Board Exam Desk

Naval Architecture Reviewer

Naval Architecture Licensure Examination | PRC | 120 original questions

2026 Edition | Updated November 2026

Original board-style practice questions with an answer key.

Practice questions

Ship Hydrostatics and Stability

1. A rectangular pontoon 60 m long and 12 m wide floats on an even keel at a draft of 3.0 m in seawater of density 1.025 t/m3. What is its displacement?

A. 1107 t
B. 2214 t
C. 2160 t
D. 2268 t

2. A vessel has a waterplane area of 1500 m2 at its load draft in seawater (1.025 t/m3). What is its tonnes per centimetre immersion?

A. 14.63 t/cm
B. 15.00 t/cm
C. 15.38 t/cm
D. 153.8 t/cm

3. A box-shaped barge 10 m wide floats at a draft of 4 m with its centre of gravity 3.5 m above the keel. What is its initial metacentric height?

A. 1.08 m
B. 2.08 m
C. 0.42 m
D. 0.58 m

4. A hull displaces 8000 m3 of water at a draft of 6 m. Its waterline length is 100 m and its beam is 16 m. What is its block coefficient?

A. 0.800
B. 0.833
C. 0.867
D. 0.750

5. During an inclining test on a 4000 t ship, a 10 t weight is shifted 8 m across the deck. A 6 m pendulum shows a deflection of 120 mm. What is the metacentric height?

A. 1.20 m
B. 0.83 m
C. 0.50 m
D. 1.00 m

6. A 5000 t ship has a slack rectangular ballast tank 10 m long and 8 m wide (athwartships) partly filled with seawater (1.025 t/m3). What is the virtual rise of G due to free surface?

A. 0.087 m
B. 0.011 m
C. 0.350 m
D. 0.044 m

7. On a 6000 t ship with a GM of 1.2 m, a 50 t load is moved 6 m transversely. What angle of list results?

A. 4.76 degrees
B. 1.19 degrees
C. 2.86 degrees
D. 2.39 degrees

8. A ship of 5000 t displacement has KG = 6.0 m. Cargo of 500 t is loaded with its centre of gravity 10.0 m above the keel. What is the new KG?

A. 6.18 m
B. 6.40 m
C. 6.36 m
D. 6.80 m

9. A ship has a displacement of 10 000 t and a TPC of 20 t/cm at its summer draft. What is its fresh water allowance?

A. 250 mm
B. 200 mm
C. 500 mm
D. 125 mm

10. A ship has a moment to change trim 1 cm (MCTC) of 150 t-m. A 100 t weight is shifted 40 m aft. What is the change of trim?

A. 26.7 cm by the head
B. 26.7 cm by the stern
C. 37.5 cm by the stern
D. 13.3 cm by the stern

11. Half-breadths of a waterplane at 10 m station spacing are 0, 4, 6, 4 and 0 m. Using Simpson's first rule, what is the full waterplane area?

A. 293.3 m2
B. 280.0 m2
C. 146.7 m2
D. 320.0 m2

12. A loaded ship flops slowly to port, then to starboard, and hangs at a similar angle on each side with no external heeling moment. What is the most likely condition?

A. Excessive positive GM making the ship stiff
B. A transverse shift of cargo to one side
C. Flooding of a wing tank on one side only
D. Negative upright GM producing an angle of loll

13. A ship has a metacentric height of 0.80 m. Using the small-angle approximation, what is the righting lever at 10 degrees of heel?

A. 0.080 m
B. 0.800 m
C. 0.141 m
D. 0.139 m

14. A wall-sided vessel has GM = 0.50 m and BM = 4.0 m. Using the wall-sided formula, what is GZ at 20 degrees of heel?

A. 0.286 m
B. 0.353 m
C. 0.262 m
D. 0.171 m

15. A hull form has a block coefficient of 0.72 and a midship section coefficient of 0.98. What is its longitudinal prismatic coefficient?

A. 0.706
B. 0.735
C. 0.680
D. 0.760

16. About which point does a ship trim when a small weight is shifted longitudinally?

A. The longitudinal centre of gravity
B. The longitudinal metacentre
C. The longitudinal centre of buoyancy
D. The centre of flotation

17. A box-shaped lighter floats at a draft of 5.000 m in seawater of 1.025 t/m3. It is towed into fresh water of 1.000 t/m3. What is its new draft?

A. 5.250 m
B. 4.878 m
C. 5.125 m
D. 5.025 m

18. Which quantity represents the dynamical stability of a ship at a given angle of heel?

A. Area under the cross curves of stability
B. Metacentric height times the angle of heel
C. Displacement times the maximum righting lever
D. Displacement times the area under the GZ curve

19. A ship of 8000 t lifts a 40 t package from the hold floor (Kg 2 m) with its own derrick whose head is 22 m above the keel. How much does G rise when the load leaves the floor?

A. 0.10 m
B. 0.11 m
C. 0.01 m
D. 0.20 m

20. A naval architect needs the displacement of a ship floating with a large trim. Which set of curves gives the sectional areas at any draft for this purpose?

A. Cross curves of stability
B. Curves of statical stability
C. Bonjean curves
D. Floodable length curves

Ship Resistance and Propulsion

21. A ship 120 m long on the waterline is running at 15 knots. What is its Froude number?

A. 0.432
B. 0.225
C. 0.137
D. 0.265

22. A 1:25 scale model is tested to represent a ship at 20 knots with equal Froude numbers. What is the corresponding model speed?

A. 0.8 knots
B. 4.0 knots
C. 5.0 knots
D. 2.0 knots

23. A 5.0 m model is towed at 2.0 m/s in water with kinematic viscosity 1.14 x 10^-6 m2/s. What is its Reynolds number?

A. 1.75 x 10^7
B. 2.28 x 10^6
C. 8.77 x 10^6
D. 4.39 x 10^6

24. Using the ITTC 1957 model-ship correlation line, what is the frictional resistance coefficient at a Reynolds number of 1.0 x 10^9?

A. 0.00188
B. 0.00250
C. 0.00153
D. 0.00107

25. A ship's total resistance is 500 kN at a speed of 8 m/s. What is its effective power?

A. 4000 kW
B. 62.5 kW
C. 8000 kW
D. 2000 kW

26. A ship runs at 7.5 m/s while the mean speed of water arriving at its propeller is 6.0 m/s. What is the Taylor wake fraction?

A. 0.15
B. 0.80
C. 0.20
D. 0.25

27. Towed bare, a hull needs 400 kN, but when self-propelled at the same speed its propeller must deliver 480 kN of thrust. What is the thrust deduction fraction?

A. 0.167
B. 0.080
C. 0.833
D. 0.200

28. A ship has a thrust deduction fraction of 0.18 and a Taylor wake fraction of 0.25. What is its hull efficiency?

A. 0.915
B. 0.930
C. 1.075
D. 1.093

29. A propeller of 4.0 m pitch turns at 120 rpm while the ship makes 6.4 m/s. What is the apparent slip?

A. 20 percent
B. 16 percent
C. 80 percent
D. 25 percent

30. A 5.0 m diameter propeller turns at 2 rev/s with a speed of advance of 6.0 m/s. What is its advance coefficient?

A. 0.30
B. 1.67
C. 2.40
D. 0.60

31. At constant displacement, a ship needs 6000 kW at 14 knots. Assuming power varies with the cube of speed, what power is needed at 16 knots?

A. 7837 kW
B. 6857 kW
C. 10 236 kW
D. 8956 kW

32. A voyage at 12 knots burns 300 t of fuel. If daily consumption varies with speed cubed, how much fuel does the same voyage burn at 10 knots?

A. 360 t
B. 250 t
C. 208 t
D. 174 t

33. Pitting and erosion are found on the back of a propeller blade near the tips. What phenomenon most likely caused it?

A. Galvanic corrosion between bronze blade and steel hull
B. Fatigue cracking from torsional shaft vibration
C. Fouling by marine growth raising surface roughness
D. Cavitation from local pressure dropping below vapour pressure

34. How does a properly designed bulbous bow reduce resistance at service speed?

A. It raises the stern to reduce wake losses
B. Its own wave system partly cancels the bow wave
C. It lowers wetted surface and frictional resistance
D. It lowers form drag by thinning the boundary layer

35. In Froude's method of extrapolating model tests, how is the frictional resistance of the model and ship estimated?

A. By scaling model friction with the cube of the scale
B. As a fixed share of total resistance found by test
C. By assuming friction follows the Froude similarity law
D. As that of a flat plate of equal length and wetted area

36. A hull has a wetted surface of 3000 m2 and a frictional coefficient of 0.0016 at 7 m/s in seawater (1025 kg/m3). What is its frictional resistance?

A. 60.3 kN
B. 120.5 kN
C. 17.2 kN
D. 241.1 kN

37. A ship's effective power is 3500 kW and the power delivered to its propeller is 5000 kW. What is the quasi-propulsive coefficient?

A. 0.65
B. 0.70
C. 1.43
D. 0.75

38. At a radius of 1.5 m, a constant-pitch propeller blade section has a pitch angle of 25 degrees. What is the propeller pitch?

A. 4.39 m
B. 2.05 m
C. 3.54 m
D. 9.42 m

39. A ferry operator wants quick stopping and reversing without reversing the engine, with the shaft at constant speed to drive a generator. Which propulsor fits best?

A. Fixed pitch propeller with reversing gear
B. Contra-rotating fixed pitch propellers
C. Controllable pitch propeller
D. Surface-piercing fixed pitch propeller

40. Why are ducted (nozzle) propellers commonly fitted to harbour tugs?

A. They raise thrust at low speeds and bollard pull
B. They give the best efficiency at high free speed
C. They allow the tug to work with no rudder fitted
D. They remove all risk of propeller cavitation

Ship Structures and Construction

41. Amidships, a ship carries a vertical bending moment of 800 000 kN-m and the hull girder section modulus at the deck is 5.0 m3. What is the deck bending stress?

A. 16 MPa
B. 320 MPa
C. 160 MPa
D. 40 MPa

42. A ship is hogging in a seaway with a wave crest amidships. What stresses act in the main deck and bottom shell?

A. Deck and bottom both in compression
B. Deck in tension, bottom in compression
C. Deck in compression, bottom in tension
D. Deck and bottom both in tension

43. For a long oil tanker where longitudinal bending dominates, which framing system is generally preferred?

A. Longitudinal framing
B. Transverse framing
C. Web-only framing
D. Cellular framing

44. What is the uppermost strake of side shell plating, joining the strength deck stringer, called?

A. Sheer strake
B. Garboard strake
C. Bilge strake
D. Stealer strake

45. Which shell strake lies immediately next to the keel plate?

A. Boot-topping strake
B. Sheer strake
C. Bilge strake
D. Garboard strake

46. Which watertight bulkhead is the forward-most and is intended to limit flooding after a bow collision?

A. Aft peak bulkhead
B. Engine room bulkhead
C. Collision bulkhead
D. Wash bulkhead

47. In transverse framing, what is the bracket connecting a deck beam to a side frame called?

A. Beam knee
B. Bilge bracket
C. Breasthook
D. Tripping bracket

48. Which of these is a main purpose of fitting a double bottom?

A. Removing the need for a keel plate
B. Increasing the metacentric height by raising G
C. Protection against flooding if the outer bottom is holed
D. Lowering the ship's lightship weight

49. A deck plate 2000 mm wide and 10 mm thick lies 5 m from the hull girder neutral axis. Ignoring its own centroidal inertia, what does it add to the section's moment of inertia?

A. 1.00 m4
B. 0.10 m4
C. 0.25 m4
D. 0.50 m4

50. In a simplified midship section, deck material 0.6 m2 is at 12 m above the keel, bottom material 0.9 m2 is at the keel, and side material 0.4 m2 has its centroid at 6 m. Where is the neutral axis?

A. 5.68 m above keel
B. 4.42 m above keel
C. 5.05 m above keel
D. 6.00 m above keel

51. A 40 m pontoon has buoyancy spread evenly along its length and carries a 200 t load concentrated amidships, ignoring its own weight. What is the midship bending moment?

A. 9810 kN-m sagging
B. 9810 kN-m hogging
C. 19 620 kN-m sagging
D. 4905 kN-m sagging

52. Why do many tankers and bulk carriers use corrugated bulkheads?

A. They increase the volume of each cargo hold
B. The corrugations stiffen the plate without separate stiffeners
C. They let cargo flow between holds for loading
D. They act as wash plates to limit sloshing

53. A fillet weld has a leg length of 8 mm. What is its theoretical throat thickness?

A. 4.00 mm
B. 6.93 mm
C. 11.31 mm
D. 5.66 mm

54. Which structural members are fitted at the fore end of a ship mainly to resist panting?

A. Panting beams and stringers
B. Bilge keels and docking brackets
C. Deck girders and hatch coamings
D. Tank top longitudinals aft

55. A ship with a light ballast draft forward often slams in head seas. Which area receives extra strengthening against this pounding?

A. Upper side shell in way of engine room
B. Forward bottom flat plating and floors
C. Main deck plating at the stern
D. Shell plating near the stern frame

56. Which structural features chiefly resist racking of a ship's transverse section in a seaway?

A. Transverse bulkheads, beam knees and web frames
B. Longitudinal deck girders and keel
C. Bilge keels and rubbing strakes
D. Hatch covers and cargo battens

57. A watertight bulkhead 10 m wide is flooded with seawater (1025 kg/m3) to a depth of 8 m on one side. What is the total hydrostatic force on it?

A. 3218 kN
B. 2145 kN
C. 6435 kN
D. 804 kN

58. A hull girder with a moment of inertia of 60 m4 carries a bending moment of 1.2 x 10^6 kN-m. What is the stress at a deck 7 m from the neutral axis?

A. 20 MPa
B. 51 MPa
C. 140 MPa
D. 120 MPa

59. Toward the ends of a ship, two shell strakes are replaced by a single wider plate because the girth decreases. What is this plate called?

A. Bosom plate
B. Insert plate
C. Stealer plate
D. Doubler plate

60. What is the main purpose of bilge keels?

A. To protect the shell when docking
B. To increase longitudinal strength
C. To improve course-keeping ability
D. To damp rolling motion

Marine Engineering and Machinery

61. A six-cylinder two-stroke engine has a 600 mm bore, a 2400 mm stroke, and runs at 100 rpm with an indicated mean effective pressure of 1.5 MPa. What is its indicated power?

A. 10 179 kW
B. 1696 kW
C. 20 358 kW
D. 5089 kW

62. A main engine develops 9200 kW indicated and 8000 kW brake power. What is its mechanical efficiency?

A. 115.0 percent
B. 87.0 percent
C. 13.0 percent
D. 82.6 percent

63. An engine delivering 8000 kW burns 1.5 t of fuel per hour. What is its specific fuel consumption?

A. 120.0 g/kWh
B. 200.0 g/kWh
C. 187.5 g/kWh
D. 5.33 g/kWh

64. A diesel engine has a specific fuel consumption of 180 g/kWh on fuel with a lower calorific value of 42 700 kJ/kg. What is its brake thermal efficiency?

A. 51.3 percent
B. 38.4 percent
C. 42.2 percent
D. 46.8 percent

65. A steam plant receives heat at 300 deg C and rejects it at 40 deg C. What is the maximum (Carnot) efficiency possible?

A. 13.3 percent
B. 54.6 percent
C. 86.7 percent
D. 45.4 percent

66. A propeller shaft transmits a torque of 500 kN-m at 120 rpm. What power does it transmit?

A. 60 000 kW
B. 6283 kW
C. 3142 kW
D. 1047 kW

67. A solid steel shaft must carry a torque of 300 kN-m with an allowable shear stress of 40 MPa. What minimum diameter is needed?

A. 195 mm
B. 424 mm
C. 267 mm
D. 337 mm

68. A ballast pump delivers 0.05 m3/s of seawater (1025 kg/m3) against a total head of 30 m with an overall efficiency of 70 percent. What input power is required?

A. 15.1 kW
B. 30.8 kW
C. 10.8 kW
D. 21.5 kW

69. In a centrifugal fuel oil purifier, what is the function of the gravity disc?

A. Positions the oil-water interface for the oil density
B. Heats the fuel to separation temperature
C. Controls the timing of the sludge discharge
D. Sets the bowl speed to suit the fuel viscosity

70. Which type of main engine is typically direct-coupled to the propeller of a large ocean-going bulk carrier?

A. Medium-speed engine without gearbox
B. High-speed four-stroke trunk diesel
C. Slow-speed two-stroke crosshead diesel
D. Gas turbine driving a fixed pitch propeller

71. Engineers find high scavenge air temperatures and sparks at the scavenge drains of a two-stroke engine. What is the most probable cause?

A. An air start valve leaking during running
B. Overcooling by the charge air cooler
C. A scavenge fire from oil residues in the air space
D. A crankcase explosion from oil mist ignition

72. What drives the turbocharger of a marine diesel engine?

A. A gear train from the crankshaft
B. Energy in the engine exhaust gas
C. Compressed starting air from receivers
D. A separate electric motor at all loads

73. Why is an intercooler fitted between stages of a multi-stage air compressor?

A. To heat the air so moisture is evaporated
B. To raise delivery temperature for starting
C. To cut the work of the next stage by cooling the air
D. To act as the main air storage reservoir

74. A jacket water cooler passes 20 kg/s of seawater (cp = 4.18 kJ/kg-K) whose temperature rises by 10 K. How much heat is removed?

A. 83.6 kW
B. 209 kW
C. 836 kW
D. 418 kW

75. Why does a shipboard fresh water generator heated by engine jacket water operate under vacuum?

A. So seawater boils at a lower temperature
B. So salt crystallises out of the brine faster
C. So less cooling seawater flow is needed
D. So jacket water pressure stays higher

76. A 3000 kW medium-speed engine runs at 600 rpm and drives a propeller through a 5:1 reduction gear. Ignoring losses, what is the propeller shaft torque?

A. 238.7 kN-m
B. 1193.7 kN-m
C. 47.7 kN-m
D. 25.0 kN-m

77. Zinc blocks are attached to the hull near a bronze propeller. On what principle do they protect the hull?

A. They insulate the propeller from the hull
B. They form a paint-like barrier coating
C. They raise the potential of the steel hull
D. They corrode sacrificially as the anode

78. A ship's six-pole alternator runs at 1200 rpm. What frequency does it generate?

A. 20 Hz
B. 60 Hz
C. 120 Hz
D. 50 Hz

79. A provision refrigeration plant removes 50 kW of heat from the cold rooms while its compressor absorbs 12.5 kW. What is its coefficient of performance?

A. 4.0
B. 3.0
C. 5.0
D. 0.25

80. What is the main job of the stern tube seal arrangement on an oil-lubricated stern tube?

A. Take the propeller thrust to the hull
B. Keep seawater out and lube oil in
C. Damp torsional shaft vibration
D. Center the shaft in the plummer blocks

Engineering Mathematics and Mechanics

81. Ordinates of a curve at 4 m spacing are 2, 5, 6 and 3 m. Using Simpson's second (three-eighths) rule, what is the area under it?

A. 48 m2
B. 76 m2
C. 57 m2
D. 56 m2

82. Ordinates of a curve at 5 m spacing are 3, 7, 9 and 4 m. Using the trapezoidal rule, what is the area under it?

A. 103.3 m2
B. 97.5 m2
C. 115.0 m2
D. 92.5 m2

83. What is the second moment of area of a 300 mm wide by 600 mm deep rectangle about its horizontal centroidal axis?

A. 0.0108 m4
B. 0.00135 m4
C. 0.0216 m4
D. 0.0054 m4

84. A fully submerged buoy displaces 2.0 m3 of seawater (1025 kg/m3). What buoyant force acts on it?

A. 19.6 kN
B. 40.2 kN
C. 2.05 kN
D. 20.1 kN

85. Neglecting losses, at what velocity does water leave a small hole in a tank wall 5 m below the free surface?

A. 7.0 m/s
B. 4.9 m/s
C. 9.9 m/s
D. 49.1 m/s

86. What is the gauge pressure on a hull at a depth of 30 m in seawater of 1025 kg/m3?

A. 403.0 kPa
B. 294.3 kPa
C. 30.8 kPa
D. 301.7 kPa

87. For f(x) = x^3 - 6x^2 + 9x, at what value of x does the local maximum occur?

A. x = 0
B. x = 1
C. x = 3
D. x = 2

88. What is the area bounded by y = x^2, the x-axis, and the lines x = 0 and x = 3?

A. 27 square units
B. 4.5 square units
C. 6 square units
D. 9 square units

89. Where is the centroid of a triangular area measured from its base?

A. One quarter of the height
B. One half of the height
C. Two thirds of the height
D. One third of the height

90. A steel rod 2 m long and 20 mm in diameter carries an axial tensile load of 50 kN. With E = 200 GPa, how much does it elongate?

A. 6.37 mm
B. 0.80 mm
C. 0.40 mm
D. 1.59 mm

91. A simply supported beam with a 6 m span carries a 20 kN point load at midspan. What is the maximum bending moment?

A. 120 kN-m
B. 30 kN-m
C. 15 kN-m
D. 60 kN-m

92. A 2 m cantilever carries a 5 kN load at its free end. With E = 200 GPa and I = 8 x 10^-6 m4, what is the tip deflection?

A. 8.33 mm
B. 4.17 mm
C. 2.08 mm
D. 25.0 mm

93. Water flows at 2 m/s in a 100 mm pipe that reduces to 50 mm. What is the velocity in the smaller pipe?

A. 1 m/s
B. 16 m/s
C. 8 m/s
D. 4 m/s

94. Taking one nautical mile as 1852 m, what is 18 knots in metres per second?

A. 33.3 m/s
B. 9.26 m/s
C. 8.33 m/s
D. 10.0 m/s

95. A vessel slowing uniformly from 8 m/s comes to rest in 400 m. How long does it take to stop?

A. 100 s
B. 200 s
C. 50 s
D. 80 s

96. A ship has a radius of gyration for rolling of 6.0 m and a GM of 1.0 m. Treating rolling as simple harmonic, what is the natural roll period?

A. 12.0 s
B. 6.0 s
C. 3.8 s
D. 19.2 s

97. A solid timber block of density 600 kg/m3 floats in seawater of 1025 kg/m3. What fraction of its volume is submerged?

A. 0.585
B. 0.708
C. 0.415
D. 0.600

98. Two tugs each pull a barge with 100 kN, their lines at 30 degrees on either side of the barge centreline. What is the resultant forward pull?

A. 141.4 kN
B. 173.2 kN
C. 100.0 kN
D. 200.0 kN

99. A deck crane hoists a 5 t load vertically at a steady 0.5 m/s. What power does the load require, ignoring losses?

A. 49.1 kW
B. 24.5 kW
C. 12.3 kW
D. 2.5 kW

100. A 100 m steel deck with a coefficient of linear expansion of 12 x 10^-6 per K warms by 30 K. If unrestrained, how much does it lengthen?

A. 36 mm
B. 3.6 mm
C. 360 mm
D. 12 mm

Ship Design, Safety and Regulations

101. Under SOLAS, the main steering gear must turn the rudder from 35 degrees on one side to 30 degrees on the other within what time, at deepest seagoing draft and full ahead speed?

A. 28 seconds
B. 60 seconds
C. 20 seconds
D. 35 seconds

102. Under MARPOL Annex I, what is the maximum oil content of machinery space bilge water discharged at sea through approved oil filtering equipment?

A. 50 ppm
B. 15 ppm
C. 5 ppm
D. 100 ppm

103. On a ship's load line mark, which line allows the deepest draft?

A. Tropical (T)
B. Summer (S)
C. Tropical fresh water (TF)
D. Winter North Atlantic (WNA)

104. Which international convention sets minimum freeboards for ships on international voyages?

A. Convention on the International Regulations for Preventing Collisions at Sea
B. International Convention on Tonnage Measurement, 1969
C. International Convention on Load Lines, 1966
D. International Convention for the Prevention of Pollution from Ships

105. Which MARPOL Annex regulates the discharge of garbage from ships?

A. Annex IV
B. Annex II
C. Annex V
D. Annex VI

106. Under the 1969 Tonnage Convention, a ship's total enclosed volume is 10 000 m3. What is its gross tonnage?

A. 3000
B. 2800
C. 2400
D. 2000

107. What is the main role of a classification society in ship design and construction?

A. Setting rules for strength and surveying compliance
B. Registering a ship under a national flag
C. Insuring cargo against loss at sea
D. Fixing freight rates for chartered vessels

108. The ship design spiral is a common description of the design process. What does it emphasise?

A. Designing machinery before the owner's needs
B. Repeated rounds refining interdependent characteristics
C. A single pass from hull form to final drawings
D. Fixing cost first, then all technical aspects

109. A ship has a loaded displacement of 15 000 t and a lightship weight of 4500 t. What is its deadweight?

A. 10 500 t
B. 19 500 t
C. 11 250 t
D. 4500 t

110. A design has a deadweight of 10 500 t on a loaded displacement of 15 000 t. What is its deadweight coefficient?

A. 0.30
B. 0.43
C. 1.43
D. 0.70

111. Why does MARPOL require new oil tankers to have double hulls in way of cargo tanks?

A. To improve the thermal insulation of cargo
B. To raise cargo capacity within the same dimensions
C. To reduce oil outflow after collision or grounding
D. To give room for extra fuel oil bunkers

112. What problem is the Ballast Water Management Convention mainly intended to address?

A. Overloading of ships beyond their load line
B. Spread of harmful aquatic organisms in ballast
C. Air pollution from ballast pump engines
D. Loss of stability when ballast tanks are slack

113. A ship has a moulded depth of 9.000 m, a deck stringer plate 15 mm thick, and a summer draft of 7.200 m. What is its summer freeboard?

A. 1.830 m
B. 1.815 m
C. 1.785 m
D. 1.800 m

114. A parent ship with L B D = 100 x 16 x 9 m has a steel weight of 2400 t. Scaling steel weight by L B D, what is the estimate for a new design of 110 x 17 x 9.5 m?

A. 3257 t
B. 2961 t
C. 2640 t
D. 2735 t

115. A design review finds a cargo ship will have a very large GM in the light ballast condition. What seakeeping problem should the designer expect?

A. Long, slow rolling with poor righting ability
B. Frequent angle of loll in calm water
C. Short, violent rolling that strains lashings
D. Loss of directional stability at speed

116. In subdivision design, how is the permissible length between watertight bulkheads obtained?

A. Margin line height times the ship's beam
B. Floodable length times the factor of subdivision
C. Length of the ship divided by bulkhead number
D. Freeboard divided by the factor of subdivision

117. What does the ISM Code require shipping companies to establish and maintain?

A. A national crew licensing scheme
B. A ship security alert system
C. A ballast water exchange plan only
D. A safety management system

118. Which Philippine government agency is mainly responsible for regulating domestic shipping and shipbuilding?

A. Maritime Industry Authority (MARINA)
B. Philippine Ports Authority (PPA)
C. Bureau of Customs (BOC)
D. Department of Public Works and Highways

119. A designer increases the beam of a preliminary design while keeping draft and displacement nearly the same. What is the main effect on initial stability?

A. BM rises sharply, roughly with beam squared
B. KB rises in proportion to the beam
C. BM falls because the hull becomes shallower
D. KG falls in proportion to the beam

120. A general cargo has a stowage factor of 1.5 m3/t. What hold volume is needed for 8000 t of it, ignoring broken stowage?

A. 13 800 m3
B. 5333 m3
C. 12 000 m3
D. 9500 m3

Answer key

Naval Architecture

1. B. 2214 t

Volume = 60 x 12 x 3 = 2160 m3; displacement = 2160 x 1.025 = 2214 t.

2. C. 15.38 t/cm

TPC = Aw x density / 100 = 1500 x 1.025 / 100 = 15.38 t/cm.

3. D. 0.58 m

KB = 2.0 m, BM = B^2/(12T) = 100/48 = 2.08 m, KM = 4.08 m; GM = 4.08 - 3.5 = 0.58 m.

4. B. 0.833

Cb = 8000 / (100 x 16 x 6) = 8000 / 9600 = 0.833.

5. D. 1.00 m

GM = w d L / (displacement x deflection) = 10 x 8 x 6 / (4000 x 0.12) = 480/480 = 1.00 m.

6. A. 0.087 m

FSM = density x l x b^3 / 12 = 1.025 x 10 x 512 / 12 = 437.3 t-m; rise = 437.3/5000 = 0.087 m.

7. D. 2.39 degrees

tan(list) = w d / (displacement x GM) = 300 / 7200 = 0.0417, so list = 2.39 degrees.

8. C. 6.36 m

New KG = (5000 x 6.0 + 500 x 10.0) / 5500 = 35000 / 5500 = 6.36 m.

9. D. 125 mm

FWA = displacement / (4 x TPC) = 10 000 / 80 = 125 mm.

10. B. 26.7 cm by the stern

Trim change = w d / MCTC = 100 x 40 / 150 = 26.7 cm, and moving weight aft trims her by the stern.

11. A. 293.3 m2

Half area = (10/3)(0 + 4x4 + 2x6 + 4x4 + 0) = (10/3)(44) = 146.7 m2; full area = 293.3 m2.

12. D. Negative upright GM producing an angle of loll

A ship with negative upright GM lolls to either side until the waterplane widens enough to give zero GZ; a list from off-centre weight would stay on one side.

13. D. 0.139 m

GZ = GM sin(theta) = 0.80 x sin 10 deg = 0.80 x 0.1736 = 0.139 m.

14. C. 0.262 m

GZ = sin(theta)(GM + 0.5 BM tan^2 theta) = 0.342 x (0.50 + 0.5 x 4 x 0.1325) = 0.342 x 0.765 = 0.262 m.

15. B. 0.735

Cp = Cb / Cm = 0.72 / 0.98 = 0.735.

16. D. The centre of flotation

Small trims occur about the centroid of the waterplane, the centre of flotation, so that the immersed and emerged wedges are equal.

17. C. 5.125 m

Displacement is constant, so the draft rises in the density ratio: 5.000 x 1.025 / 1.000 = 5.125 m.

18. D. Displacement times the area under the GZ curve

Dynamical stability is the work done in heeling the ship, equal to displacement multiplied by the area under the GZ curve up to that angle.

19. A. 0.10 m

A suspended weight acts at the point of suspension, so G rises 40 x (22 - 2) / 8000 = 0.10 m.

20. C. Bonjean curves

Bonjean curves give each station's immersed area against draft, so a trimmed waterline can be laid over them and integrated.

21. B. 0.225

V = 15 x 0.5144 = 7.72 m/s; Fn = V / sqrt(gL) = 7.72 / sqrt(9.81 x 120) = 7.72/34.31 = 0.225.

22. B. 4.0 knots

Speed scales with the square root of length: 20 / sqrt(25) = 20/5 = 4.0 knots.

23. C. 8.77 x 10^6

Re = VL/nu = 2.0 x 5.0 / 1.14e-6 = 8.77 x 10^6.

24. C. 0.00153

CF = 0.075 / (log10 Re - 2)^2 = 0.075 / (9 - 2)^2 = 0.075/49 = 0.00153.

25. A. 4000 kW

PE = RT x V = 500 kN x 8 m/s = 4000 kW.

26. C. 0.20

w = (V - VA)/V = (7.5 - 6.0)/7.5 = 0.20.

27. A. 0.167

t = (T - R)/T = (480 - 400)/480 = 0.167.

28. D. 1.093

Hull efficiency = (1 - t)/(1 - w) = 0.82/0.75 = 1.093.

29. A. 20 percent

Propeller speed = pitch x n = 4.0 x 2 = 8.0 m/s; apparent slip = (8.0 - 6.4)/8.0 = 20 percent.

30. D. 0.60

J = VA/(nD) = 6.0 / (2 x 5.0) = 0.60.

31. D. 8956 kW

P2 = 6000 x (16/14)^3 = 6000 x 1.4927 = 8956 kW.

32. C. 208 t

Voyage fuel varies with speed squared: 300 x (10/12)^2 = 300 x 0.694 = 208 t.

33. D. Cavitation from local pressure dropping below vapour pressure

Low pressure on the suction (back) side lets vapour bubbles form and collapse against the blade, causing cavitation erosion.

34. B. Its own wave system partly cancels the bow wave

The bulb generates a wave that is out of phase with the bow wave, reducing wave-making resistance.

35. D. As that of a flat plate of equal length and wetted area

Froude split resistance into a flat-plate frictional part, scaled with Reynolds-dependent coefficients, and a residuary part that obeys Froude's law.

36. B. 120.5 kN

RF = 0.5 rho S V^2 CF = 0.5 x 1025 x 3000 x 49 x 0.0016 = 120 540 N = 120.5 kN.

37. B. 0.70

QPC = PE / PD = 3500 / 5000 = 0.70.

38. A. 4.39 m

P = 2 pi r tan(phi) = 2 x 3.1416 x 1.5 x 0.4663 = 4.39 m.

39. C. Controllable pitch propeller

A controllable pitch propeller changes blade pitch, even to astern, while the shaft keeps turning at constant speed and direction.

40. A. They raise thrust at low speeds and bollard pull

The duct produces extra thrust at heavily loaded, low-speed conditions such as towing and bollard pull.

41. C. 160 MPa

Stress = M/Z = 800 000 / 5.0 = 160 000 kN/m2 = 160 MPa.

42. B. Deck in tension, bottom in compression

In hogging the ends droop relative to amidships, stretching the deck and compressing the bottom.

43. A. Longitudinal framing

Longitudinal stiffeners add to hull girder section modulus and resist buckling of deck and bottom plating under longitudinal stress.

44. A. Sheer strake

The sheer strake is the top side strake; it is highly stressed and often thicker than the other side plating.

45. D. Garboard strake

The garboard strake is the first strake on each side of the flat keel.

46. C. Collision bulkhead

The collision (fore peak) bulkhead is the first watertight bulkhead abaft the stem and protects the ship if the bow is damaged.

47. A. Beam knee

The beam knee connects beam and frame, keeping the corner rigid and helping resist racking.

48. C. Protection against flooding if the outer bottom is holed

The inner bottom keeps the ship watertight if the outer shell is breached by grounding, and the spaces also serve as tanks.

49. D. 0.50 m4

A = 2.0 x 0.010 = 0.020 m2; I = A d^2 = 0.020 x 25 = 0.50 m4.

50. C. 5.05 m above keel

NA = (0.6 x 12 + 0.9 x 0 + 0.4 x 6) / (0.6 + 0.9 + 0.4) = 9.6/1.9 = 5.05 m.

51. A. 9810 kN-m sagging

Taking moments of the half-length buoyancy (W/2 at L/4) gives M = WL/8 = 200 x 9.81 x 40 / 8 = 9810 kN-m; the central load causes sagging.

52. B. The corrugations stiffen the plate without separate stiffeners

Folding the plate gives it bending stiffness, so separate stiffeners are not needed and tanks are easier to clean.

53. D. 5.66 mm

Throat = 0.707 x leg = 0.707 x 8 = 5.66 mm.

54. A. Panting beams and stringers

Panting is the in-and-out flexing of the bow shell from pressure changes; beams, stringers and closer frames forward stiffen it.

55. B. Forward bottom flat plating and floors

Slamming loads the flat bottom just abaft the forefoot, so plating, floors and stiffening there are increased.

56. A. Transverse bulkheads, beam knees and web frames

Racking distorts the cross-section like a parallelogram; transverse bulkheads and rigid frame corners resist it.

57. A. 3218 kN

F = rho g b h^2 / 2 = 1025 x 9.81 x 10 x 64 / 2 = 3 217 680 N = 3218 kN.

58. C. 140 MPa

Stress = M y / I = 1.2e6 x 7 / 60 = 140 000 kN/m2 = 140 MPa.

59. C. Stealer plate

A stealer plate takes the place of two strakes where the hull girth narrows toward bow or stern.

60. D. To damp rolling motion

Bilge keels create vortices and drag that damp rolling, with little added resistance if aligned with the flow.

61. A. 10 179 kW

Per cylinder: p L A n = 1.5e6 x 2.4 x 0.2827 x (100/60) = 1696 kW; x 6 cylinders = 10 179 kW (two-stroke, one power stroke per revolution).

62. B. 87.0 percent

Mechanical efficiency = brake/indicated = 8000/9200 = 0.870.

63. C. 187.5 g/kWh

SFC = 1 500 000 g/h / 8000 kW = 187.5 g/kWh.

64. D. 46.8 percent

Efficiency = 3600 / (0.180 x 42 700) = 3600/7686 = 0.468.

65. D. 45.4 percent

Carnot efficiency = 1 - T2/T1 = 1 - 313.15/573.15 = 0.454.

66. B. 6283 kW

P = 2 pi n T = 2 x 3.1416 x 2 rev/s x 500 = 6283 kW.

67. D. 337 mm

d^3 = 16T/(pi tau) = 16 x 300e3 / (pi x 40e6) = 0.0382 m3, so d = 0.337 m.

68. D. 21.5 kW

P = rho g Q H / eta = 1025 x 9.81 x 0.05 x 30 / 0.70 = 21 547 W = 21.5 kW.

69. A. Positions the oil-water interface for the oil density

The gravity disc diameter sets where the oil-water interface sits in the bowl; it is chosen according to oil density.

70. C. Slow-speed two-stroke crosshead diesel

Slow-speed crosshead engines run at propeller speed, so they need no reduction gear and give high efficiency.

71. C. A scavenge fire from oil residues in the air space

Unburnt fuel and cylinder oil collecting in the scavenge space can be ignited by blow-by gases, giving a scavenge fire.

72. B. Energy in the engine exhaust gas

Exhaust gas drives the turbine, which drives the compressor on the same shaft to supply charge air.

73. C. To cut the work of the next stage by cooling the air

Cooling between stages brings compression nearer isothermal, reducing work and keeping temperatures safe.

74. C. 836 kW

Q = m cp dT = 20 x 4.18 x 10 = 836 kW.

75. A. So seawater boils at a lower temperature

Lowering pressure lowers the boiling point, letting low-grade jacket heat at about 70 to 80 deg C evaporate seawater.

76. A. 238.7 kN-m

Propeller speed = 120 rpm = 2 rev/s; T = P/(2 pi n) = 3000/(2 x 3.1416 x 2) = 238.7 kN-m.

77. D. They corrode sacrificially as the anode

Zinc is more anodic than steel, so it corrodes preferentially and makes the hull the cathode.

78. B. 60 Hz

f = pN/120 = 6 x 1200 / 120 = 60 Hz.

79. A. 4.0

COP = refrigerating effect / work input = 50 / 12.5 = 4.0.

80. B. Keep seawater out and lube oil in

Forward and aft seals keep lubricating oil inside the stern tube and prevent seawater from entering; thrust is taken by the thrust block.

81. C. 57 m2

A = (3h/8)(y0 + 3y1 + 3y2 + y3) = 1.5 x (2 + 15 + 18 + 3) = 57 m2.

82. B. 97.5 m2

A = h(y0/2 + y1 + y2 + y3/2) = 5 x (1.5 + 7 + 9 + 2) = 97.5 m2.

83. D. 0.0054 m4

I = b h^3 / 12 = 0.3 x 0.216 / 12 = 0.0054 m4.

84. D. 20.1 kN

Fb = rho g V = 1025 x 9.81 x 2.0 = 20 110 N = 20.1 kN.

85. C. 9.9 m/s

Torricelli: v = sqrt(2gh) = sqrt(2 x 9.81 x 5) = 9.9 m/s.

86. D. 301.7 kPa

p = rho g h = 1025 x 9.81 x 30 = 301 658 Pa = 301.7 kPa.

87. B. x = 1

f'(x) = 3x^2 - 12x + 9 = 3(x - 1)(x - 3) = 0; f''(1) = -6 < 0, so x = 1 is the maximum.

88. D. 9 square units

Area = integral of x^2 from 0 to 3 = 27/3 = 9.

89. D. One third of the height

The centroid of a triangle lies at h/3 from the base, where the medians intersect.

90. D. 1.59 mm

Stress = 50 000 / (pi x 0.01^2) = 159.2 MPa; elongation = 159.2e6 x 2 / 200e9 = 1.59 mm.

91. B. 30 kN-m

Mmax = PL/4 = 20 x 6 / 4 = 30 kN-m.

92. A. 8.33 mm

delta = PL^3/(3EI) = 5000 x 8 / (3 x 200e9 x 8e-6) = 0.00833 m = 8.33 mm.

93. C. 8 m/s

Continuity: v2 = v1 (D1/D2)^2 = 2 x 4 = 8 m/s.

94. B. 9.26 m/s

18 x 1852 / 3600 = 9.26 m/s.

95. A. 100 s

Average speed = 4 m/s, so t = 400/4 = 100 s (deceleration = 64/800 = 0.08 m/s2).

96. A. 12.0 s

T = 2 pi k / sqrt(g GM) = 2 x 3.1416 x 6.0 / sqrt(9.81 x 1.0) = 12.0 s.

97. A. 0.585

Fraction submerged = 600/1025 = 0.585.

98. B. 173.2 kN

Resultant = 2 x 100 x cos 30 deg = 173.2 kN; the side components cancel.

99. B. 24.5 kW

P = m g v = 5000 x 9.81 x 0.5 = 24 525 W = 24.5 kW.

100. A. 36 mm

dL = alpha L dT = 12e-6 x 100 000 mm x 30 = 36 mm.

101. A. 28 seconds

SOLAS Chapter II-1 requires 35 degrees one side to 30 degrees the other in not more than 28 seconds.

102. B. 15 ppm

Annex I limits such discharges to an oil content not exceeding 15 parts per million.

103. C. Tropical fresh water (TF)

Tropical fresh is the highest line on the load line mark because both tropical conditions and lower water density allow more immersion.

104. C. International Convention on Load Lines, 1966

The 1966 Load Line Convention assigns freeboards and the load line marks.

105. C. Annex V

Annex V covers garbage; Annex IV covers sewage, Annex II noxious liquid substances, and Annex VI air pollution.

106. B. 2800

K1 = 0.2 + 0.02 log10(10 000) = 0.28; GT = K1 V = 0.28 x 10 000 = 2800.

107. A. Setting rules for strength and surveying compliance

Class societies publish rules for structure and machinery, approve plans and survey ships during construction and service.

108. B. Repeated rounds refining interdependent characteristics

Dimensions, form, weights, stability, power and cost depend on one another, so the design is refined in successive loops.

109. A. 10 500 t

Deadweight = displacement - lightship = 15 000 - 4500 = 10 500 t.

110. D. 0.70

Deadweight coefficient = deadweight / displacement = 10 500 / 15 000 = 0.70.

111. C. To reduce oil outflow after collision or grounding

Wing and double-bottom spaces separate cargo from the outer shell, so minor breaches do not release oil.

112. B. Spread of harmful aquatic organisms in ballast

The convention aims to stop ships transferring invasive organisms and pathogens between regions through ballast water.

113. B. 1.815 m

Freeboard is from the top of the deck line to the summer load line: 9.000 + 0.015 - 7.200 = 1.815 m.

114. B. 2961 t

Ratio = (110 x 17 x 9.5)/(100 x 16 x 9) = 17 765/14 400 = 1.234; steel = 2400 x 1.234 = 2961 t.

115. C. Short, violent rolling that strains lashings

A large GM makes the ship stiff, with a short roll period and rapid accelerations that stress cargo, crew and structure.

116. B. Floodable length times the factor of subdivision

Permissible length = floodable length x factor of subdivision, which gives a margin below the floodable length.

117. D. A safety management system

The International Safety Management Code requires a documented safety management system for safe operation and pollution prevention.

118. A. Maritime Industry Authority (MARINA)

MARINA, created in 1974, regulates the domestic merchant fleet, shipbuilding and ship repair; the PPA manages ports.

119. A. BM rises sharply, roughly with beam squared

BM = I/V and waterplane inertia varies with B^3; with volume roughly fixed per unit beam, BM grows about with B^2, raising GM.

120. C. 12 000 m3

Volume = mass x stowage factor = 8000 x 1.5 = 12 000 m3.

Topics to review

• Hydrostatics, buoyancy and vessel stability

• Ship resistance and propulsion

• Hull structures and construction

• Ship design, regulation and safety

Online question banks and study resources

Naval Architecture - Pass Harbor (Question bank)

Official PRC board information

Current PRC exam programs

Independent study material prepared by Board Exam Desk.