

METEOROLOGY & OCEANOGRAPHY

A USCG Deck Officer Study Guide with Worked Explanations — Third Mate through Master

The National Maritime Center's published meteorology and oceanography questions, each with the correct key and a full paragraph explaining *why* that answer is right and the others are not — followed by a management-level practice set for the Chief Mate / Master candidate. Read the question, commit to an answer, then read the explanation; the reasoning is what transfers to the questions you have not seen.

How the meteorology exam is actually structured

At the **operational level** (Third Mate / Second Mate of unlimited tonnage, exam code ONC02) the NMC publishes no standalone 'Advanced Meteorology' module. All weather and oceanography items sit inside the Navigation General modules — **Q114 Navigation General – Oceans** and **Q113 Navigation General – Near Coastal** — mixed in with buoyage, chartwork and celestial. The 51 questions here are the meteorology and oceanography items pulled from those two sample exams. At the **management level** (Master / Chief Mate, exam code ONC01) meteorology again lives within the Navigation General modules, and in addition **Advanced Meteorology** is a required training course under 46 CFR 11.305(a)(3)(iii) and 11.307(a)(3)(iii) (IMO Model Course 7.01), covering weather systems, tropical revolving storms and the avoidance of storm centres and dangerous quadrants, ocean currents, and weather routing. Part Three below is a practice set at that level. Passing standard: most deck modules require **70%**; Rules of the Road requires 90%.

Two working cautions carried over from the source set: the maneuvering-board items (storm-avoidance CPA and true-wind problems — questions 13, 26, 39, 42 and 50) cannot be solved by inspection; they need a maneuvering board and the Bowditch / Pub 217 construction, and the explanations say so rather than pretending otherwise. And two items reference illustration D041NG (WS Form B-80), which is a Coast Guard plate not reproduced here.

PART ONE

Q114 Navigation General – Oceans

Topic areas: characteristics of weather systems · ocean current systems · weather charts and reports · tides and tidal currents.
Sample exam rev. 8/11/2026.

BUYS BALLOT'S LAW · NMC Q3

1. You are steaming eastward in the North Atlantic in an extratropical cyclonic storm and the wind is dead ahead. According to the law of Buys Ballot, where does the center of the low pressure lie?

- A. Astern of you
- B. To the south**
- C. To the north
- D. Directly ahead of you

Answer: B

Why. Buys Ballot's law says that in the Northern Hemisphere, if you stand with your back to the wind, the centre of low pressure lies to your left. Steaming east with the wind dead ahead means the wind is out of the east (from 090). Turn your back to it — you now face west (270) — and your left hand points south. So the low lies to the south. It is the same tool you would use to fix a storm centre from one wind observation; only the hemisphere flips the hand.

HUMIDITY · NMC Q5

2. Relative humidity is the percentage of water vapor that is in the air as compared to the maximum amount it can hold at _____.

- A. a specific wind speed
- B. a specific barometric pressure
- C. a specific temperature**
- D. any time

Answer: C

Why. Relative humidity is a ratio — the vapour actually present against the maximum the air could hold — and that maximum is set almost entirely by temperature, because warm air holds far more vapour than cold. So RH is always referenced to a specific temperature. Warm a parcel without adding any moisture and its RH falls even though the water content is unchanged; cool it and RH climbs until, at the dew point, it reaches 100%.

WAVE TERMINOLOGY · NMC Q6

3. What is the distance from the bottom of a wave trough to the top of a wave crest?

- A. Wave length
- B. Wave height**
- C. Wave breadth
- D. Wave depth

Answer: B

Why. Wave height is the vertical distance from the bottom of the trough to the top of the crest — the figure that governs freeboard, slamming and comfort. Do not confuse it with wavelength (the horizontal crest-to-crest distance) or period (the time between crests). 'Breadth' and 'depth' are not standard wave terms and are pure distractors.

PRESSURE SYSTEMS · NMC Q10

4. Which term is used to describe a generally circular low-pressure area?

- A. An occluded front
- B. A cold front
- C. An anticyclone
- D. A cyclone**

Answer: D

Why. A cyclone is simply a low-pressure area with a roughly circular closed circulation — the general term, tropical or not. An anticyclone is its opposite, a high. An occluded front and a cold front are fronts, not areas, so neither can describe a circular pressure centre. Note that 'cyclone' by itself carries no tropical meaning; that requires the full phrase 'tropical cyclone'.

AIR MASSES · NMC Q12

5. Which is a characteristic of warm air masses?

- A. Heavy precipitation
- B. Turbulence within the mass
- C. Good visibility
- D. Stratiform clouds**

Answer: D

Why. On these exams a 'warm air mass' means warm air lying over a cooler surface, which chills it from below and makes it stable. Stable air resists vertical motion, so it forms flat, layered stratiform cloud along with drizzle, haze and poor visibility. The turbulence, showers and good visibility offered in the other choices are the signature of a cold air mass (cold air over a warmer surface), which is unstable.

GLOBAL CIRCULATION · NMC Q13

6. Which is an area of strong westerly winds occurring between 40°S and 60°S latitude?

- A. Prevailing westerlies
- B. Jet streams
- C. Polar easterlies
- D. Roaring forties**

Answer: D

Why. The question wants the named Southern-Ocean belt between about 40°S and 60°S — the Roaring Forties — famous for persistent strong westerlies uninterrupted by land. 'Prevailing westerlies' is the generic circulation term and not what is asked; the polar easterlies lie poleward of 60°; and the jet stream is an upper-air feature, not a surface belt.

TROPICAL CYCLONES · NMC Q20

7. The hurricane season in the North Atlantic Ocean reaches its peak during which month?

- A. June
- B. November
- C. July
- D. September**

Answer: D

Why. The Atlantic hurricane season runs 1 June to 30 November, and its climatological peak falls around 10 September, when sea-surface temperatures are highest and shear is typically lowest. So September is the peak month. June and November sit at the shoulders of the season, and July is early and comparatively quiet.

TROPICAL CYCLONE AVOIDANCE · NMC Q21

8. In a tropical cyclone in the Northern Hemisphere, a vessel hove to with the wind shifting counterclockwise, would be in which location?

- A. In the navigable semicircle**
- B. Ahead of the storm
- C. Directly in the path of the center
- D. In the dangerous semicircle

Answer: A

Why. In the Northern Hemisphere a wind that backs (shifts counter-clockwise) over time places you in the left, navigable semicircle. A veering (clockwise) wind means the right, dangerous semicircle, and a steady direction with a falling barometer means you are in the storm's path. Backing wind therefore equals the navigable side — answer A.

CLOUD INTERPRETATION · NMC Q25

9. Which type of weather could you expect soon after seeing "hook" or "comma" shaped cirrus clouds?

- A. The formation of a tropical depression
- B. Continuing fog and rain
- C. Clearing with the approach of a cold front
- D. Rain with the approach of a warm front**

Answer: D

Why. Hooked or comma-shaped cirrus is the very leading edge of a warm front's cloud sequence — cirrus, then cirrostratus, altostratus and finally nimbostratus with steady rain. It therefore warns of rain with an approaching warm front, often a day or more ahead. It is not a tropical-depression sign, and clearing behind a cold front is the opposite situation.

BAROMETRY · NMC Q30

10. Which of the following is a standard correction applied to the reading of an aneroid barometer?

- A. Height**
- B. Temperature
- C. Latitude
- D. Wind speed

Answer: A

Why. An aneroid barometer takes a height (elevation) correction to reduce its reading to sea level so it can be compared with other stations. Temperature, latitude and index corrections belong to the mercurial barometer, whose mercury column expands with heat and whose effective gravity varies with latitude. Wind speed is not a barometric correction at all.

WIND OBSERVATION · NMC Q31

11. What does a wind vane on a moving vessel show?

- A. The dead reckoning wind direction
- B. The estimated wind direction
- C. The apparent wind direction**
- D. The true wind direction

Answer: C

Why. Anything mounted on a moving vessel — a vane or an anemometer — reads the apparent (relative) wind, the vector sum of the true wind and the wind created by the ship's own motion. To recover the true wind you must vectorially remove the ship's course and speed, on a maneuvering board or by calculator. 'DR wind' and 'estimated wind' are not quantities a vane shows.

CURRENTS · NMC Q32

12. Which term refers to the direction a current is flowing?

- A. Stand
- B. Drift
- C. Set**
- D. Vector direction

Answer: C

Why. Set is the direction toward which a current flows; drift is its speed. Keep the convention straight, because it trips everyone: wind is named for where it comes FROM, but current is named for where it flows TO. 'Stand' is a tidal term (slack water) and 'vector direction' is not standard usage.

TROPICAL CYCLONE AVOIDANCE · NMC Q34

13. You are underway on course 050°T and your maximum speed is 11 knots. The eye of a hurricane bears 070°T, 80 miles from your position. The hurricane is moving towards 270°T at 19 knots. What course should you steer at 11 knots to have the maximum CPA?

- A. 234°
- B. 227°
- C. 250°
- D. 215°**

Answer: D

Why. This is a maneuvering-board problem, not one you can eyeball. Plot the eye's position and the storm's true motion (270° at 19 kt), construct the relative-motion line as seen from your ship, then test own-ship courses to find the one that pushes the storm's relative track farthest from you — the maximum CPA. The Bowditch / Pub 217 construction yields 215°, which also keeps you on the navigable side while opening the range.

FRONTS · NMC Q35

14. What type of clouds are associated with a cold front?

- A. Altostratus and cirrus
- B. Altostratus and fracto-cumulus
- C. Cirrus and cirrostratus
- D. Cumulus and cumulonimbus**

Answer: D

Why. A cold front has a steep leading slope that shoves the warm air upward violently, so it builds convective cloud — cumulus and cumulonimbus — with squalls, hail and short, heavy bursts of rain. The gentle stratiform families (cirrus, cirrostratus, altostratus) belong to the warm front. Convective cloud with a cold front is the reliable pairing.

BAROMETRY · NMC Q38

15. Which name is given to the pressure-sensitive element of an aneroid barometer?

- A. Constant pressure capsule
- B. Sylphon cell**
- C. Column of mercury
- D. Pressure bellows

Answer: B

Why. The pressure-sensitive element of an aneroid is the sylphon cell — an evacuated, corrugated metal capsule that flexes as atmospheric pressure changes. 'Column of mercury' describes the mercurial barometer, and the remaining choices are invented terms. This is purely a vocabulary question — know the word verbatim.

FOG · NMC Q43

16. Steam fog will occur when which conditions exists?

- A. Cool rain passes through a warm air mass
- B. Warm dry air from shore passes over cooler water
- C. Extremely cold air from shore passes over warmer water**
- D. Cold ocean water evaporates into warm air

Answer: C

Why. Steam fog (also sea smoke or arctic sea smoke) forms when very cold air moves over much warmer water: the water evaporates and immediately recondenses in the cold air just above the surface, so the sea appears to steam. It is the mirror image of advection fog, where warm moist air moves over cold water. Only choice C describes that cold-air-over-warm-water setup.

OCEAN CURRENTS · NMC Q51

17. What natural feature is responsible for the rather even climate found on the Florida peninsula throughout the year?

- A. The Gulf Stream**
- B. Strong masses of continental air
- C. The cool waters of the Sargasso sea
- D. The Bermuda high

Answer: A

Why. The Gulf Stream, a warm western-boundary current, runs close along Florida and moderates the peninsula's air temperature year-round, giving its notably even climate. The Sargasso Sea is not cold; strong continental air masses make a climate more extreme, not even; and the Bermuda High steers weather but is not the heat reservoir doing the moderating.

WEATHER BROADCASTS · NMC Q52

18. Which is TRUE concerning weather information?

- A. Weather information is available on scheduled marine information broadcasts
- B. It is available through VHF-FM continuous marine weather broadcasts provided by the National Weather Service
- C. Weather information is available through commercial radio broadcasts
- D. All of the above**

Answer: D

Why. Marine weather reaches you through scheduled marine information broadcasts, the National Weather Service's continuous VHF-FM weather channels, and commercial radio — all valid sources. Because each individual option is legitimate, 'all of the above' is the correct answer.

CLOUDS AND PRECIPITATION · NMC Q53

19. Which type of cloud is hail most likely to fall from?

- A. Nimbostratus
- B. Cumulonimbus**
- C. Altocumulus
- D. Cumulus

Answer: B

Why. Hail requires the deep vertical development and powerful updrafts that only a mature cumulonimbus provides — strong enough to carry droplets up repeatedly through the freezing level until they grow heavy enough to fall. Nimbostratus gives steady rain, while altocumulus and ordinary cumulus lack the updraft strength. The cumulonimbus is the hail cloud.

TIDES · NMC Q57

20. The datum from which the predicted heights of tides are reckoned in the tide tables is _____.

- A. the same as that used for the charts of the locality**
- B. given in table three of the tide tables
- C. mean low water
- D. the highest possible level

Answer: A

Why. The tide tables are reckoned from the same sounding datum as the local chart, so a predicted tidal height adds directly to a charted depth to give the water you actually have. Do not answer 'mean low water' by reflex — U.S. charts and tables use mean lower low water (MLLW). Sharing the datum with the chart is the operationally correct answer.

WIND SHIFTS · NMC Q63

21. A weather forecast states that the wind will commence veering. In the Northern Hemisphere, what changes will occur?

- A. The wind will increase in velocity
- B. The wind will shift in a counterclockwise manner
- C. The wind will continue blowing from the same direction
- D. The wind will shift in a clockwise manner**

Answer: D

Why. Veering means the wind shifts clockwise (for example S → SW → W); backing means counter-clockwise. The definitions are identical in both hemispheres — only the tactical meaning (which semicircle of a storm you are in) flips. So a veering wind shifts in a clockwise manner.

PUBLICATIONS · NMC Q65

22. The National Oceanic and Atmospheric Administration publishes which item?

- A. Pilot charts
- B. Sailing Directions
- C. Light Lists
- D. Coast Pilots**

Answer: D

Why. NOAA publishes the Coast Pilots, along with the U.S. tide tables and NOAA charts. Pilot Charts and Sailing Directions come from NGA, and the Light Lists come from the U.S. Coast Guard. Match the product to the agency: NOAA → Coast Pilots.

WAVE TERMINOLOGY · NMC Q70

23. Which term is used to describe the time interval between successive wave crests?

- A. Period
- B. Frequency
- C. Trough
- D. Epoch

Answer: A

Why. Wave period is the time interval, in seconds, between successive crests passing a fixed point. Frequency is its reciprocal (cycles per second) and is not the quantity asked for; trough and 'epoch' do not describe that interval. Period is also your swell range-finder — deep-water wave speed in knots is roughly 1.5 times the period.

PART TWO

Q113 Navigation General – Near Coastal

Topic areas: characteristics of weather systems · ocean current systems · weather charts and reports · tides and tidal currents.
Sample exam rev. 8/5/2025.

FOG · NMC Q1

24. Which fog is produced by warm moist air passing over a cold surface?

- A. Conduction fog
- B. Frontal fog
- C. Radiation fog
- D. Advection fog

Answer: D

Why. Advection fog forms when warm, moist air is carried horizontally over a colder surface that chills it to its dew point — the Grand Banks and California-coast mechanism, and the fog that persists in a wind because the wind keeps feeding in new moist air. 'Advection' means horizontal transport. Radiation fog is a calm-night land phenomenon, and the other two are not standard fog types.

PRESSURE · NMC Q5

25. Pressure gradient is a measure of _____.

- A. pressure difference over horizontal distance
- B. vertical pressure variation
- C. a high-pressure area
- D. pressure difference over time

Answer: A

Why. Pressure gradient is the change in pressure over horizontal distance — how tightly the isobars are packed. Tight spacing means a strong gradient and strong wind; wide spacing means light wind. It is a horizontal measure (not vertical) and it is per unit distance (not per unit time).

TROPICAL CYCLONE AVOIDANCE · NMC Q6

26. You are underway on course 120°T and your maximum speed is 12 knots. The eye of a hurricane bears 150°T, 120 miles from your position. The hurricane is moving towards 295°T at 20 knots. If you maneuver at 12 knots to avoid the hurricane, what could be the maximum CPA?

- A. 89 miles
- B. 96 miles
- C. 105 miles
- D. 117 miles**

Answer: D

Why. Another maneuvering-board avoidance problem. Plot the eye's bearing and range (150°T, 120 mi) and the storm's motion (295°T at 20 kt), build the relative-motion line, then choose the own-ship course at 12 kt that maximises the perpendicular distance from you to that line — the maximum CPA, here about 117 miles. It cannot be found by inspection; it needs the plot.

TROPICAL CYCLONE AVOIDANCE · NMC Q7

27. If you are caught in the left semicircle of a tropical storm, in the Southern Hemisphere, which action should you take?

- A. Place the wind on the port bow, and make as much way as possible**
- B. Place the wind on the starboard quarter, hold course and make as much way as possible
- C. Place the wind 2 points on the port quarter, and make as much way as possible
- D. Place the wind dead ahead and heave to

Answer: A

Why. In the Southern Hemisphere the LEFT semicircle is the dangerous one — the mirror of the north. The dangerous-semicircle tactic there is to bring the wind onto the port bow and make all possible way, which works the vessel out ahead of and away from the track. Putting the wind on the starboard quarter is the navigable-side (run) tactic, and heaving to surrenders the sea room you need.

PRESSURE SYSTEMS · NMC Q12

28. Two well-developed high-pressure areas may be separated by which item?

- A. A ridge of low pressure
- B. A hill of low pressure
- C. A valley of low pressure
- D. A trough of low pressure**

Answer: D

Why. A trough is an elongated area of low pressure, and that is exactly what lies between two well-developed highs. A ridge is the high-pressure analogue and cannot separate two highs; 'hill' and 'valley' of low pressure are not standard terms. (The saddle point between two highs and two lows is a col, but that was not offered.) Trough = elongated low.

PRECIPITATION AND DEPOSITS · NMC Q13

29. Which term describes a light, feathery deposit of ice by sublimation of water vapor directly into the crystalline form on objects whose temperatures are below freezing?

- A. Snow
- B. Frost**
- C. Glaze
- D. Dew

Answer: B

Why. Frost is water vapour turning directly into ice crystals (deposition, or sublimation) on surfaces whose temperature is below freezing — a light, feathery deposit. Glaze is liquid that freezes on contact; dew is liquid condensation above freezing; snow forms aloft within cloud. Vapour straight to solid on a cold surface is frost.

BAROMETRY · NMC Q16

30. What is the purpose of the "reference hand" on an aneroid barometer?

- A. To adjust the barometer
- B. To provide a correction for height above sea level
- C. To provide a correction for temperature changes
- D. To indicate any change in the reading of the barometer**

Answer: D

Why. The reference (or set) hand of an aneroid is a manually positioned pointer you park over the current reading so that, at a glance later, you can see how far and which way the needle has moved — the tendency. It corrects nothing; it simply marks a datum for reading the change, and the change is what actually forecasts the weather.

BAROMETRY · NMC Q22

31. Barometer readings in weather reports are given in terms of pressure at which reference location?

- A. Washington, D.C.
- B. The broadcasting station
- C. Sea level**
- D. The weather station

Answer: C

Why. Weather-report pressures are all reduced to sea level so that stations at different elevations can be compared and isobars drawn meaningfully. The value is not referenced to Washington, to the station's own elevation, or to the broadcaster — it is standardised to sea level.

TIDES · NMC Q23

32. Which is TRUE concerning the occurrence of Spring tides?

- A. They occur only when the Sun and Moon are on the same side of the Earth and nearly in line
- B. They occur when the Sun, Moon, and Earth are nearly in line, in any order**
- C. They commence at the start of spring, when the Sun is nearly over the equator
- D. They occur when the Sun and Moon are at approximately 90° to each other as seen from the Earth

Answer: B

Why. Spring tides occur at syzygy — when the Sun, Moon and Earth are nearly in line — which happens at BOTH new moon and full moon, in any order of Sun and Moon. That is why choice A is the trap: it excludes the full-moon case. Springs have nothing to do with the calendar season; the name means 'to spring up'.

WEATHER CHARTS · NMC Q25

33. On a working copy of a weather map what color is the line that represents a stationary front?

- A. Alternating red and blue**
- B. Blue
- C. Purple
- D. Red

Answer: A

Why. On a working weather map a stationary front is drawn as an alternating red-and-blue line, with warm semicircles and cold triangles on opposite sides. Cold fronts are blue, warm fronts red, and occlusions purple. Alternating red/blue therefore signifies a stationary front.

GLOBAL CIRCULATION · NMC Q28

34. The southeast trade winds actually blow in which direction?

- A. Southeast
- B. South
- C. East
- D. Northwest**

Answer: D

Why. Winds are named for the direction they come FROM, so the 'southeast trades' blow FROM the southeast TOWARD the northwest. The question asks for the direction of travel, which is northwest. This naming convention is the entire point of the item.

AIR MASSES · NMC Q29

35. Which is TRUE concerning air masses near the earth's surface?

- A. They are not deflected by the earth's rotation
- B. They move from areas of high pressure to areas of low pressure**
- C. Air masses are not affected by the earth's gravity
- D. In North America the air masses move from east to west

Answer: B

Why. Surface air moves from high pressure toward low pressure, down the pressure gradient — then it is deflected by Coriolis and slowed by surface friction, which is why the surface wind crosses the isobars slightly toward the low. Air is deflected by the earth's rotation, it is subject to gravity, and in North America systems generally move west to east, so the other three statements are false.

WEATHER PRODUCTS · NMC Q31

36. Plain language is usually used on marine weather _____.

- A. observations
- B. forecasts**
- C. synoptic chart
- D. analyses

Answer: B

Why. Marine forecasts are issued in plain language so that any mariner can act on them immediately. Observations and analyses, by contrast, are transmitted in code (the synoptic code) or as graphics (charts). Plain language therefore goes with forecasts.

APPARENT WIND · NMC Q34

37. The velocity of the apparent wind can be more than the true wind, and come from the same direction, if certain conditions are present. One condition is that the _____.

- A. true wind must be from dead astern
- B. true wind velocity must be faster than the ship's speed
- C. ship's speed must be less than the true wind velocity
- D. true wind must be from dead ahead**

Answer: D

Why. Apparent wind can exceed the true wind while coming from the same direction only when the true wind is dead ahead — then the ship's speed adds directly to the true wind speed and the direction is unchanged. From any other angle the vectors change the direction as well as the magnitude. Head-on is the special case that keeps the direction constant.

APPARENT WIND · NMC Q37

38. In most cases, the direction of the apparent wind lies between the bow and which reference point?

- A. The direction of the true wind**
- B. The true north
- C. The beam on the lee side
- D. The beam on the windward side

Answer: A

Why. The ship's own motion always drags the apparent wind forward of the true wind, so the apparent wind lies between the bow and the true-wind direction. That is why a boat feels windier and more forward than the true breeze actually is. Apparent is forward of true.

VOLUNTARY OBSERVING SHIP CODING · NMC Q36

39. Your vessel is participating in the Voluntary Observing Ship Program, you are preparing WS Form B-80. The sky is overcast, and the anemometer indicates that the apparent wind is from 144° relative at 8 knots. You are on course 162°T at 15 knots. How should you encode group Nddff?

- A. 01615
- B. 91521
- C. 81408
- D. 83322**

Answer: D

Why. This is a coded-report problem tied to WS Form B-80 (illustration D041NG). In the group Nddff, N is total cloud in oktas (8 = overcast), dd is the TRUE wind direction in tens of degrees, and ff is the TRUE wind speed in knots — so you must first solve the true-wind vector from the apparent wind (144° relative at 8 kt) and the ship's motion (162°T at 15 kt), then encode it. The worked key is 83322.

CLOUDS · NMC Q39

40. What are Cirrus clouds primarily composed of?

- A. Ice crystals**
- B. Nitrogen
- C. Snow crystals
- D. Water droplets

Answer: A

Why. Cirrus are high, cold clouds composed of ice crystals — note the deliberate distractor 'snow crystals', which is wrong, since snow is precipitation rather than cloud composition. Water droplets belong to lower, warmer clouds. Ice crystals is the answer.

WEATHER CHARTS · NMC Q42

41. How is an occluded front represented on a weather map?

- A. A dashed blue line
- B. An alternate red and blue line
- C. A blue line
- D. A purple line**

Answer: D

Why. An occluded front is drawn as a purple line, with alternating triangles and semicircles on the same side, all in purple. It pairs with the stationary-front item — expect one or the other on any given form. Purple signifies an occluded front.

TRUE WIND SOLUTION · NMC Q47

42. Your ship is proceeding on course 320°T at a speed of 25 knots. The apparent wind is from 30° off the starboard bow, speed 32 knots. What is the relative direction, true direction and speed of the true wind?

- A. Relative 40°, true 080°T, 16.4 knots
- B. Relative 80°, true 060°T, 15.2 knots
- C. Relative 60°, true 040°T, 18.6 knots
- D. Relative 80°, true 040°T, 16.2 knots**

Answer: D

Why. A maneuvering-board true-wind construction. Lay off the ship's vector (320°T, 25 kt) and the apparent wind (30° off the starboard bow, 32 kt), then close the triangle to read the true wind — relative 80°, true 040°T, 16.2 kt. The identical item also appears in the Oceans set; drill the Bowditch construction until it is automatic.

LIFTING MECHANISMS · NMC Q50

43. Which term is given to the mechanical lifting of air by the upslope slant of the terrain?

- A. Advective lifting
- B. Convective lifting
- C. Vertical lifting
- D. Topographic lifting**

Answer: D

Why. Air forced up the slope of rising terrain is topographic lifting (also called orographic) — and the NMC key uses the word 'topographic'. Convective lifting is thermal (heated ground); advective lifting is horizontal transport; 'vertical lifting' is not a named mechanism. Terrain-forced ascent is topographic.

INSTRUMENTS · NMC Q55

44. What does a barometer measure?

- A. Temperature
- B. Relative humidity
- C. Dew point
- D. Atmospheric pressure**

Answer: D

Why. A barometer measures atmospheric pressure — full stop. Temperature is read by a thermometer, humidity by a hygrometer, and dew point is derived from wet- and dry-bulb readings. This is a free point; do not overthink it.

STORM LOCATION · NMC Q60

45. How can you estimate the position of a tropical storm's center?

- A. Observe the wind direction and apply Buys Ballot's law
- B. Using shipboard radar
- C. With a radio weather bulletin or weather fax
- D. All of the above**

Answer: D

Why. You can locate a tropical storm's centre by wind direction with Buys Ballot's law, by shipboard radar (which shows the eye directly once you are within roughly 100 nm), and by radio weather bulletins or weather fax. All three methods are legitimate, so 'all of the above' is correct.

WAVES · NMC Q62

46. Swell is the rise and fall of the ocean's surface due to _____.

- A. the pull of the moon
- B. local storms
- C. fetch
- D. distant winds**

Answer: D

Why. Swell is the smooth, long-period sea generated by distant winds that has outrun its generating area — the forerunner of far-off weather. The locally wind-driven, short, steep component is called 'sea'; the moon's pull produces the tide; and fetch is one of the ingredients that build waves, not the definition of swell. Distant winds produce swell.

TIDES · NMC Q63

47. Which class of tide prevails in the greatest number of important harbors on the Atlantic Coast?

- A. Semidiurnal**
- B. Mixed
- C. Interval
- D. diurnal

Answer: A

Why. Semidiurnal tides — two nearly equal highs and lows each day — prevail in most important Atlantic-coast harbours. The West Coast is mixed (unequal highs and lows) and much of the Gulf is diurnal (one cycle a day). The East Coast is semidiurnal.

HUMIDITY · NMC Q66

48. Which is TRUE as the temperature for a given mass of air increases?

- A. The dew point increases
- B. The relative humidity decreases**
- C. The relative humidity increases
- D. The dew point decreases

Answer: B

Why. Warm a given parcel of air without adding moisture and its capacity to hold vapour rises, so the relative humidity FALLS. The dew point, fixed by the actual vapour content, does not change. So as temperature rises, RH decreases — the same physics as question 2, asked the other way round.

CIRCULATION AROUND LOWS · NMC Q67

49. If a weather bulletin shows the center of a low-pressure system to be 100 miles due east of you, what winds can you expect in the Southern Hemisphere?

- A. North-northeasterly
- B. South-southwesterly**
- C. South-southeasterly
- D. North-northwesterly

Answer: B

Why. In the Southern Hemisphere air circulates clockwise and inward around a low. With the centre 100 miles due east of you, the clockwise inflow at your position arrives from roughly the south-southwest. (In the Northern Hemisphere, with counter-clockwise flow, it would be the reverse.) Sketch the low to the east and the clockwise arrows and SSW falls out.

TRUE WIND SOLUTION · NMC Q68

50. A ship is on course 195 at a speed of 15 knots. The apparent wind is from 40° on the port bow, speed 30 knots. What are the direction and speed of the true wind?

- A. 068°T, 30 knots
- B. 127°T, 21 knots**
- C. 263°T, 42 knots
- D. 292°T, 42 knots

Answer: B

Why. A maneuvering-board true-wind problem: ship 195°T at 15 kt, apparent wind 40° on the port bow at 30 kt. Constructing the triangle gives 127°T at 21 kt. Two quick sanity checks kill the wrong answers before you even plot — the true wind must lie abaft the apparent wind and must be slower than the 30-kt apparent (because the ship's motion added to it), which eliminates the 42-kt options C and D at once.

GLOBAL CIRCULATION · NMC Q70

51. What wind reverses directions seasonally?

- A. Secondary winds
- B. Monsoon winds**
- C. Hooked trades
- D. Jet stream

Answer: B

Why. Monsoon winds reverse direction seasonally, driven by the differential heating of land and sea: the land heats and draws a moist onshore flow in summer, then cools and pushes a dry offshore flow in winter, reversing the pressure gradient. The jet stream, the trades and 'secondary winds' do not reverse with the seasons in that way. Monsoon means the seasonal reversal.

PART THREE

Management Level — Master / Chief Mate Practice Set

These fifteen items are **instructor-written practice questions** in the NMC format, aligned to the Navigation General meteorology topics of the ONC01 (Master / Chief Mate) examination and to the Advanced Meteorology course competencies (46 CFR 11.305 / 11.307; IMO Model Course 7.01): tropical revolving storm avoidance and dangerous quadrants, upper-air and synoptic analysis, weather routing, wave and swell forecasting, and ocean currents. They are written for study and are not reproductions of the current Coast Guard answer key — verify against live NMC material before using them in a formal course.

TROPICAL CYCLONE MANEUVERING

M1. You are in the Northern Hemisphere in the dangerous (right) semicircle of a tropical cyclone, with sea room. Which action is correct?

- A. Put the wind on the starboard quarter and run before it
- B. Bring the wind 1 to 4 points on the starboard bow and make all possible way**
- C. Put the wind dead astern and run
- D. Heave to with the wind on the port bow

Answer: B

Why. In the Northern-Hemisphere dangerous semicircle the classic rule is to keep the wind about one to four points (roughly 10–45°) on the starboard bow and make as much way as possible, which works the vessel out ahead of the advancing centre and away from the track. Running with the wind on the starboard quarter is the NAVIGABLE-semicircle tactic; used in the dangerous semicircle it would carry you across the storm's path.

TROPICAL CYCLONE AVOIDANCE**M2. The mariner's '1-2-3 rule' for tropical cyclone avoidance refers to:**

- A. Adding roughly 100/200/300 NM to the forecast 34-kt wind radius at 24/48/72 hours**
- B. Carrying three days of provisions per person
- C. Keeping the wind 1, 2 or 3 points off the bow
- D. The pressure fall that defines explosive deepening

Answer: A

Why. The 1-2-3 rule is a danger-area rule of thumb: add about 100 NM at 24 h, 200 NM at 48 h and 300 NM at 72 h to the forecast 34-kt wind radius to bound the track-forecast uncertainty. The U.S. National Hurricane Center formally withdrew the specific construction in 2016 as over-simplified, but it survives as a useful mental check — in practice, plot the published wind radii and stay outside the 34-kt field.

UPPER-AIR STEERING**M3. A surface low is steered by, and tends to deepen fastest beneath, which feature?**

- A. The 1000-mb surface isobar
- B. An upper-level ridge
- C. A region of divergence ahead of the 500-mb trough**
- D. The subtropical high

Answer: C

Why. Mid-latitude surface lows travel roughly parallel to the 500-mb flow and deepen where the upper air diverges — classically downstream (ahead) of the 500-mb trough — because upper divergence removes air from the column faster than the surface converges it, so surface pressure falls. A ridge aloft suppresses development, and neither the surface isobar nor the subtropical high does the steering.

THICKNESS CHARTS**M4. The 1000–500-mb thickness line most often used at sea to separate rain from snow is approximately:**

- A. 5100 m
- B. 5400 m**
- C. 5700 m
- D. 6000 m

Answer: B

Why. The 1000–500-mb thickness is a direct measure of the mean temperature of the lower half of the atmosphere; the 5400-metre (540-decametre) line is the classic rain/snow divider over the ocean — below it the column is cold enough for snow, above it rain. Greater thickness means a warmer column.

EXPLOSIVE CYCLOGENESIS**M5. Explosive cyclogenesis (a meteorological 'bomb') is defined as a central-pressure fall of at least:**

- A. 24 mb in 24 hours (normalised for latitude)**
- B. 10 mb in 24 hours
- C. 24 mb in 12 hours
- D. 50 mb in 24 hours

Answer: A

Why. A 'bomb' is a rapid deepening of about 24 mb in 24 hours, formally normalised by latitude ($24 \times \sin\phi / \sin 60^\circ$). It happens when a surface low sits under a strong divergent jet with a steep temperature contrast — often just off the U.S. east coast in winter — and it raises gale-to-storm winds very quickly, which is why the tendency, not just the height of the glass, is what you watch.

WEATHER ROUTING

M6. The primary aim of optimum ship weather routing is to:

- A. Always steer the great-circle track
- B. Find the least-time or least-damage track through the forecast weather**
- C. Avoid all winds over 20 knots
- D. Follow the rhumb line to save fuel

Answer: B

Why. Weather routing seeks the most efficient safe track — usually least time, sometimes least motion/damage or least fuel — through the weather actually forecast, which may be longer in distance than the great circle. It is not about rigidly following any one sailing or dodging every breeze; it trades distance for better conditions and, above all, shaves off the crossings that go badly wrong.

ISOCHRONE METHOD

M7. In the isochrone method of least-time routing, an isochrone is:

- A. A line of equal atmospheric pressure
- B. A line joining the points the ship could reach in a given elapsed time**
- C. A line of equal wave height
- D. The great-circle track between departure and destination

Answer: B

Why. An isochrone is the locus of farthest points the vessel could reach in a set time step, given the speed she can make in the forecast sea on each heading. Successive isochrones are stepped forward until one touches the destination, then the track is back-traced. Where a gale slows the ship the isochrone develops a notch, and the least-time track runs around the outside of it — which is all a routing computer is doing, faster and in more places.

WAVE STATISTICS

M8. 'Significant wave height' is defined as:

- A. The single highest wave observed
- B. The average height of the highest one-third of the waves**
- C. The average height of all waves
- D. Twice the swell height

Answer: B

Why. Significant wave height (H_s) is the average height of the highest one-third of the waves, and it closely matches what a trained observer reports by eye. It is not the maximum — in a real sea about one wave in ten exceeds H_s , and over a watch you may meet one roughly one-and-a-half to two times H_s . Rig and set up for the wave you will meet once, not for the average one.

SWELL FORECASTING

M9. A swell whose period is observed to shorten over several hours indicates that the generating storm is:

- A. Moving away
- B. Approaching**
- C. Dissipating
- D. Stationary

Answer: B

Why. The longest-period components travel fastest and arrive first, so as a storm closes on you the periods you receive shorten — you are now getting the slower waves whose source is nearer. Lengthening period means the storm is moving away. Watching the trend in swell period and bearing is a deck-level way to track a system still below the horizon.

EXTRATROPICAL TRANSITION

M10. When a hurricane recurves into the mid-latitudes and undergoes extratropical transition, it typically:

- A. Dissipates within a few hours
- B. Loses its warm core, grows fronts, expands, and can accelerate to the northeast**
- C. Intensifies into a Category 5
- D. Reverses course to the west

Answer: B

Why. In extratropical transition the storm trades its warm tropical core for a cold, frontal, baroclinic one — it develops fronts, spreads its wind field over a far larger area, often accelerates to the northeast, and can still throw dangerous gales and seas well away from the old centre. In effect it becomes a vigorous mid-latitude low, which is why a recurving hurricane is not 'over' once it leaves the tropics.

TROPICAL CYCLONE FORMATION

M11. A minimum sea-surface temperature generally required for tropical cyclone development is about:

- A. 18°C
- B. 21°C
- C. 26.5°C**
- D. 30°C

Answer: C

Why. Tropical cyclones generally need sea-surface temperatures of about 26.5°C (80°F) or higher, warm through roughly the top 50 m, to supply the latent heat that drives the warm-core engine. Below that the evaporation–condensation feedback cannot sustain deep convection. Warm water is necessary but not sufficient — low vertical shear and a pre-existing disturbance are also required.

VERTICAL WIND SHEAR

M12. Strong vertical wind shear affects a developing tropical cyclone by:

- A. Strengthening it
- B. Tilting and ventilating the warm core, inhibiting development**
- C. Having no measurable effect
- D. Lowering the sea-surface temperature

Answer: B

Why. Vertical wind shear tilts the storm over and vents its heat downwind, displacing the latent-heat release from over the surface centre and destroying the vertical alignment the system needs — so shear is the single most effective inhibitor of tropical development, and a common reason a promising system never organises. In mid-latitude, baroclinic systems, by contrast, shear is part of the engine, not a brake.

SURFACE VS GEOSTROPHIC WIND

M13. Over the open ocean the surface wind, compared with the geostrophic wind computed from the isobars, is typically:

- A. Equal to it and parallel to the isobars
- B. About 70–80% of it, backed 10–20° across the isobars toward the low**
- C. Stronger than it, and veered
- D. At right angles to the isobars

Answer: B

Why. Friction slows the surface wind to roughly two-thirds to four-fifths of the geostrophic value and lets the pressure-gradient force turn it slightly across the isobars toward lower pressure — about 10–20° over water, nearer 30° over land. That inflow angle is exactly why surface air spirals into a low. The geostrophic wind itself blows parallel to straight isobars.

OCEAN CURRENTS AND SEA STATE

M14. Why can a strong western-boundary current such as the Agulhas or the Gulf Stream produce dangerous seas?

- A. It lowers the air temperature
- B. When a gale raises a sea running against the current, the waves shorten and steepen into abnormally high, breaking seas**
- C. It increases the local tidal range
- D. It produces fog and nothing more

Answer: B

Why. When wind and sea run against a strong current the waves are compressed — shortened and steepened, sometimes into abnormal breaking seas with a deep hollow ahead of them. The Agulhas off South Africa in a south-westerly gale is the textbook ship-breaker; wind against the Gulf Stream off Hatteras is milder but the same physics. Plan to meet such a current with the weather, not against it.

STORM SURGE

M15. In a landfalling Northern-Hemisphere hurricane, the highest storm surge is generally found:

- A. In the left-rear quadrant
- B. In the right-front quadrant relative to the storm's motion**
- C. Exactly at the centre, under the eye
- D. Well inland, ahead of the centre

Answer: B

Why. The worst surge normally sits in the right-front quadrant of a Northern-Hemisphere hurricane, where the storm's forward motion adds to its counter-clockwise circulation so the strongest onshore winds pile water against the coast. The eye's calm and the left side see far less water. South of the equator, mirror it to the left-front quadrant.

ANSWER KEYS

Quick Reference

Operational level — questions 1–51 (NMC published keys)

1: B	2: C	3: B	4: D	5: D	6: D
7: D	8: A	9: D	10: A	11: C	12: C
13: D	14: D	15: B	16: C	17: A	18: D
19: B	20: A	21: D	22: D	23: A	24: D
25: A	26: D	27: A	28: D	29: B	30: D
31: C	32: B	33: A	34: D	35: B	36: B
37: D	38: A	39: D	40: A	41: D	42: D
43: D	44: D	45: D	46: D	47: A	48: B
49: B	50: B	51: B			

Management-level practice set — M1–M15

M1: B	M2: A	M3: C	M4: B	M5: A	M6: B
M7: B	M8: B	M9: B	M10: B	M11: C	M12: B
M13: B	M14: B	M15: B			

Sources and notes

Operational-level questions and keys: NMC sample examinations Q113 Navigation General – Near Coastal (rev. 8/5/2025) and Q114 Navigation General – Oceans (rev. 8/11/2026), exam code ONC02, published by the U.S. Coast Guard National Maritime Center at dco.uscg.mil. USCG sample examinations are U.S. Government works. Exam structure and the Advanced Meteorology course requirement: NMC examinations pages (ONC01 / ONC02) and 46 CFR 11.305(a)(3)(iii) & 11.307(a)(3)(iii). Illustrations referenced in the source PDFs (e.g. D041NG / WS Form B-80) are Coast Guard plates and are not reproduced here. The explanatory paragraphs and the Part Three practice questions are original instructor commentary.

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