineering Knowledge, General;
 - Engineering Knowledge, Motor and/or
 - Engineering Knowledge, Steam.
- (2) Questions may refer to any of the areas of knowledge mentioned in the syllabus.
- (3) For each subject, you will be given 9 questions; only 6 must be attempted.
- (4) On completion of the written examinations, you must also pass an oral examination to test your practical knowledge; this examination may include references to the answers given in the written examinations.

Before beginning the written examinations, read carefully the rules on the first page of the Answer Booklet. Any question should be addressed to the Examiner before beginning the examination.

Please visit the following Transport Canada Web sites:

For more information on the general requirements, qualifying service, validity and examination syllabus of the third-class certificates,

<http://www.tc.gc.ca/MarineSafety/TP/TP2293/PDF/CHAPTER-28.pdf>

For any other question about the Examination and Certification of Seafarers,

<http://www.tc.gc.ca/MarineSafety/TP/TP2293/menu.htm>

3. APPLIED MATHEMATICS

Time allowed: 3.5 hours

Six (6) questions only to be attempted

- (1) A pump can empty a tank in 12 hours, another pump can empty the same tank in 4 hours, and another can empty this tank in 9 hours. If all three pumps are set working together on this tank, how long will it take to empty it?
- (2) A windlass drum has a diameter of 0.8 m. Calculate the length (m) of rope taken in when the drum turns through 16 revolutions.
- (3) A simple spur gear train consists of a 36-tooth wheel turning 180 revolutions per minute meshing with a 15-tooth wheel. What is the speed of the 15-toothed wheel?
- (4) The rim of a cast iron flywheel is 1.5 m outside diameter and 1.2 m inside diameter. If the rim is 0.25 m wide and the density of cast iron is 7.2 t/m^3 , find the mass of the flywheel rim.
- (5) Find the area left over from an equilateral triangle, the sides of which are 8 cm long, after a hole 3 cm in diameter has been punched out of it.
- (6) Simplify the following and find the value if $X = -2$, and $Y = -3$.
$$3[4X + 2\{X - 2Y - (3X + Y)\} - 3X]$$
- (7) In a three-cylinder engine, the power developed in no. 1 cylinder is 15% more than in no. 3 and 4% less power is developed in no. 2 than in no. 3. What percentage of the total engine power is developed in each cylinder?
- (8) The propeller pitch is 5 m, the slip is 10% and the engine turns 95 revolutions per minute. What is the speed of the ship in knots? Note: 1 nautical mile = 1,852 m.
- (9) A ship steaming due West at 16 knots runs into a 3-knot current running South West. Find the resultant speed and direction of the ship.

4. APPLIED MECHANICS

Time allowed: 3.5 hours

Six (6) questions only to be attempted

- (1) Find the factor of safety allowed in a piston rod 200 mm diameter if the maximum tensile pull in the rod under working conditions is one mega Newton and the tensile strength of the piston rod material is 600 MN/m^2 .
- (2) A single cylinder double acting pump has a cylinder diameter of 135 mm and a stroke of 270 mm. The pump is working on seawater of relative density 1.0295 at the rate of 54 working strokes per minute. Calculate the mass of water pumped per hour.
- (3) An engine turns at 250 revolutions per minute and its stroke is 450 mm. Find the average piston speed in meters per minute, and the speed of the centre of the crank pin in meters per minute.
- (4) A solid block of cast iron weighing 220 kilograms is completely immersed in fresh water, when it appears to weigh 189.5 kilograms. Calculate the specific gravity of the cast iron.
- (5) A box barge 210 ft. long and 40 ft. wide floats at a draught of 18 ft. in seawater. Calculate:
 - (a) Displacement of the barge in tonnes;
 - (b) Draught in fresh water in meters. (Relative density of sea water is 1.026)
- (6) A block of wood is pulled along a horizontal table by a force of 25 N inclined at 20 degrees above the horizontal. Find the vertical and horizontal components of the force.
- (7) The rate of water supply to a hydraulic crane is 90 liters per minute at a steady pressure of 70 bars. Find the input power and the efficiency if the output is 7.5 kW. The power in watts is the product of water supply pressure in N/m sq. and volume flow in M^3 per second.
- (8) The mass of a propeller is 4.5 tons and its centre of gravity is 3.5 mm from the centre of rotation. Find the pull due to centrifugal force when it is rotating at 120 rev/min.
- (9) A hole 12 mm diameter is to be punched through a plate 18 mm thick. If the shear strength of the material is 300 N/mm^2 , find the load required on the punch.

5. THERMODYNAMICS

Time allowed: 3.5 hours

Six (6) questions only to be attempted

- (1) 15 kg of steel ball bearings at 100 °C is immersed in 25 kg of water at 20 °C. Assuming no loss of heat to or from the container, calculate the final temperature of the water after equilibrium has been attained.

Specific heat of steel: 0.4857 kJ/ kg/ °K

Specific heat of water: 4.187 kJ/ kg/ °K

- (2) (a) State Charles's Law.
 (b) A receiver contains 20 kg of air at 3,200 kN/m sq. gauge and 16 °C. Calculate the new pressure and heat energy transfer if air is heated to 35 °C. Neglect any expansion of the reservoir.

Take R for air: 0.287 kJ/ kg/ °K,

Specific heat at constant volume Cv: 0.718 kJ/ kg/ °K,

Atmospheric pressure: 100 kN/m²

- (3) A diesel engine is being assembled in a shop where the temperature is kept at 20 °C. At this temperature, the length of a steel valve push rod is 460 mm. Calculate the clearance required if the engine is expected to reach an operating temperature of 96 °C.

Linear coefficient (steel): $12 \times 10^{-6}/\text{°C}$.

- (4) 0.113 cubic meter of air at 8.25 bar is expanded in a cylinder until the volume is 0.331 cubic meters. Calculate the final pressure and work done if the expansion is

(a) Isothermal

(b) Adiabatic (take $\gamma = 1.4$)

- (5) A continuous flow calorimeter was used to obtain the calorific value of a sample of fuel and the following data collected:

Mass of fuel: 2.25 kg

Inlet water temperature: 11 °C

Outlet water temperature: 60 °C

Quantity of water: 360 Liters

Calorimeter efficiency: 85%

Calculate the calorific value of the sample (kJ/ kg).

- (6) The steel cables supporting the "Lion's Gate" suspension bridge are approximately 1,200 meters long. If the temperature ranges from -9° to +26 °C between winter and summer extremes, calculate the variation in the length of the cables.

Linear coefficient (steel): $12 \times 10^{-6}/\text{°C}$.

- (7) (a) State Boyle's Law.

- (b) A receiver contains 0.25 m³ of air at a pressure of 1,700 kPa and a temperature of 18 °C. Calculate the final pressure after 2.5 kg of air is added if the final temperature is 20.5 °C.

Take R for air = 0.287 kJ/ kg/ °K

- (8) The following data were taken during a one-hour trial run on a single cylinder, single acting, four-stroke diesel engine of cylinder diameter of 175 mm and stroke 225 mm, the speed being constant at 1,000 rpm:

Indicated mep:	5.5 bars
Diam. of rope brake:	1,066 mm
Load on brake:	400 N
Reading of balance:	27 N
Fuel consumed:	5.7 kg
Calorific value:	44.2 MJ/kg

Calculate the indicated power, brake power, specific fuel consumption per indicated kWh and per brake kWh, mechanical efficiency, indicated thermal and brake thermal efficiency.

- (9) In a single cylinder, four stroke, single acting gas engine, the cylinder diameter is 180 mm and the stroke is 350 mm. When running at 250 rpm, the mean area of the indicator diagram taken off the engine is 355 mm², length of diagram 75 mm, scale of the indicator spring 90 kN/m sq per mm, and the number of explosions was counted to be 114 per minute. Calculate the indicated power.

6. ELECTROTECHNOLOGY

Time allowed: 3.5 hours

Six (6) questions only to be attempted

- (1) What is a Wattmeter? Describe, with the aid of a sketch, the internal construction of a Wattmeter.
- (2) State the advantages of the alternating current generators over the direct current generators.
- (3) Describe, with the aid of a sketch, the essential parts of a typical gas engine ignition system.
- (4) A wire is cutting magnetic lines of force at the rate of 200,000,000 lines per second. What average voltage is induced across the terminals of the wire?
- (5) Describe the construction of lead storage cell. Give the chemical reaction produced in the cell on discharge.
- (6) A cell whose internal resistance is 0.16 ohm is delivering 0.5 amps. The external resistance is 2.8 ohms. Find:
 - (a) The number of Volts used in overcoming the internal resistance;
 - (b) The terminal voltage;
 - (c) The Electromotive Force.
- (7) Explain the effects of temperature on resistance of the following conductors:
 - (a) Aluminum;
 - (b) Manganin;
 - (c) Liquid;
 - (d) Carbon.
- (8) A wire has a resistance of 10 ohms at 0 °C and 15 ohms at 100 °C. What is the temperature coefficient of the resistance of the material? At what temperature will its resistance be 30 ohms?
- (9) The brush potential of a generator is 110 volts. The total line resistance is 6 ohms. How much extra line resistance is necessary to limit the current flow to 10 amperes?

7. ENGINEERING KNOWLEDGE (GENERAL)

Time allowed: 3.5 hours

Six (6) Questions only to be attempted

- (1) Why is feed water heated before entering a boiler? What are the dangers involved in pumping cold feed into a steaming boiler? What arrangements are used to heat feed water?
- (2) Describe the operation of surface condenser. What are the indications of incorrect cooling water circulation? Name all the valves and fittings on the circulating water system between the shipside suction and the overboard discharge.
- (3) Why is it important to exclude air from telemotors systems and the ram cylinders of steering gears? What methods are employed to rid these systems of air?
- (4) Describe a stern tube for use on a single-screw steel vessel and explain how the tube is held in position at the stern frame and bulkhead.
- (5) Describe the operation and principle of construction of an aneroid barometer. In what units is the instrument graduated? What useful purpose does it serve? What is the normal atmospheric pressure reading at sea level?
- (6) For what are the double bottom tanks of a ship used? What precautions must be taken before entering any empty tanks that have contained (a) oil and (b) water?
- (7) Describe a bilge pumping system. Sketch a typical bilge well, complete with suction pipe, valve and mud-box. What type of valve is used as a bilge suction valve? Why is it so constructed?
- (8) What care and maintenance do electric generators and motors require? What are the dangers of excess oil in the pedestal bearings of generators?
- (9) Describe a portable foam fire extinguisher and explain how it operates and how it is recharged and maintained in good condition. In what locations is this extinguisher found aboard ship and for what kind of fire is it suitable?

8. ENGINEERING KNOWLEDGE (MOTOR)

Time allowed: 3.5 hours

Six (6) questions only to be attempted

- (1) Before fitting new rings to the piston of a diesel engine, what tests and checks must be carried out to ensure that the rings will function properly? What damage may be caused by improperly adjusted rings? What clearance is usually allowed between the butts?
- (2) Describe how you would adjust the clearance between the valves and the rocker arms of 4-stroke multi-cylinder diesel engine. Why is clearance necessary and what amount is usually given?
- (3) How is the low-pressure air necessary for scavenging the cylinders of two-stroke diesel engines obtained? Describe the different methods of scavenging systems. Explain what can cause fires or explosions in these systems and how they can be extinguished.
- (4) Describe the general location and purpose of all the auxiliary machinery, including that required to service the main engines, found in the machinery spaces of a motor ship.
- (5) State several causes of a diesel engine failing to start. Explain how you would check out these faults and what action you would take to overcome them.
- (6) Describe an air-starting valve as used on the cylinder of a diesel engine. At what part of the cycle is air admitted to the cylinder and what regular attention do air-starting valves require?
- (7) Describe a type of centrifuge or lubricating oil purifier. Explain how it operates and how it is used in connection with diesel engines. What are the possible consequences of operating an engine with dirty or contaminated oil?
- (8) What two types of ignition systems are used in gasoline engines? List some of the common defects found with these systems and explain the function of a distributor in a multi-cylinder engine.
- (9) Explain with reference to a diesel engine the following control terms:
 - (a) Closed loop;
 - (b) Feed back;
 - (c) Desired value.

9. ENGINEERING KNOWLEDGE (STEAM)

Time allowed: 3.5 hours

Six (6) questions only to be attempted

- (1) Discuss the advantages and disadvantages of using a two or three row velocity compounded impulse wheel in a turbine.
- (2) Describe how you would ascertain the mechanical clearance between the piston and the cylinder cover and also between the piston and the bottom of the cylinder. Why are these clearances important and what wear or adjustments to the engine would affect them? Explain why the clearance at the bottom is greater than that at the top.
- (3) Sketch and describe the gland steam arrangement for a turbine set. State which valves are open and shut under any given circumstances?
- (4) Explain how you would prepare a set of main steam turbines and its auxiliary equipment for sea. Describe the warm up procedure and state the precautions to be taken before turning the turbines by steam.
- (5) What action would you take if, while steaming a water tube boiler, one of the tubes ruptured? Describe how the tube may be plugged and the boiler put back into service.
- (6) What is meant by 'priming' of a marine boiler? State the possible reasons for a boiler priming. What serious damage to main and auxiliary machinery may be caused by a boiler priming and what precautions are taken to avoid this damage?
- (7) Describe a steam driven duplex water pump suitable for fire mains or general service. State the materials of which the various parts are made and explain the action of the steam valve gear.
- (8) If all the fires in an oil-burning boiler suddenly went out, what causes would you look for and what action would you take? What precautions would you take before lighting up the fires again?
- (9) Why is it necessary to have an auxiliary feed arrangement incorporated with the main boiler feed system of a steamship? Under what conditions is the auxiliary feed system used and what procedure would you adopt to ensure it is always maintained in good condition?