



**MERCHANT SHIPPING SECRETARIAT
GOVERNMENT OF SRI LANKA
CERTIFICATE OF COMPETENCY EXAMINATION**

GRADE : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF 500
GT OR MORE (UNLIMITED)

SUBJECT : MARINE METEOROLOGY

DATE : 30th April 2024

Time : 1300 to 1600 hrs

Time allowed **THREE hours**

Total marks : 120

ANSWER ALL QUESTIONS

Pass marks : 50%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required. Electronic devices capable of storing and retrieving are **not** allowed.

1.

a) With the aid of a detailed diagram, briefly explain the principal and construction of an Aneroid barometer.

(10 marks)

b) With regard to an Aneroid barometer, explain the operation and the procedure of taking observations which includes the precautions to be followed during such observations.

(10 marks)

2.

a) Briefly list down the basic conditions required for formation of a TRS.

(06 marks)

b) List the warning signs of a TRS.

(06 marks)

c) In relation to Tropical cyclone describe following:

i. Track

ii. Path

iii. Dangerous semi circle

iv. Navigable semi circle

(02 marks each)

3.

- a) Polar Regions of the earth are having least surface temperature compared to other regions. Explain with suitable diagrams why Polar Regions are colder than equatorial regions.

(08 marks)

- b) Define following meteorological terms:

- i. DALR
- ii. SALR
- iii. Stable air

(04 marks each)

4.

- a) Monsoons in the Indian Ocean seasonally change the weather system in the region. Explain in detail SW /NE monsoon in the Indian Ocean region.

(10 marks)

- b) A ship steering 235° (T) at 16 Knots observes a relative wind six (6) points on the starboard quarter with relative speed 5 Knots.

Determine the true wind speed and the direction from which it is blowing.

(10 marks)

5.

- a) Radiation fog and advection fog are having many different characteristics. Differentiate radiation fog and advection fog.

(10 marks)

- b) There are many processes leading to formation of clouds. Explain what are the main processes leading to formation of clouds?

(10 marks)

6.

- a) Define the "Air mass"?

(03 marks)

- b) What are the factors affecting the air mass?

(04 marks)

- c) What is meant by "Cold Front" and "Warm front"?

(06 marks)

- d) Explain frontolysis with suitable diagrams?

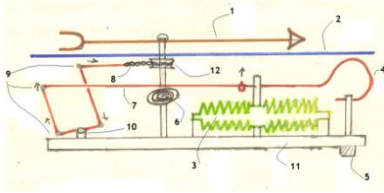
(07 marks)

Answers

1.

a) Illustrate in a sketch with a brief explanation the principal and construction of Aneroid barometer.

The Aneroid barometer



1. Pointer
2. Dial face
3. Vacuum capsule
4. spring
5. adjust meant screw
6. Hairs spring
7. lever system
8. fine chain
9. pivots
10. Fulcrum
11. Substantial back plate
12. Spindle Pulley

Principal :-

As the atmospheric pressure changes, it alters the physical shape of a partially evacuated (Partially vacuumed) Capsule. The capsule is prevented from collapsing by a spring which is attached to the top surface of the capsule. The movement of the capsule is magnified by a lever system. This is attached to the pointer spindle by a fine chain which is kept in tension by a hair spring.

Construction:-

The Capsule spring lever and pointer system are all attached to a substantial back plate. The dial is protected by a glass face. Adjustments to the readings are accompanied by altering the tension in the spring.

(20 marks)

b) Explain its operation and procedure for observation and Precautions during observations.

Operation:-

The aneroid barometer is normally mounted on a vertical bulkhead. Before reading, the glass face is gently tapped to free any constriction of the fine chain around the spindle pulley. The reading is obtained by the pointer against a circular graduated face. Most Aneroid Barometers are compensated for temperature, but have to be corrected for height (approx 1mb/ 10M) and for index error, at different pressure readings.

The Atmospheric Pressure what is recorded in the OLB by the OOW is the pressure corrected to at sea level, i.e. the pressure at barometer level has to be reduced at a rate of 1mb / 10 M and recorded.

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2. Briefly list down the basic conditions required for formation of a TRS.

- For the formation and development of tropical cyclone considerable amount of energy is required.
- Mainly this energy being supplied by the process of condensation.
- That is when water vapour becoming water droplets latent heat is released to the atmosphere.
- This latent heat is the one of the main energy source for the formation of tropical cyclones.
- Sufficiently warm temperatures: Normally an ocean temperature of 26.5°C is the minimum requirement for TRS formation.
- Potentially unstable atmosphere: There must be an atmosphere that cools quickly with height, so that it becomes potentially unstable. If the air is unstable, then it will continue rising and the disturbance will grow.
- High relative humidity :A necessary amount of relative humidity must be present in the lower to middle levels of the troposphere. The required amount of humidity is about 50 to 60%.
- Adequate value of Coriolis Effect: It has been observed that TRS does not form within 3 degrees latitude from the equator, as Coriolis effect is negligible at the equator. So a minimum distance of 500 km from the equator is normally needed to form TRS.
- Largest low pressure: Pressure must be lowered with largest amount and this LP area must be surrounded by areas of HP, which is required for preexisting near-surface disturbance.
- Limited vertical wind shear: Limited vertical wind shear can be positive for tropical cyclone formation. This amount should be less than 10 m/s between the surface and the tropopause. On other hand, strong wind shear can blow the tropical cyclone apart.

(10 marks)

List down 8 warning signs of TRS.

- i. Heavy and long swell from Cyclone center.
- ii. Pressure will be very much lower than the normal. TRS becomes confirm, when barometric pressure is lower then normal 5 mb along with other TRS confirmation factors.
- iii. Cirrus cloud will be at sky.
- iv. At sunset time cloud color will be red or copper.
- v. Clouds will be dense and heavy with threatening appearances.
- vi. Frequent lighting will be experienced.

- vii. Availability of storm warnings from local authority.
- viii. Occurrence of squalls, which are increasing in frequency and intensity.
- ix. Possibility of rain with violent torrential character.
 - x. Sea waves are becoming heavy and dangerous.
 - xi. Shift of wind direction, in accordance with the rotation of winds of cyclonic spin.
 - xii. The absence of diurnal variation

In relation to Tropical cyclone describe following

- i. **Track:** is the route over which the storm center has already passed.
- ii. **Path:** Predicted route over which the storm center is likely to travel.
- iii. **Dangerous semi circle:** Is the RHSC in the NH and LHSC in the SH.
- iv. **Navigable semi circle:** Is the LHSC in the NH and RHSC in the SH.

3.

- a. Polar regions of the earth are having least surface temperature compared to other regions. Explain with suitable diagrams why polar regions are colder than equatorial regions.
 - Curvature of the earth
 - Tiltation of earths spinning axis
 - i. Earth is a spheroid and due to its curvature Unit energy spread at equatorial regions is higher than polar regions.
 - ii. Hence equatorial regions become warmer than the polar regions.
 - iii. Secondly earth spinning axis is tilted 23.5 deg to its perpendicular.
 - iv. This causes unequal length of day and night over earth surface.
 - v. Equatorial regions throughout the year receives the sunlight but higher latitudes which is over 66.5 deg will receives the sunlight only during summer.
 - vi. Due to these effects polar regions are colder than equatorial regions.

(15 marks)

- b. Define following meteorological terms

DALR

- The dry adiabatic lapse rate (DALR) is the rate of change of temperature due to increase or decrease of altitude for a parcel of dry or unsaturated air under adiabatic conditions. This usually considered as 10C.

SALR

- The saturated adiabatic lapse rate (SALR) is the rate of change of temperature due to increase or decrease of altitude for a parcel of wet or saturated air under adiabatic conditions. This usually considered as 5C.

Stable air

- Stable air tends to return to its original altitude when forced to ascend or descend.

- This occurs when the Environment Lapse Rate is less than both the Dry and Saturated Adiabatic Lapse Rates.
- The temperature of an ascending or descending parcel of air changes more than that of the surrounding air.
- Air moved upward becomes cooler and denser than the surrounding air, then descends to its original level when the upward force is removed.
- Air moved downward becomes warmer and less dense than the surrounding air, then ascends to its original level when the downward force is removed.

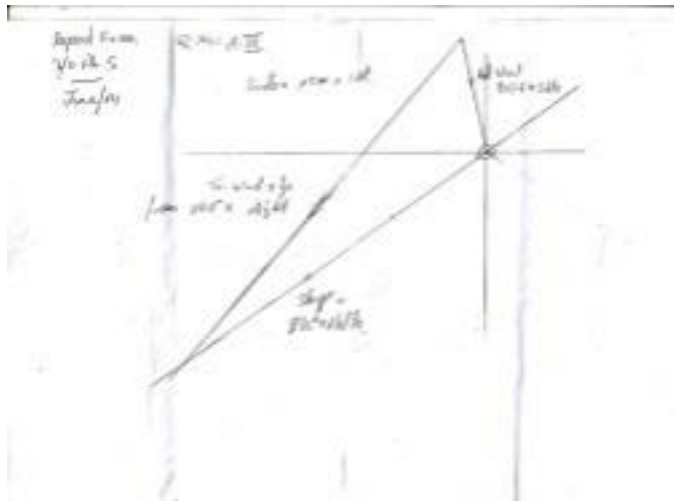
4.

- c. Monsoons in Indian Ocean seasonally change the weather system in the region. NE monsoon is one of the seasonal or periodical wind which influence these weather changes in the region. Explain in detail NE monsoon in Indian ocean.
- During northern winter Asian continent become very cold and resulting high pressure about 1036mb over the Siberia.
 - This pressure is considerably higher than the equatorial low which is about 1012mb being unaffected by change of season.
 - Therefore pressure gradient exist from equator towards Siberian region.
 - Anti cyclonic wind blows from Siberian high towards equatorial low affecting areas of Bay of Bengal and Arabian sea.
 - This wind blows NE direction hence termed as NE Monsoon.
 - Due to ascent and convergence east coast of India will receive heavy rain but intensity is lower than SW monsoon due less moisture associate during it's travel over land.
 - During months of December to April NE monsoon can be experience.

(15 marks)

- d. A ship steering 235° (T) at 16 Knots observes a relative wind six (6) points on the starboard quarter with relative speed 5 Knots.
Determine the true wind speed and the direction from which it is blowing.

True wind direction from & speed = $18.5\text{kts } 040^{\circ} \times 18.5 \text{ Kts.}$



(15 marks)

5. e. Radiation fog and advection fog are having many different characteristics. Differentiate radiation fog and advection fog.

Characteristics	Advection Fog	Radiation Fog
Duration	Can last for several days	Generally short duration (< 24 hrs), often dissipating by afternoon
Intensity	Can range from thin to dense, but dense conditions may cover large area. Changes in intensity tend to be more gradual than with radiation events.	Varies with denser fog likely over open areas or near water bodies
Coverage	May be advected over large areas and across great distances	Typically remains in one place, patchy and localized
Depth	Varies with the boundary layer but tends to be deeper than radiation fogs since it is often driven by synoptic scale factors	Varies with the depth of the radiation inversion. Can be as deep as advection fogs, but tends to be shallower as it is formed more by local factors
Time of day	Can form and advect into a region almost any time of day. Some tendency to develop in late afternoon or evening hours over coastal areas.	Tends to form late at night or in early morning hours. Can also form following precipitation that clears near or after sunset.

(15 marks)

f. There are many processes leading to formation of clouds. Explain what are the main processes leading to formation of clouds?

- Convection
- Topography or orographic lifting
- Frontal
- Convergence
- Turbulence

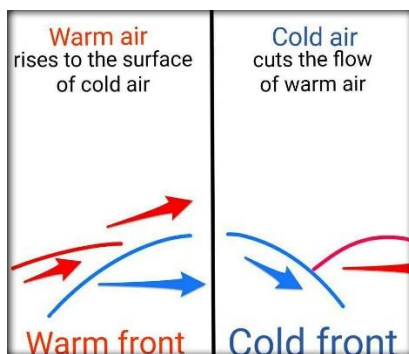
6.

a) Air mass, in meteorology, large body of air having nearly uniform conditions of temperature and humidity at any given level of altitude. Such a mass has distinct boundaries and may extend hundreds or thousands of kilometers horizontally and sometimes as high as the top of the troposphere (about 10–18 km) above the Earth's surface).

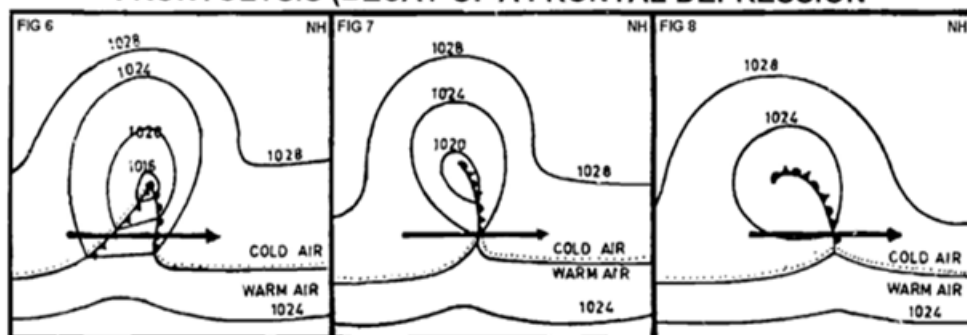
b)

- Its source region
- Its track over earth surface
- The extent of convergence and divergence
- Its age
- Its rate of travel

c) Candidate should define Cold and Warm fronts



FRONTOLYSIS (DECAY OF A FRONTAL DEPRESSION)



d.)