MARINE METEOROLOGY

2nd Mate written notes

Question wise

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: SMART MARINER

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METEOROLOGY

Paper format

TIME - 2 HOURS | PASS MARKS - 50 | MAX MARKS - 100

Note:- Question 1 is compulsory. Attempt any 4 out of remaining 5 question.

Q.1) CODING or DECODING (20 Marks)

Q.2) A) CALCULATION OF TRUE AND APPARENT WIND (15 Marks)

B) THEORY ON WIND (5 MARKS)

7 to 9 (1) Buys ballot's law :- (i) Describe it and its application with diagram
(ii) Precautions to be observed when applying buys ballot's law in vicinity of land or near the equator.
OR
ITS LIMITATIONS

9 to 10 (2) True & Apparent wind :- (i) True wind
(ii) Apparent wind
(iii) What are the various methods to find true and Apparent wind at sea?

10 to 13 (3) Wind rose :- (i) What are the information available from wind rose and explan it? With Diagram.
OR,
Write short note on wind rose?
(ii) Explain with the sketch wind rose given in Admiralty sailing direction?
(OR) Routing charts

14 (4) Pressure gradient force :- (i) Explan it (OR) Short notes on it

15,16 (5) Corious force :- (i) Explan it (OR) Short notes on it
(ii) How it affect the wind it both the hemisphere?

16,17 (6) Geostrophic wind (i) Explan it (OR) Short notes on it

17 (7) Gradient wind (i) Explan it (OR) Short notes on it

18 (8) Geostrophic wind scale (i) Explain it (OR) Short notes on it
(ii) State how wind speed can be predicted using geostrophic wind scale on weather map?

19 (9) Beaufort wind scale (i) Explan it (OR) Write short notes on it.

20,21 (10) Explain with sketch Fohn wind effect

21 (11) What are the characteristics and location of Trade winds?

22 (12) Discuss the formation of SW monsoon with sketch

23 (13) Discuss the formation of NE monsoon.

Q.3. SHIP BORNE METEORDLOGICAL INSTRUMENTS

77 (1) Aneroid Barometer: (i) State the principle and describe the working of an aneroid barometer with suitable sketch

78 (ii) What are the corrections to be applied to its reading before making entries in Deck log book

79 (iii) What are the precautions necessary for an Aneroid Barometer.

79 (iv) Why Aneroid Barometer is preferred over mercury Barometer for use on-board ship?

80 (v) Compare mercury barometer with aneroid barometer.

80, 81 (2) Precision Aneroid Barometer: (i) Describe the working of a precision aneroid barometer with suitable sketch

81, 82 (ii) What are the procedure for reading the precision barometer.

82 (iii) What are the correction to be applied to the precision Aneroid Barometer?

83, 84 (3) Barograph: (i) Describe the use, construction and working of Barograph with suitable sketch

85 (ii) What are the care & maintenance required for a barometer.

86 (4) Hygrometer: (i) Describe the working principle of Hygrometer

86, 87 (ii) What are the precautions required in its use

87, 88 (5) Stevenson's screen: (i) Describe Stevenson screen

88 (ii) List the precaution necessary for sitting of Stevenson screen

88, 89 (6) Whirling psychrometer: (i) Sketch & describe the whirling psychrometer & its use.

90 (ii) What are the precautions required in its use

90, 91 (iii) What are the advantage of whirling psychrometer over the hygrometer

91, 92 (7) Anemometer: (i) Sketch & describe the working principle of vane anemometer.

93 (ii) What are the care & maintenance required for anemometer?

* - very important

Q.4 ATMOSPHERE/ ATMOSPHERIC PRESSURE (20 MARKS)

24 (1) Short notes on :- *(i) relative and absolute humidity.

25,26 (ii) Dew point temperature (& saturation) and frost point

26,27 *(2) Short notes on ELR, DALR & SALR; Why SALR is less than DALR

27,28 (3)(i) Explain change of pressure with height?

(ii) what happens to atmospheric temperature in troposphere and stratosphere

28 (4) Diurnal range of atmospheric temperature - Why it is higher over land than over sea

(5) Write short notes on:-

29 to 31 (i) Land & sea breeze

31 to 33 *(ii) Anabatic & Katabatic wind

*(iii) What is barometric tendancy? Explain how it can be used to predict movement of pressure system?

34 to 36 (6) Air Masses :- (i) What is an air mass? (OR) describe an air mass?

**(ii) What are the factors affecting properties of an airmass

**(iii) How air masses are classified & state their characteristics

36 to 46 (7) Isobars :- (i) What are isobars & how they predict weather?

(ii) What is isallobars? what is the difference beetween isobars & isallobars?

39 to 46 *(iii) With suitable sketches, describe seven isobaric pattern & weather associated with them?

46(1), 46(2) (8) Write short notes on (a) Doldrums, ITCZ (b) Westerlies

(9) Sketch and explain mean surface distribution of pressure on oceans during summer & winter months

Q.5. CLOUDS/VISIBLITY/CLIMATOLOGY

47 to 50 (1) Fronts :- (i) Define front

(ii) (a) Explain cold front, warm front, stationary front and occluded front & how these fronts are formed?

*(b) Explain weather associated with these fronts

(c) Give necessary diagram.

(iii) How fronts are depicted on a weather map?

51,52 (2) Frontal depression :- (i) Write short note on frontal depression

(ii) Describe the features of mid-latitude depression

53,54 (3) Write short notes on :- (a) Dew (b) Hoarfrost (c) Glazed frost

(d) RIME

54 to 56 (4) Define percipitation & explain various forms of percipitation?

56, 57 (5) Define :- @ Fog & Mist - explain how it is formed (OR) *Describe the formation of fog
ⓑ Haze ⓒ Spray

57 to 59 (6) Types of fog :- @ Radiation fog *ⓑ Advection fog
ⓒ Arctic sea smoke/ *Steam fog @ SMOG ⓔ Orographic fog

59, 60 (7) Describe the method of estimating visibity at sea by day or by night

60 (8) How will you predict fog at sea

61 (9) Clouds :- (i) How clouds are formed? Explain classification of different types of clouds as per height from sea level?

62, 63 (ii) Explain various type of cloud.

64 to 66 *(iii) Discuss formation of cloud by Turbulence, orographic lifting, convection and frontal lifting.

67 to 69 (10) Write short notes on : @ sea & swell ⓑ Gust and squall
ⓒ veering & backing @ Tsunami
ⓔ Tidal bore

Q.6. WEATHER SYSTEM / SEA AND SWELL / WEATHER FORECASTING

70 (1) Fascimile reciever : (i) What is fascimile recorder? Describe various type of information recieved by fascimile reciever?

71 (ii) What is weather analysis & weather prognosis chart.

72 (iii) Sketch and describe the symbols shown in weather charts & synoptic charts.

72 (2) Weather routeing : (i) What are the advantages of shore bases weather routeing?

73 (ii) Explain the factors to be considered by ship officer for weather routeing of his ship.

73, 74 (iii) Describe the information contained in coastal weather bulletin

74, 75 (3) How are weather warning recieved on-board?

75, 76 (4) Why polar regions are colder than equitorial region? Why the lower latitude areas are warmer than high latitude areas

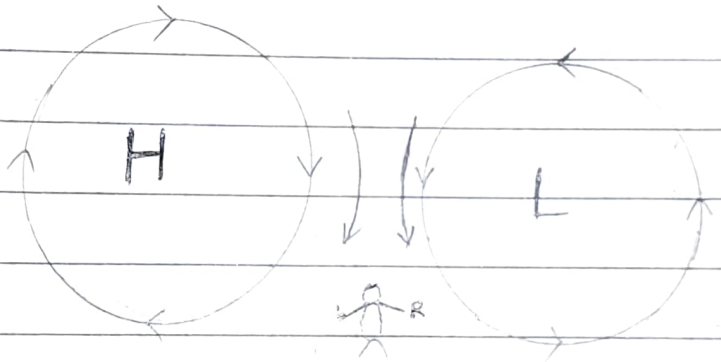
76 (5) Explain fetch and significant wave height.

(1) Buys ballot's law

(i) Describe it and its application with diagram

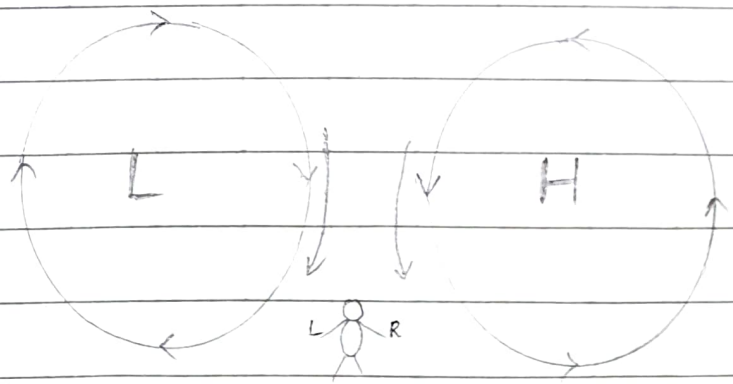
Ans:- In 1857, Buys ballot formulated a law identifying the relation -ship beetween wind and pressure distribution. The law states that :-

In Northern Hemisphere, if observer faces the true wind, the center of low pressure will be on his right and somewhat behind him and the center of high pressure will be on his left and somewhat in front of him



NORTHERN HEMISPHERE

In Southern Hemisphere, if observer faces the true wind, the center of low pressure will be on his left and somewhat behind him and center of high pressure will be on his right and somewhat in front of him

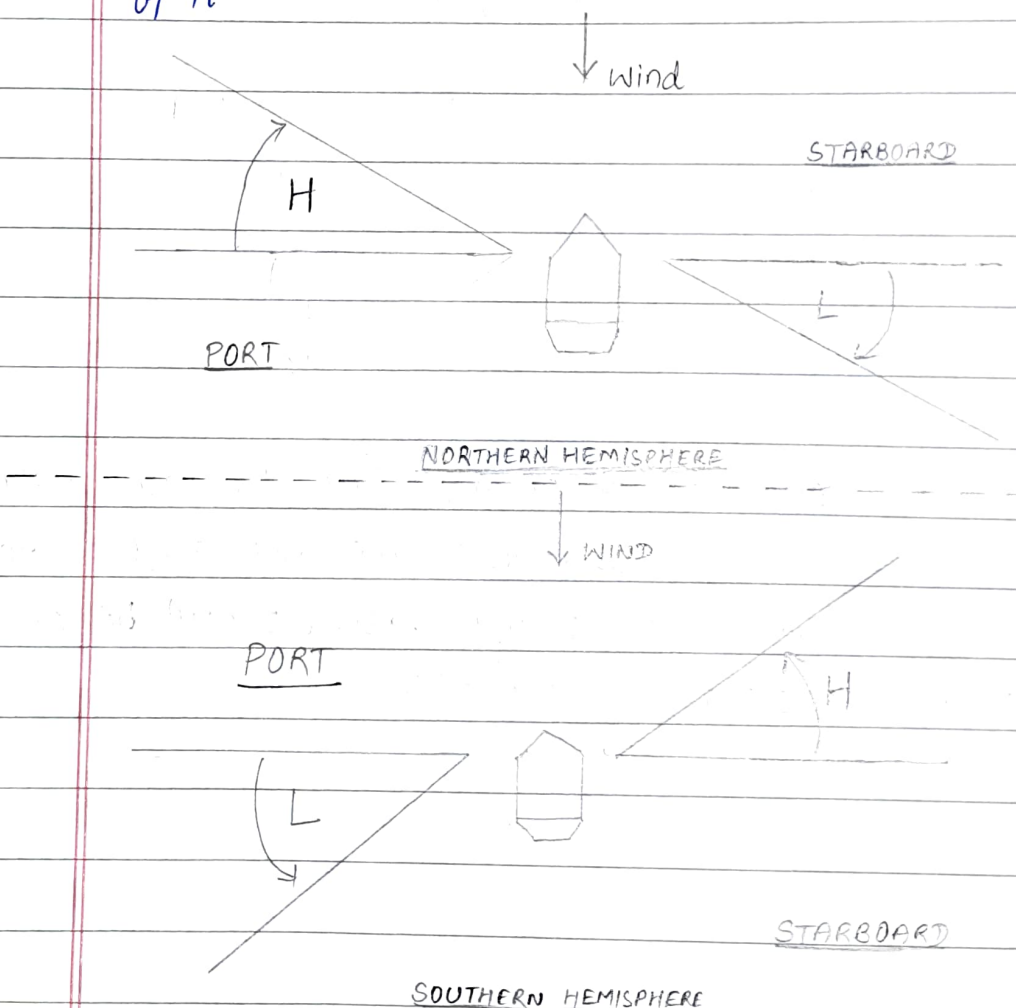


SOUTHERN HEMISPHERE

Application

The general purpose of the law is to assist steering a vessel away from the center and right in Northern Hemisphere, and away from the left in Southern Hemisphere during hurricanes or any other rotating disturbance at sea.

It also help to analyze the probability of existence of a storm and best course to steer to avoid the worst of it.



(ii) Precautions to be observed when applying buys ballot's law in vicinity of land or near the equator

Ans:- This is the limitation of buys ballot's law and hence precautions to be observed when applying buy's ballot's law in :-

- Near the equator :- This is because corolis force is negligible at or within few degress of equator and therefore wind blow directly across the isobars from high pressure to low pressure areas.
- In vicinity of land :- This is because, in vicinity of land, the wind experienced may not be the free unobstructed wind. It may be wind deflected by the land.

(2) TRUE & APPARENT WIND

(i) True wind :- True wind is the actual speed and direction of the wind blowing as experienced by an observer that is stationary and at any location & altitude. He might be at sea level or top of the masts but as long as the ship is stationary, then the wind speed and direction are true wind speed and direction.

Always true wind is quoted in weather observation. and also used during passage planning.

(ii) Apparent wind :- Apparent wind is the wind what you feel on you as you sail. It is caused due to motion of a body. We sail the vessel by reference to the apparent wind speed. It depend on your direction of travel relative to the wind.

Like if you are at anchor. There is a true wind speed of 10 Kts You picked up your anchor & starts moving at 6 Knots speed into the same 10 Kts breeze. You would now feel 16 Knots apparent wind on your face.

(iii) What are the various methods to find true and apparent wind at sea?

- True wind:-
  i) Solving wind traingle
  ii) From direction of sea waves
  iii) Weather facsimile wind arrows
  iv) Routeing charts, wind rose
  v) Navtex message
- Apparent wind
  i) Solving wind Traingle
  ii) Funnel smoke
  iii) Flags
  iv) Wind Soc
  v) Holding a handkerchief

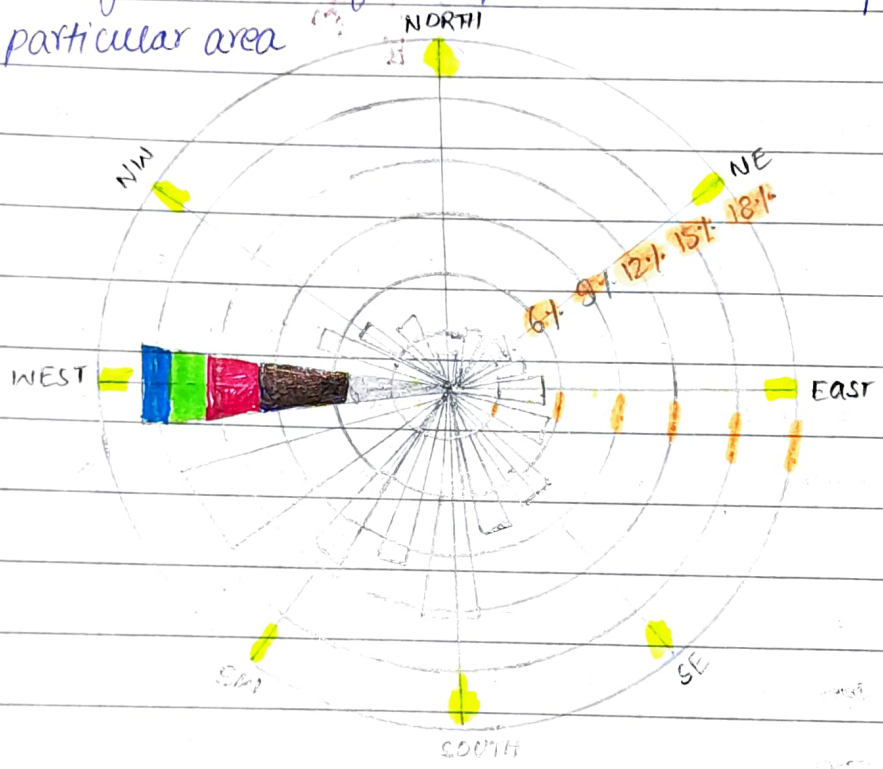
(3) WIND ROSE

(i) What are the information available from wind rose and explan it with diagram.

Ans:- Wind roses are found on climatological charts that summarizes information about the wind at a particular location over a specified time period. They depict the frequency and strengths of the winds, blowing from various direction.

(OR) in other words.

Wind rose is a graph showing the speed, direction and frequency of wind in a particular area



Wind rose diagram consist of three components:

(a) 8 or 16 radial lines, which represents the wind direction

(b) 5 to 10 concentric lines, which indicates the wind frequency

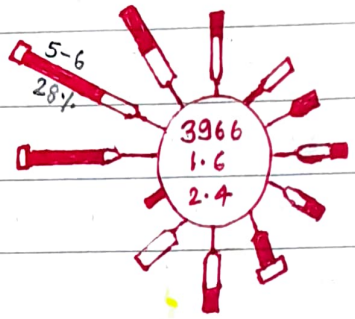
(c) colour coded bars on each radial line, which indicates the wind speed.
(there is a table provided that what colour indicates what speed like 11-15 (KNOTS))

From the figure, we can say that the most common wind direction is "WEST". From this direction, the wind comes approxiamately 16% of the time. We can also say that, it is calm for approx. 7% of the time.

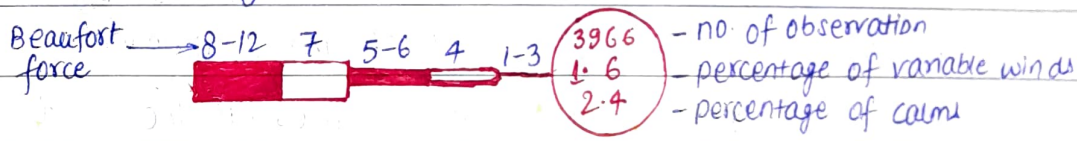
(ii) Explain with the sketch the wind rose given in

(a) Routeing charts.

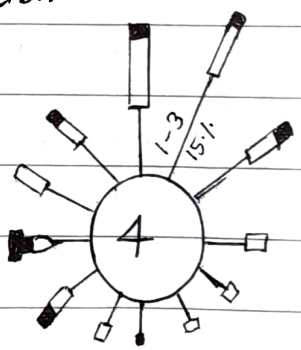
Ans :-



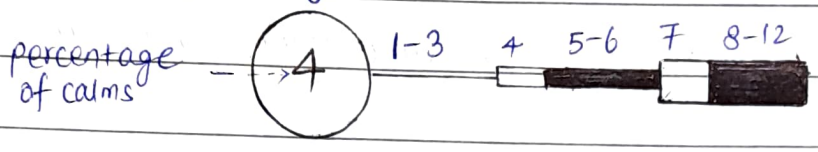
- In Routeing charts, the wind data used in the making of wind roses are from ship's observations within each 5'x5' area
- Wind roses with less than 100 observations are not reliable
- From the windrose, we can get the most common wind direction i.e WNW 292.5°
- The frequency of wind can be obtained by measuring the leg of wind rose & then refer to scale given at top right corner. in routeing charts i.e. in above figure, the highest frequency is 28.1%, that of wind force 5-6
- Further, wind speed can be obtained by observing the thickness of windrose leg



(b) Sailing direction.



- From the wind rose, we can get the most common wind direction. The wind direction is towards the circle centre.
- The frequency of wind can be obtained by measuring the leg of wind rose & then refer to the scale in bottom of the page in sailing direction
- Further, wind speed can be obtained by observing the thickness of windrose leg



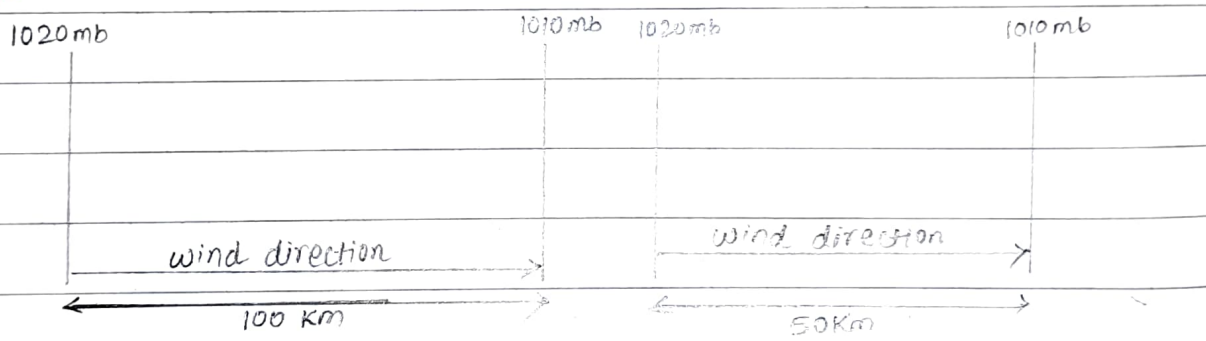
The above wind rose of a particular location shows, the most common wind is from NNE i.e. 22.5° & the highest frequency is 15% that of beaufort wind force 1-3; the percentage of calm is 4%.

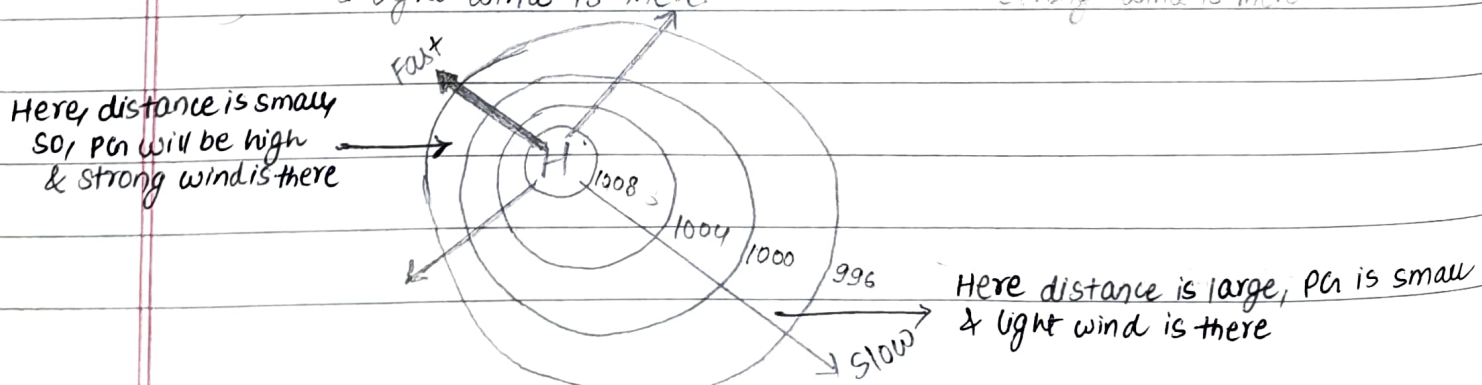
(4) Pressure gradient force

Ques:- Write a short notes on pressure gradient force

Ans:- Pressure gradient is the fall of pressure per unit distance, as shown on a weather chart. If the distance beetween consecutive isobars is small, the pressure gradient is said to be high and strong winds are expected to blow. If the distance beetween consecutive isobars is large, the pressure gradient is said to be small and light winds are expected to blow

Pressure gradient is the primary cause of wind; the speed of wind being closely proportional to the pressure gradient. The greater the pressure gradient force is faster the wind will blow.





(5) Coriolis force

(i) Short note on it (OR) Explain it

Ans:- While blowing from High pressure (HP) to low pressure (LP) areas, the wind is deflected by Coriolis force (also called as Geostrophic force). Coriolis force is caused by the rotation of the earth. So, The deflection of wind due to earth's rotation is known as Coriolis force.

It is represented by formula,

$$C = 2 \cdot V \cdot \omega \cdot \sin lat$$

where, V = wind velocity

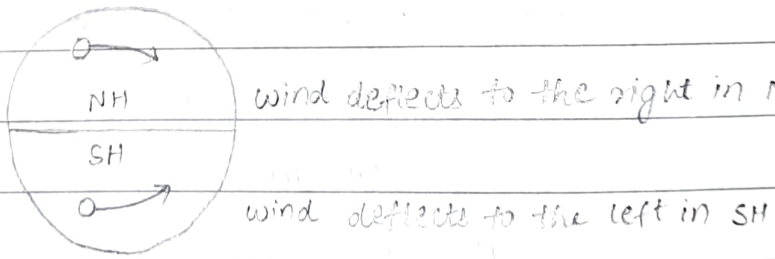
ω = angular velocity of earth rotation.

Coriolis force is minimum at the equator and increases as latitude increases and is maximum at the poles.

(bcz diameter of earth is maximum at equator)

(ii) How it affect the wind in both the hemisphere?

Ans:- In Northern Hemisphere, wind is deflected to the right from its path, while, In Southern hemisphere, wind is deflected to the left from its path.

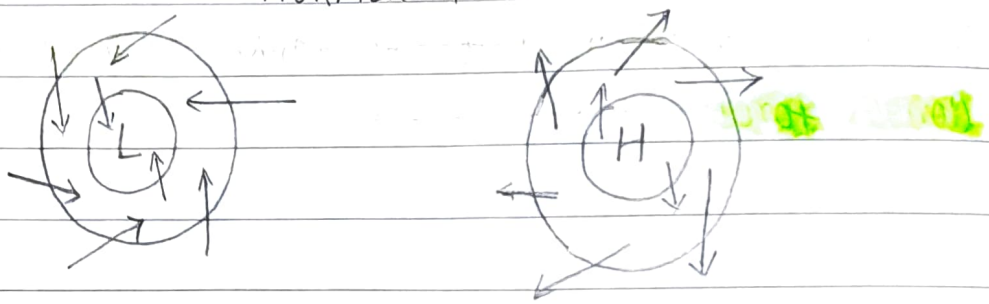


Wind blowing in any area are the resultant of gradient force and coriolis force. Because of this, it will be observed that

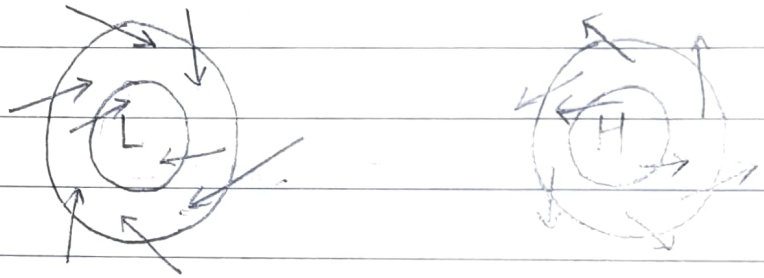
- Wind blows spirally inwards towards a depression (LP areas surrounded by HP areas), and anticlockwise in NH & clockwise in SH.

- Wind blows spirally outwards from the center of an anticyclone (HP areas surrounded by LP), clockwise in NH and anticlockwise in SH.

NORTHERN HEMISPHERE



SOUTHERN HEMISPHERE

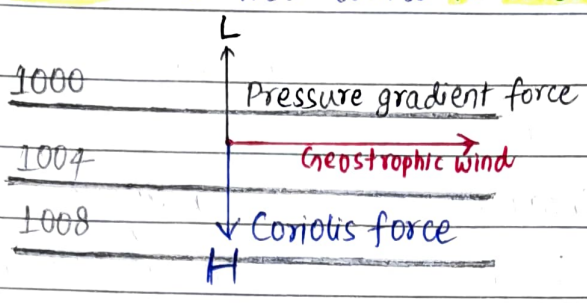


(6) Geostrophic wind

(i) Write a short notes on it

Ans:- (Geostrophic wind is the wind that result from an exact balance beetween coriolis force and pressure gradient force) (As we know, a parcel of air moves from high pressure to low pressure area due to pressure gradient force) (That parcel of air, then starts deflecting to the right in N/H & to the left in S/H due to coriolis force) (As the wind gains speed, the deflection increases and a stage comes when pressure gradient force becomes equal &

opposite to coriolis force) (Resultant wind will be blowing parellel to isobars & this wind is known as geostrophic wind)



(7) Gradient wind

(i) Write short notes on it

Ans:- It is the extension of the concept of geostrophic wind. In geostrophic wind, the wind is assumed to move along straight and parellel isobars. But if the isobars begins to curve, another force comes into act, known as centrifugal force, which act outward from the center, referred as a gradient wind

- The wind which blow along curved isobars is known as gradient wind
- It can be defined as :-

Gradient wind is the wind that result from the balance of three forces :- The pressure gradient force, the coriolis force and centrifugal force arising from the curvature of a parcel (curved isobars) trajectory.

- Around a low pressure center, the gradient wind blows anticlock-wise along the curved isobars in the N/H & clockwise in S/H.
- Around a high pressure center, the gradient wind blows clockwise along the curved isobars in the NH & anticlockwise in S/H

(8) Geostrophic wind scale

(i) Write a short notes on it? (OR) Explan it

(ii) State how wind speed (OR) can be predicted using geostrophic wind scale on weather map.

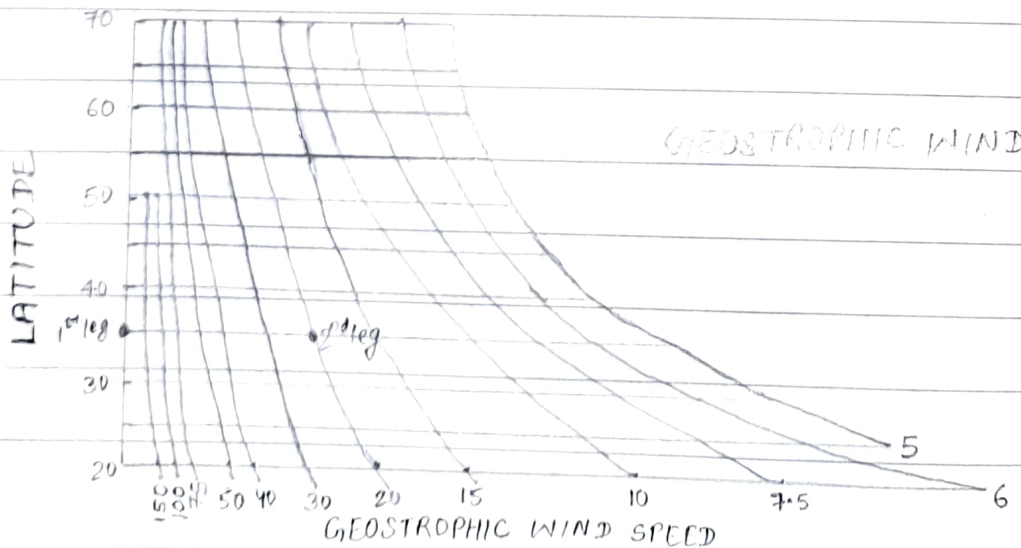
Ans:- Synoptic weather charts normally contain a diagram from which geostrophic wind speed can be determined by measuring the distance beetween two successive isobars. This diagram is known as a geostrophic wind scale.

(ii) To determine the geostrophic wind speed using geostrophic wind scale :-

① The distance beetween two consecutive isobars is taken from weather map by a divider at the desired latitude (like at 35° Lat distance b/w two consecutive isobar is 1.65cm (200NM))

② The divider is then placed at geostrophic wind scale, both legs on horizontal line of that desired latitude.

③ The left leg of the divider is placed on left most margin of scale and the position of other leg gives the geostrophic wind speed. (At 35° lat, distance b/w isobar - 1.65cm, wind speed will be 20 knots)



(9) Beaufort wind scale

(i) Explan it OR) write a short notes on it

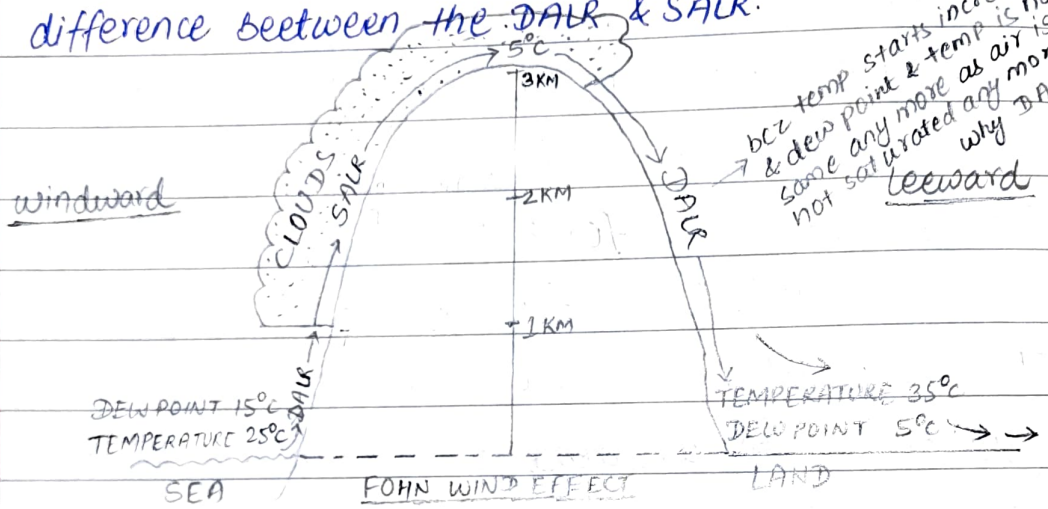
Ans:-

- In 1805, Rear Admiral Sir Francis Beaufort of Royal Navy devised (depeloved) a scale for estimating wind speed at sea based on simple sea surface observation. Later, the WMO (world meteorological organisation) accepted the beaufort wind scale and standarised the probable wind speed associated with each beaufort number.
- The beaufort wind scale have 13 levels of sea state numbered 0 to 12 (beaufort wind force)
- The beaufort wind force and hence the wind speed are judged by the appearence of the sea only in open and deep sea, where the wind is unaffected by land features.
- In harbours, river and other area close to land, the actual wind may be higher than estimated by sea appearence because of fetch, depth, heavy rain and tide effects.

Beaufort wind force	Mean wind speed in KNOTS		Description	Probable height of waves in m
0	00	<1	Calm	—
1	02	1-3	Light air	.1
2	05	4-6	Light breeze	.2
3	09	7-10	Gentle breeze	.6
4	13	11-16	Moderate breeze	1
5	18	17-21	Fresh breeze	2
6	24	22-27	Strong breeze	3
7	30	28-33	Near gale	4
8	37	34-40	Gale	5.5
9	44	41-47	Strong gale	7.5
10	52	48-55	Storm	9
11	60	56-63	Violent storm	11.5
12	68+	64-71+	Hurricane	14

(10) Explain with sketch foehn wind effect.

Ans:- Foehn wind effect is a phenomenon where the leeward side of a mountain range is drier and warmer than the windward side. Foehn wind effect is direct result of the difference beetween the DALR & SALR.



- Imagine a breeze of 25°c temperature & 15°c dew point blowing against a 3Km high mountain range
- The breeze begins to ascend and its temperature drops 10°c per Km height (DALR). After reaching a height of 1Km, the temperature of air has fallen to 15°c.
- Now as dew point and air temperature is same, the air is then saturated.
- On ~~descending~~ ascending further, temperature drops 5°c per Km height (SALR). The excess moisture in the air is given off as orographic cloud and heavy rain falls on the windward side.
- On reaching the top air will be still saturated and its temperature is about 5°c.
- Now, the breeze begins to descend on the leeward side

and the air temperature increases at 10°C per Km (DALR). Beca-use, once the air temperature begins to rise, air is not saturated anymore.

- On reaching sea level, the air temperature reaches to 35°C. Since, no water vapour is let in or taken out, the dew point would be 5°C.
- Hence it is clear that leeward side is warmer & drier than windward side.

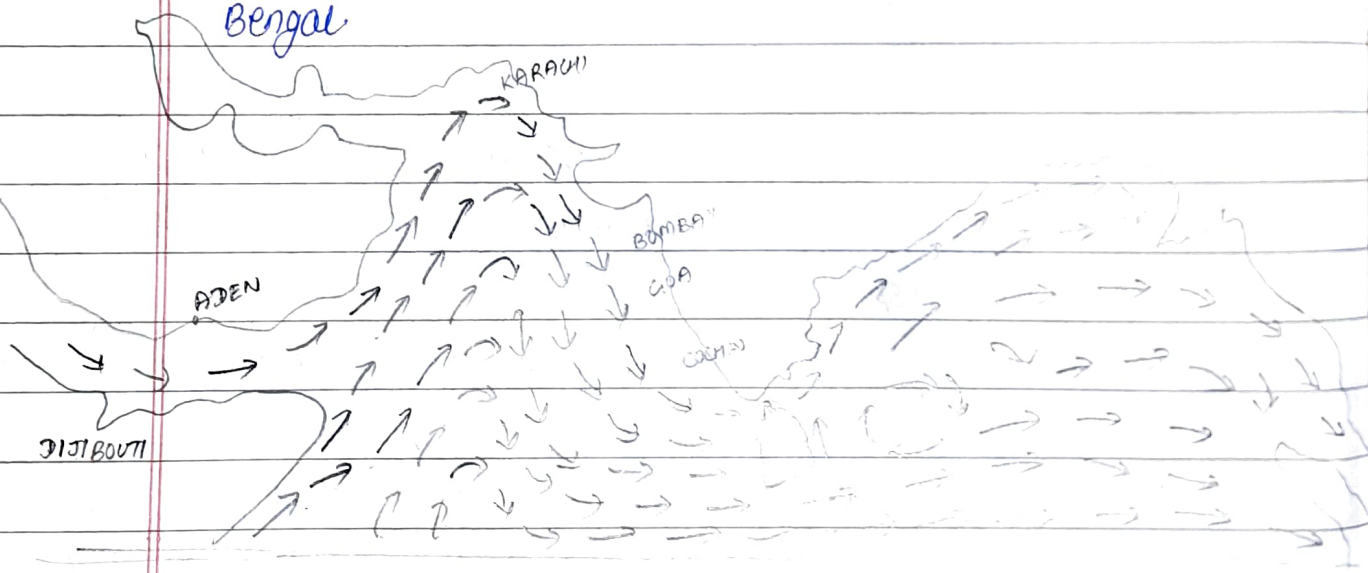
(11) What are the characteristics and location of Trade winds.

Ans:-
- Except in the Arabian sea, Bay of bengal and china seas, the trade winds are clearly prominent over all sea areas in both summer and winter.
- The trade winds blows more or less constantly through the year from about 30° latitude towards the equator. They blow north-easterlies in northern hemisphere and south-easterlies in southern hemisphere.
- (The trade wind areas tends to shift northwards and southward following the sun.)
- In Atlantic ocean, the mean wind speed is about 13 to 15 knots. The highest value i.e. 18 knots found in south-east trades of Indian ocean.
- The trade winds blows more strongly ~~at the end of~~ winter in both the hemisphere.

Name trade wind came because in early days the sailing ship used this trade wind to sail the ship for trade.

(12) Discuss the formation of SW monsoons with sketch

Ans:- The SW monsoon blows June to october and brings heavy rain in the west coast of India, West Bengal, Bangladesh and myanmar. The continent of Asia get very warm and hence result to low pressure of about 994mb over its center, over the Thar desert. The south-easterlies trade winds blow from 30°s towards the equator, crosses the equator, and blows as a strong SW wind called the SW monsoon. The SW direction is the result of gradient force and coriolis force. The wind force is about 7 or 8 in Arabian sea and 6 or 7 in Bay of Bengal



(13) Discuss the formation of NE monsoon

Ans:- The NE monsoon blows from december to April and brings heavy rain fall on east coast of India. The continents of Asia gets cold and hence result to high pressure of about 1036 mb over its center, over Siberia. The anticyclonic wind force of about 3 to 4 reaches the Bay of bengal and the arabian sea & about 5 to 7 in china seas.

Q.4 ATMOSPHERE/ ATMOSPHERIC PRESSURE (20 Marks)

(1) Write short notes on

(i) Relative and absolute humidity

Ans:- **Relative humidity:-** Relative humidity is the percentage ratio of the actual water vapour contained in a sample air to the maximum quantity of water vapour that sample air can hold at that temperature.

$$RH\% = \frac{\text{Present quantity of water vapour}}{\text{Max}^m \text{ possible at that temperature}} \times 100$$

If the temperature of sample air is raised, its capacity to hold water vapour increases, hence relative humidity decreases. the air becomes relatively drier.

If the temperature of sample air is cooled, its relative humidity increases, the air becomes relatively moist.

So, relative humidity is inversly proportional to temperature

$$RH \propto \frac{1}{t}$$

Absolute Humidity:- Absolute humidity is the mass of water vapour contained in a sample of air. It is expressed as grams of moisture per cubic meter of air (g/m^3)

The maximum absolute humidity of warm air at 30°C is approximately (30 gm of water vapour per cubic meter of air 30 gm/m³

The maximum absolute humidity of cold air at 0°C is approxiametely 5 gm/m^3.

(ii) Dew point temperature (and saturation) and Frost point

Ans:- If the temperature of sample air is cooled, its relative density increases and the air becomes relativey moist. At some temperature, the air becomes wet i.e. when relative humidity become 100%. The air is then said to be saturated and the temperature at which the air becomes wet & relative humidity becomes 100%, that temperature is said to be **dew point temperature**.

In case of very low temperature, when a parcel of air is cooled below its dew point, the water vapour (air moisture) is most likely to freeze to become ice, instead of falling as a rain. The dew point temperature at which this process of ice formation takes place is called as **frost point**

Ques:- What is its importance in cargo hold temperature?

Ans:- Dew point temperature cause the water vapours to condense into droplets of water also known as ship sweat. Sweat can cause damage to dry cargo

There are three causes of sweat in a hold:-

1) Atmospheric sweat: If the temperature inside cargo hold is low, any air brought in by ventilator will be cooled & if it is cooled below its dew point, it will give off moisture which condense as a sweat on cargo. Hence, it is said that

- If hold temperature is less than dew point of outside air, restrict ventilation
- If hold temperature is greater than dew point of outside air, ventilate freely.

2) Cargo sweat : Some cargoes such as hides, skins, ores etc. give off large quantities of water vapour causes relative humidity to increase making air relatively more moist which cause sweat to form on the steel part of the hold, that would further drip into cargo and damage it.

3) Ship sweat :- When sea temperature is much lower than the temperature above it, the underwater parts of the hold is cooled by contact with sea which cause sweat to form on the steel part of the hold.

(2) Write short notes on ELR, DALR & SALR

Ans:- Environmental lapse rate (ELR) :- The temperature of still atmospheric air decreases when ascend because pressure decreases with height and temperature falls due to expansion and increases when descending at average rate of about 6.5°C per KM. which is also known as Normal Lapse rate.

Dry Adiabatic Lapse rate (DALR) :- The temperature of dry parcel of air decreases when ascend because pressure decreases with height and temperature falls due to expansion and increases when descend at steady rate of 10°C per KM i.e. the adiabatic lapse rate of dry parcel of air (or) Dry adiabatic lapse rate (DALR).

Saturated adiabatic lapse rate (SALR) :- The temperature of saturated parcel of air decreases when ascend

because pressure decreases with height and temperature falls due to expansion and increases when descent at steady rate at 5°C per km i.e. adiabatic lapse rate of saturated parcel of air (OR) saturated adiabatic lapse rate

Ques:- Why is SALR less than DALR

Ans:- SALR is less than DALR because as the saturated air is cooled, its capacity to hold water decreases. The water vapour then condenses into water droplets. This condensation releases latent heat and thus warms that rising parcel of air. Hence, temperature of rising saturated parcel of air fall by 5°C per km instead of 10°C per km.

(3)(i) Explain change of pressure with height?

Ans:- As the altitude increases, the atmosphere pressure decreases. Because, as we know the density of air near the earth surface is heavier because of gravity and it begins to lighten as we go to higher altitudes.

The high density of air leads to high atmospheric pressure at lower altitudes.

With increase in height, density of air decreases leads to low atmospheric pressure at higher altitudes.

(ii) What happens to atmospheric temperature in troposphere and stratosphere?

Ans:- Normally all the weather changes and all the water vapour of atmosphere contained in the troposphere which extend

to a height of about 8 to 16 Km above the sea level.
In the troposphere, atmospheric temperature falls steadily as the height increases.
In the stratosphere, the air temperature remains steady around -56°C.

(4) Diurnal range of atmospheric temperature

The difference beetween the maximum and minimum value of temperature in a day is known as diurnal range of atmospheric temperature for that day.
Diurnal range of air temperature over land is high (as much as 20°C) & low over sea (as less than 1°C).

Ques:- Why is diurnal range of atmospheric temperature over land is higher than that over sea?

Ans:-

Over land	Over sea
1. Land, being a solid, has a low value of specific heat and so heats up or cool quickly.	1. Sea, being a liquid, has a higher value of specific heat and so heat up or cools slowly.
2. Heat recieved from the sun is retained by the top layer of land as land is a poor conductor of heat	2. Heat recieved from the sun is distributed over a large mass of water by convection currents.
3. Negligible evaporation.	3. Evaporation of water in a day causes adiabatic cooling which balance some of the heat recieved by the sun.

Thus, the temperature of the sea surface does not vary much beetween day & night but over land maximum ground temperature may be as high as 40°c than air temperature

(5) Write short notes on

(i) Land & sea breezes

Land and sea breezes are the result of the large difference of diurnal range of atmospheric temperature over land and over sea.

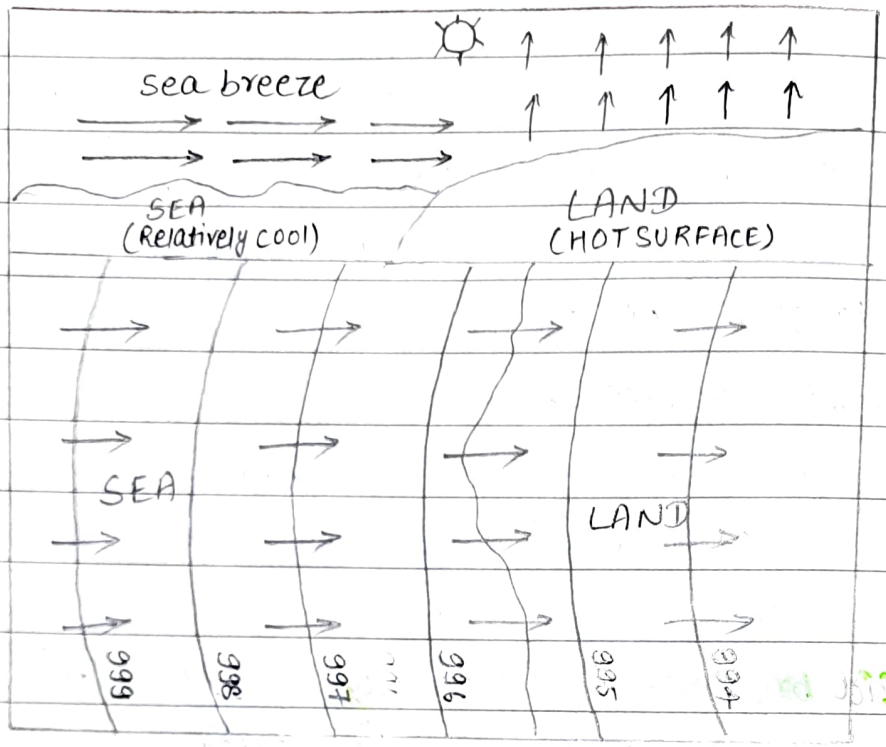
- Sea breeze :- During the day, land get extremely hot and air in contact with it also get heated, resulting in low pressure over the land. The temperature of sea surface and air above it cause the relatively high pressure over the sea. The isobars run parellel to coast. Since the distance beetween Low pressure over land and high pressure over sea is small, the wind blows directly through the isobars from the sea towards the land. The sea breeze sets in by about 1000 HRS LMT & reaches a maximum wind force 4 by 1400 LMT & dies down about sunset.

* only the highlighted part will change in land breeze

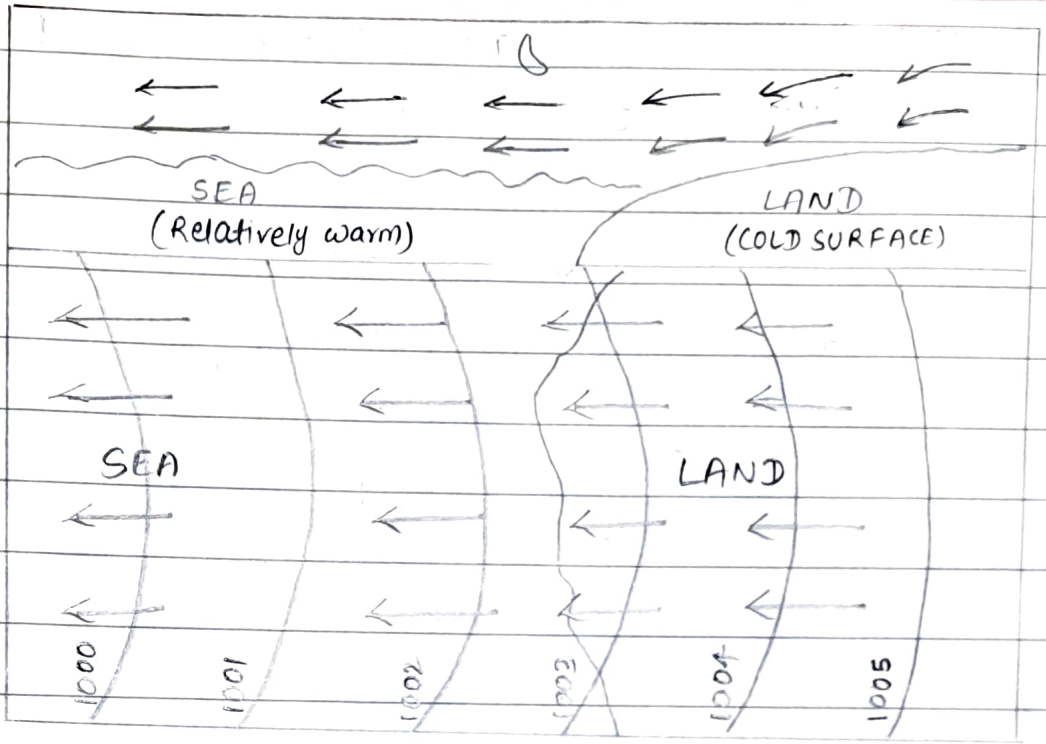
For diagram, please turn the page because here is not enough space.

"SMILE" ☺

bcz "Peace begins with smile"
bcz you still have teeth



- **Land breeze** :- During the **night**, lands **cools** very **quickly** and air in contact with it also **cools** **rapidly**, resulting in **high** **pressure** over the land. The temperature of sea surface and air above it cause the relatively **low** **pressure** over the sea. The isobars run parallel to the coast. Since the distance between **high** **pressure** over the land and **low** **pressure** over the sea is small, the wind blows directly through the isobars from the **land** towards the **sea**. The land breeze set in a couple of hours after sunset and blows until half hour after sunrise



* Summary to the Sea & Land breeze

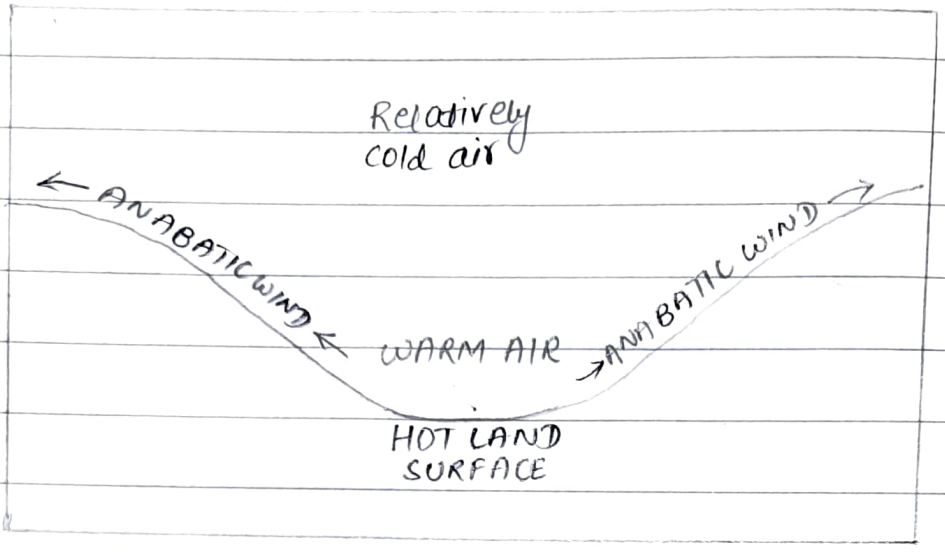
Sea breeze: day - land heat - LP over land & HP over sea = sea to land

Land Breeze: night - land cools - HP over land & LP over sea = land to sea

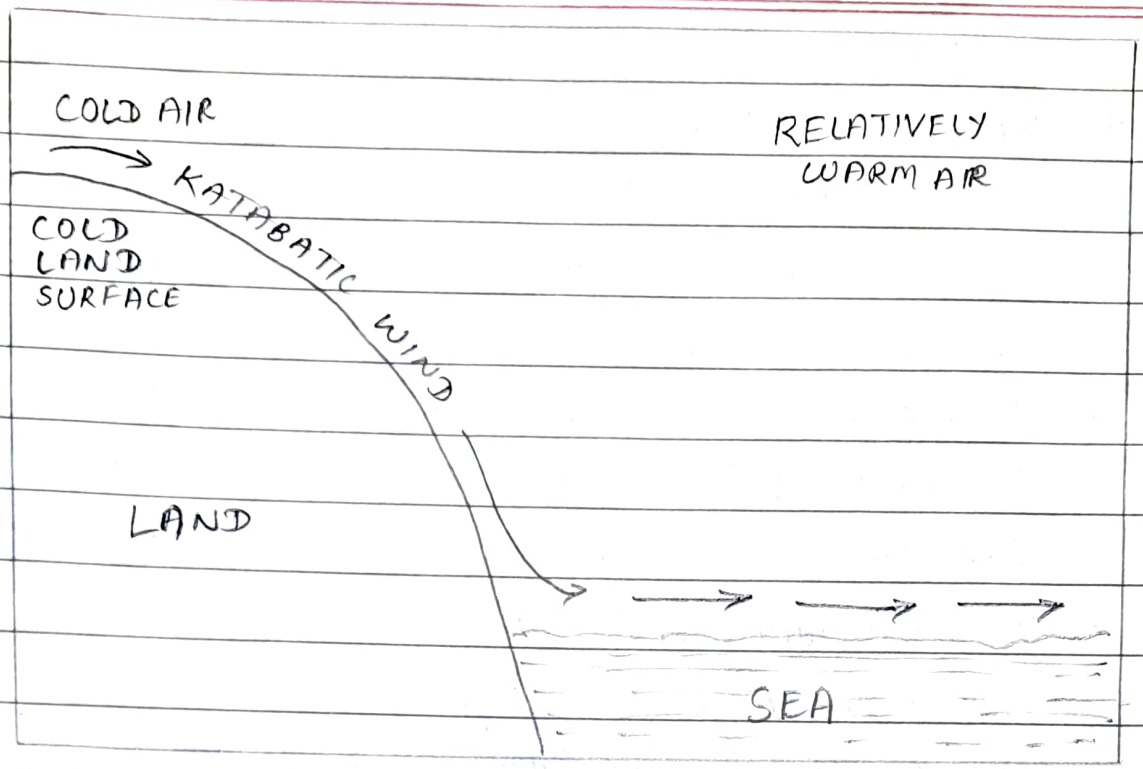
(iii) Anabatic & Katabatic wind

- Anabatic wind :-
  - During daytime, the land surface gets heated quickly, results in heating the air near the ground by conduction
  - The air near to the ground become warmer than the air above ground
  - As the air warms, its volume increases and hence density and pressure decreases.
  - The air becomes relatively buoyant and rises up, thus

displacing the colder air, resulting in anabatic flow or anabatic wind.



- Katabatic wind
  - On clear nights, the land surface radiates its heat very quickly, results in cooling the air near to the ground.
  - As the air cools, its volume decreases and hence become denser and heavier.
  - The heavy & dense cold air then flows down from the top of the hill (also due to gravitational force), results in Katabatic flow or wind.
  - If the mountain is high and slope is steep, Katabatic wind can reach sea level with force 7 or more in very short while.



(iii) What is barometric tendancy? Explain how it can be used to predict movement of pressure system?

Ans:- Barometric tendency is the difference beetween the atmospheric pressure at the time of observation and the atmospheric pressure three hours earlier. It is expressed in millibar and upto one decimal of a millibar.

Barometric tendency gives a good idea of rate of change of pressure to the forecaster, which is useful for predicting the movement of pressure system (also called isobaric pattern)

It is obtained from barograph & if barograph is not working or not provided on-board, it can also be obtained from Aneroid barometer by aligning the fixed pointer to the dial pointer every three hours, starting from 00 UTC & note the change each time.

(6) Air Masses

(i) What is an Air mass? OR, Describe an airmass

Ans:- • An air mass is a large volume of air in the atmosphere whose temperature and relative humidity values are more or less uniform (in a given horizontal plane).

• Air masses can extend upto thousands of kilometer across the earth surface & can reach upto the stratosphere (16 km from the ground level) into the atmosphere.

• The temperature and relative humidity values of an air mass depends on its point of origin and its journey (over the land or sea). • If they have an origin over a land region, their moisture content are likely to be low (Dry) and if they have an origin over a oceanic region, their moisture content are likely to high (wet).

(ii) What are the factors affecting the properties of an air masses?

Ans.- 1 Its source region:- If it is a polar region, the air mass will be cold & if it is a tropical region, the air mass will be warm.

2. It's track over the earth's surface:- If it passes over the land region, it will be dry and if it passes over the oceanic region, it will be moist.

3. The extent of convergence and divergence: Convergence at lower level (in depressions) cause air at the centre to ascend.

Divergence at lower level (in anticyclones) causes air from above to descend.

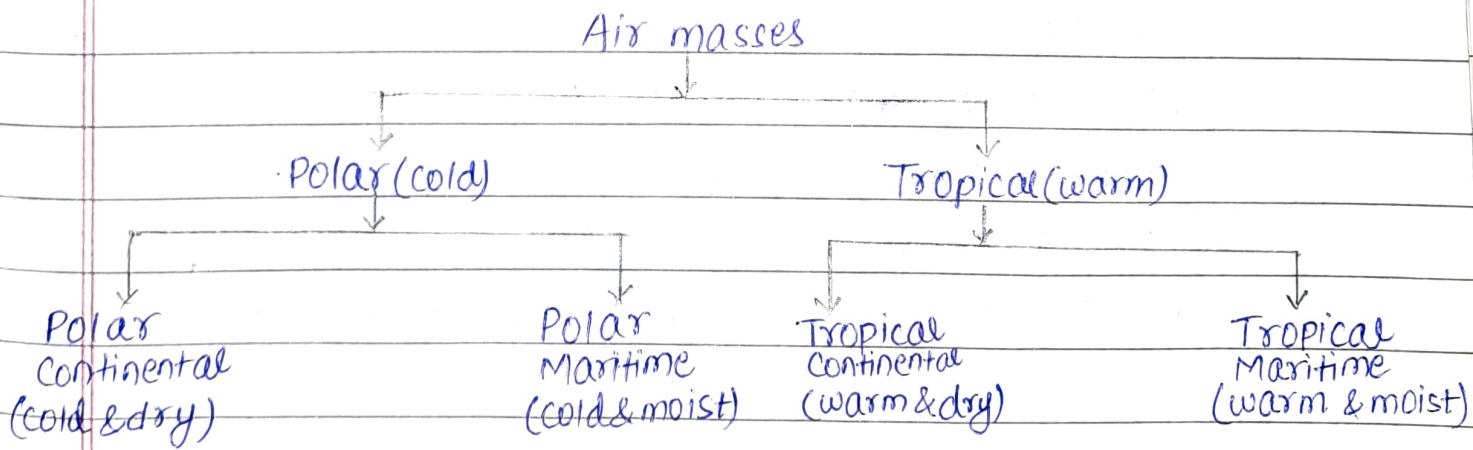
4. Its age :- The age of an air mass is the number of days it has spend in its source region. The longer it stayed in the source region, the greater it has influence by the climate of the place.

5. Its rate of travel :-

- If it is moving quickly, the area over which it blows does not have sufficient time to influence the properties of an air mass. Hence, quick moving air mass retain its original characteristics.
- If it is slow moving, the area over which it blows have sufficient time to influence the properties of an air mass. Hence, slow moving air mass differ from its original characteristics.

(iii) How air masses are classified & state their characteristics

Ans:- Based of their properties, air masses are divided into four main classes :-



Characteristics of air masses :-

(a) Polar continental (PC) :- Polar air mass coming over land.
It will be cold & dry

(b) Polar maritime (PM) :- Polar air mass coming over sea.
It will be cold & moist.

(c) Tropical continental (TC) :- Tropical air mass coming over land.
It will be warm and dry.

(d) Tropical maritime (TM) :- Tropical air mass coming over sea.
It will be warm and moist.

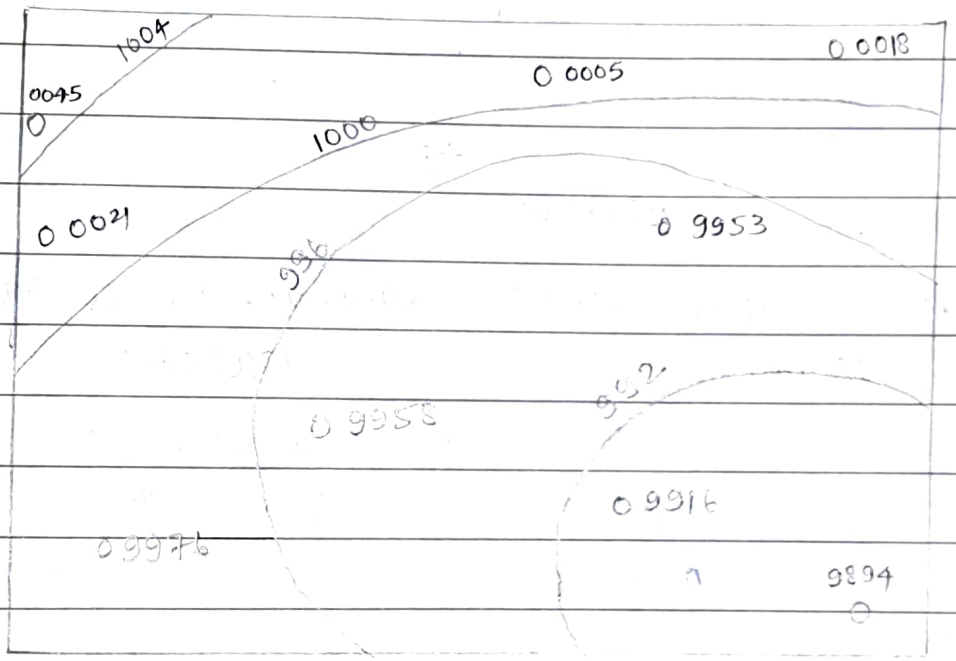
(7) Isobars

(i) What are isobars & how they predict weather?

Ans:-
- An isobars is a line drawn on a weather map connecting all the places having same atmospheric pressure at the time for which that weather map has drawn.
- Isobars are used to depict atmospheric pressure over an area.
- For standarisation, isobars are drawn at 4 mb interrals and pressure denoted by isobars must be divisible by 4 like 996, 1000, 1004 etc. & not like 997, 1002, 1005 etc
- Where consecutive isobars are very far apart, 2 mb interval may be inserted like 996, 998, 1000 etc.
- Also for standarisation, all barometer readings are according to UTC (not ship's time) & at sea level

Few extra points if want

- Isobars are smooth lines which curves gently without any sudden change of direction except at "Fronts"
- Isobars cannot cross or met because atmospheric pressure values can not be different at one place at same time.

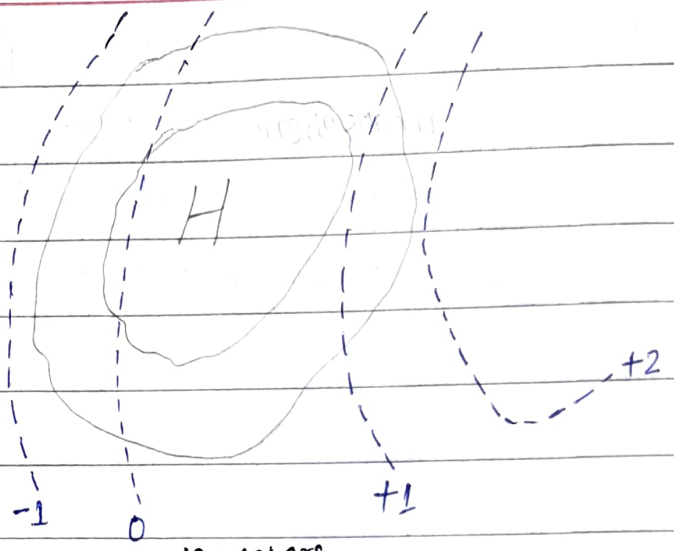


O – observing station
1000 – isobars

(ii) What are isallobars? What is the difference beetween isobars and isallobars?

Ans:-
- An isallabars is a line drawn on a weather map through the places having same tendancy
- Isallobars are used to depict rate of change of atmospheric pressure with respect to time.
- For standarisation, isallobars are drawn at 3 hours interval.

Note:- The word tendancy used above to describe rate of change of pressure with time.



Issalobars

Difference beetween isobars & isallobars are as follows:-

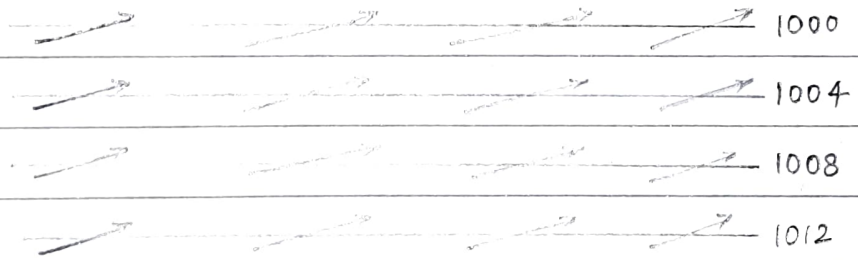
	Isobars	Isallobars
1	Isobars are line drawn on the map through all places having same atmospheric pressure at that time	Isallobars are line drawn on the map through all places having same tendancy with respect to time.
2	Isobars are drawn at 4 mb interval	Isallobars are drawn at 3 hours interval
3.	It is referred for the atmospheric pressure at the time of observation	It is referred for the movement of various pressure in next 3 hours from the time of observation
4.	Isobars have to be corrected for index error and height correction	Isallobars have to be corrected for ship's movement before it can be plotted on weather chart

(iii) With suitable sketches, describe seven isobaric pattern & weather associated with them.

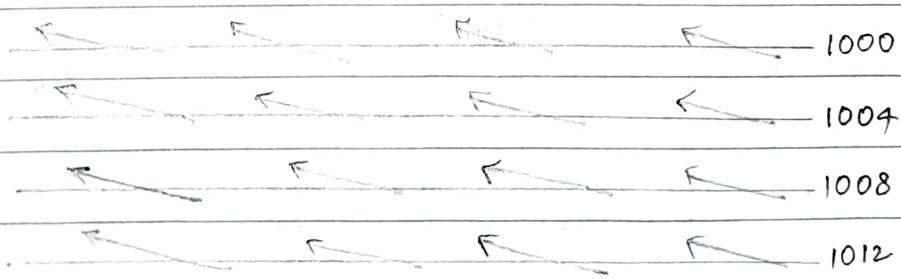
1. Straight isobars

- Straight isobars are said to exist when isobars run straight and nearly parellel for few hundred miles.
- Pressure gradient (fall of pressure per unit distance) is low, resulting in low wind speed
- Wind force and direction remains constant until isobars remain unchanged.
- The weather associated with straight isobars cannot be defined because it depends on properties of air mass present at that particular place.

NORTHERN HEMISPHERE

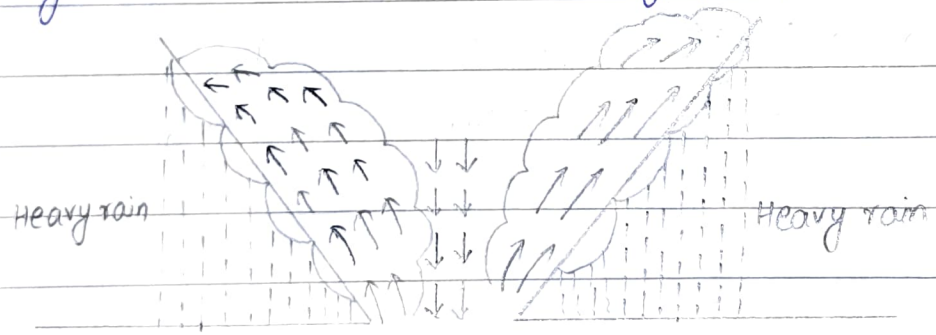


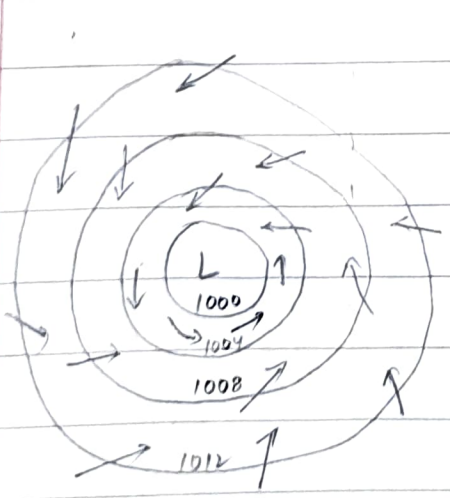
SOUTHERN HEMISPHERE



2. cyclone or low

- Cyclone or low is an area of low pressure surrounded by areas of high pressure.
- The isobars forms a closed shapes.
- Pressure gradient (fall of pressure per unit distance) is usually high, resulting in strong winds.
- The wind blows spirally inwards towards a low pressure anticlockwise in Northern Hemisphere & clockwise in Southern Hemisphere
- A cyclone is an area of convergence of air. On reaching the center, the air moves up as a strong current resulting in cumulus or cumulonimbus clouds of very high vertical extent and heavy percipitation(rain)





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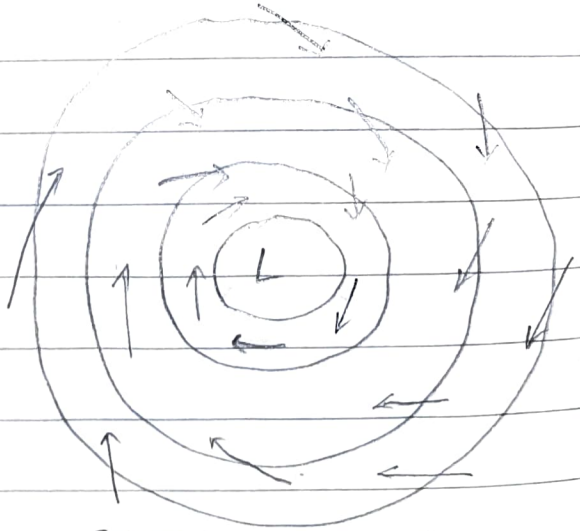
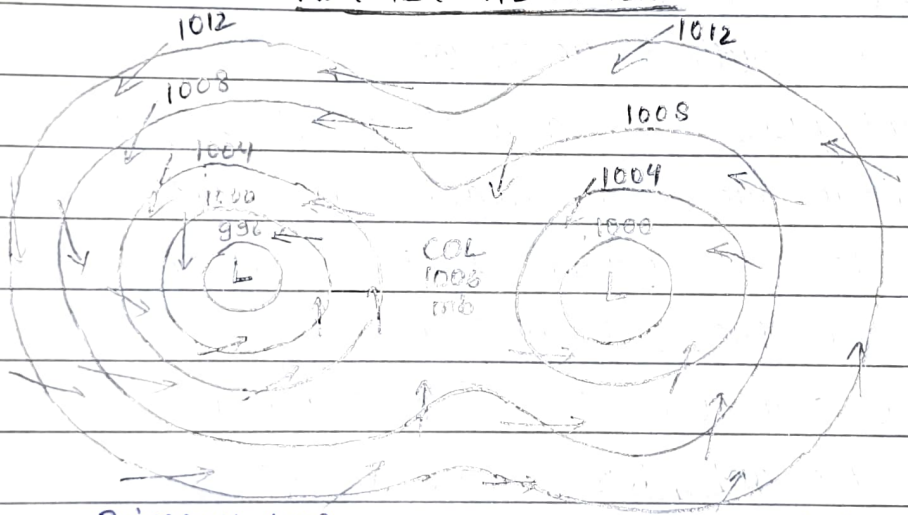


SOUTHERN HEMISPHERE

3. Secondary cylone or secondary low

- Sometimes a low is closely followed by another within its pattern of isobars.
- The first one is called primary low and second one is called secondary low
- The secondary is name secondary only because it formed later but it possesses all the quality of the primary.

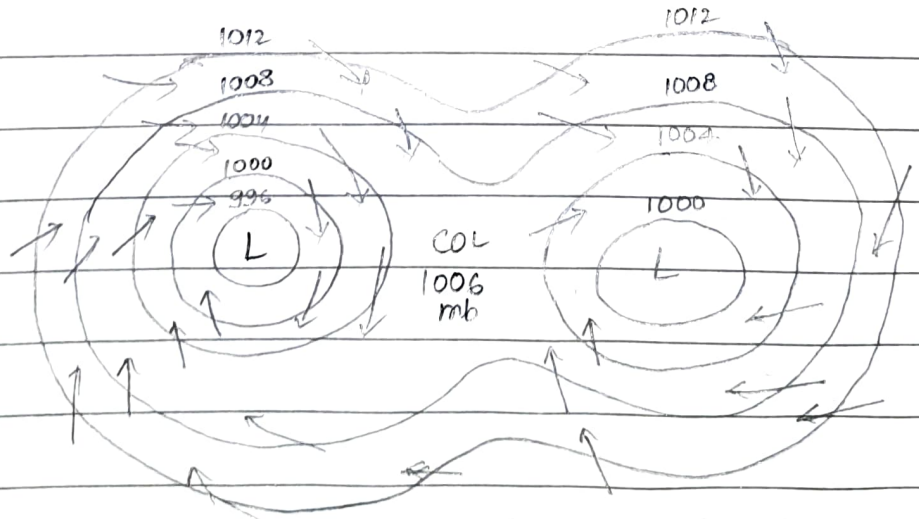
NORTHERN HEMISPHERE



Primary low

Secondary low

SOUTHERN HEMISPHERE

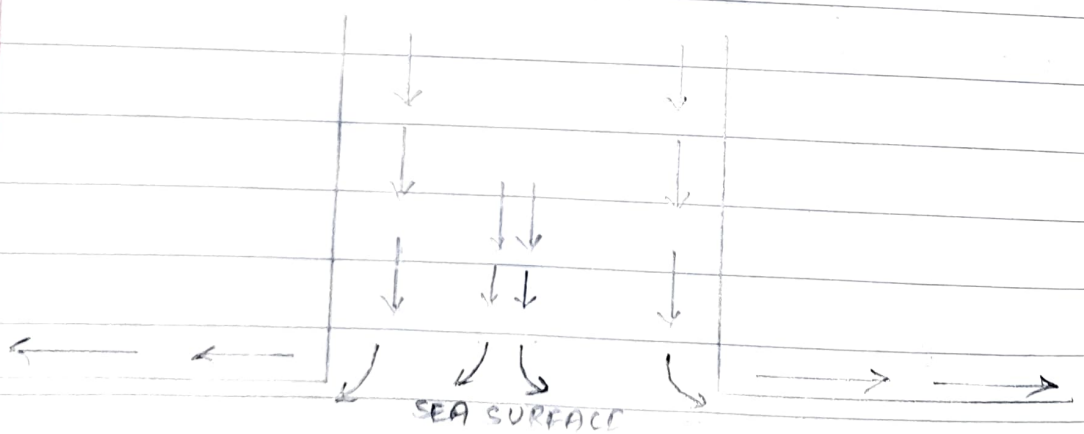


Primary low

Secondary low

4. Anticyclone or high

- Anticyclone or high is an area of high pressure surrounded by areas of low pressure
- The isobars forms a closed shape
- Pressure gradient (falls of pressure per unit distance) is usually low, resulting in low wind speeds
- The wind blows spirally outwards from the center of anticyclone, clockwise in northern Hemisphere and anticlock-wise in Southern Hemisphere
- A anticyclone is an area of divergence of air. The outflow of air is due to downward current of air at center.
- This descending column of air warms up and becomes relatively drier and more drier as it descends.
- There is a total absence of any cloud or percipitation over the anticyclone. Hence, anticyclone is a sign of good weather - light winds, no clouds, good visibility, no percipitation etc.

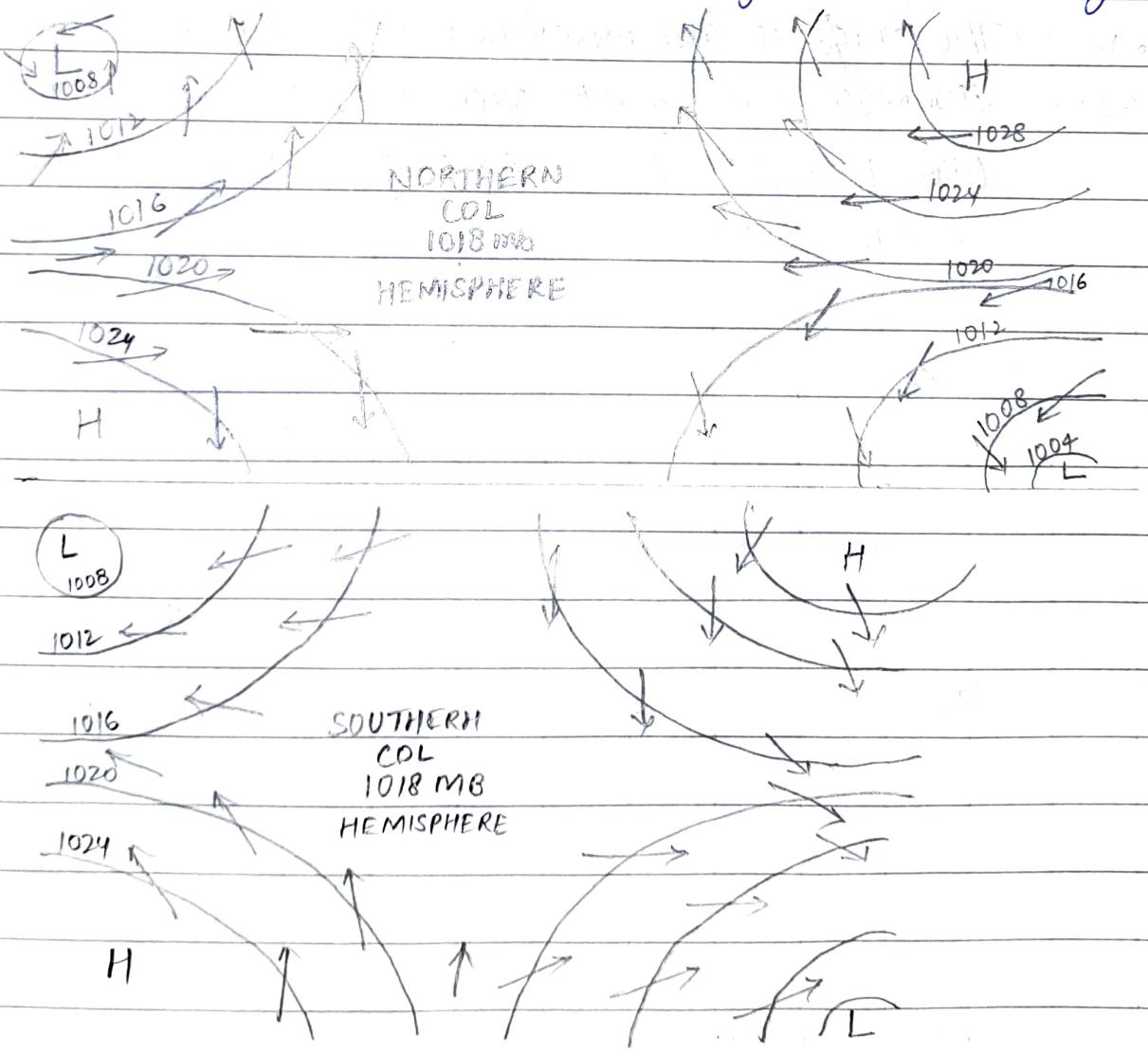


NORTHERN HEMISPHERE

SOUTHERN HEMISPHERE

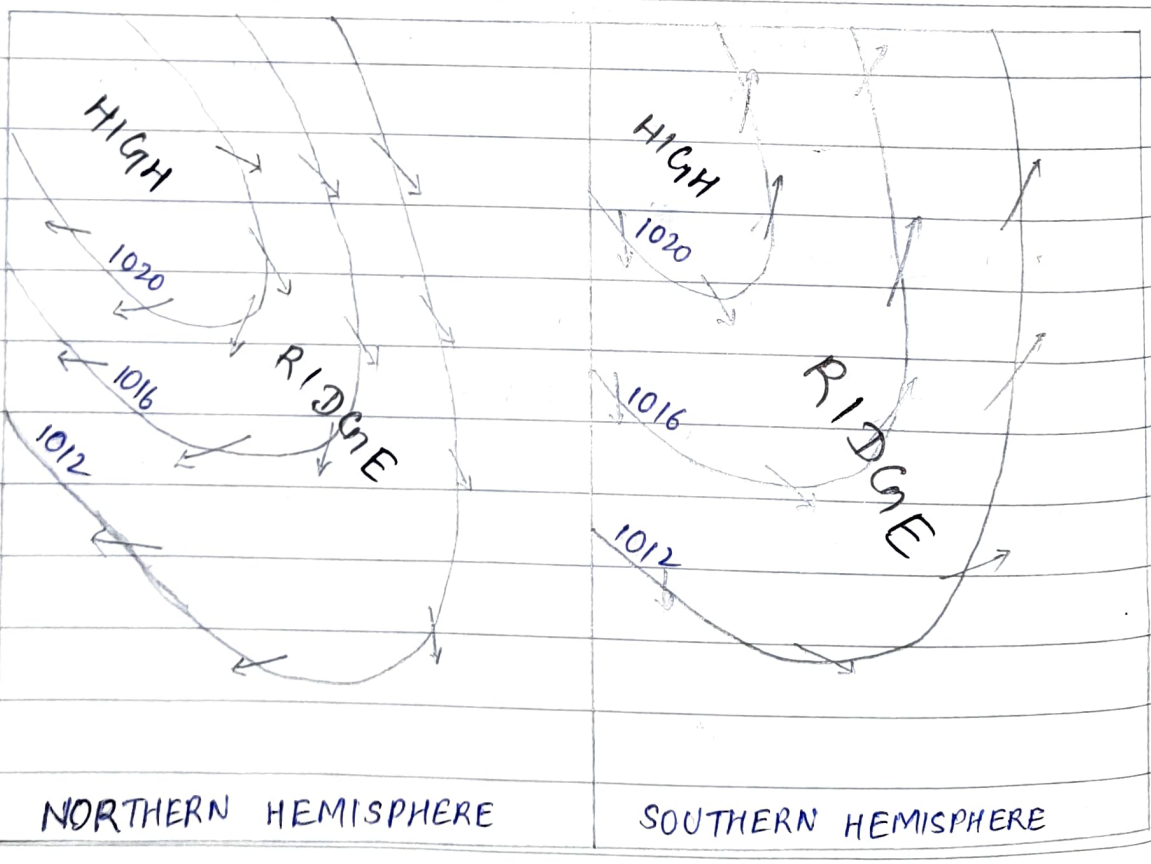
5. Col

- A col is an area between two high pressure & two low pressure area situated alternately.
- Light variable winds are expected but not for long period.
- Sudden change of weather is likely to be experienced.
- NO definite weather pattern is associated with the col. It depend on the air mass above it.
- If there is cold air mass, thunderstorms are expected & if there is warm air mass, radiation fog or advection may develop.



* 6. Ridge or wedge

- A ridge is an area of high pressure extending into areas of low pressure.
- The isobars are curved, in which the pressure is higher on the inside than on the outside.
- It is usually an extension of an anticyclone but may also form by itself.
- The weather associated with ridge is same as that of anticyclone - no percipitation, light winds, no clouds.
- The ridge is also experienced beetween a primary low and its secondary low. In such case, the good weather is likely to experience but for a short period of time (couple of hours only).



*(7) Trough

- A trough is an area of low pressure extending into areas of high pressure.
- The isobars are curved, in which pressure is lower on the inside than on the outside, but they do not form closed shapes.
- The pressure gradient is high resulting in strong winds.
- The wind blows from high pressure (HP) to low pressure (LP) areas, wind gets deflected to the right in NH & to the left in SH by coriolis force.
- The weather associated with trough is bad. Before the trough, pressure falls & weather deteriorates. After the passage of a trough, pressure rises & weather improves.

There are two forms of trough:

Non-frontal trough:

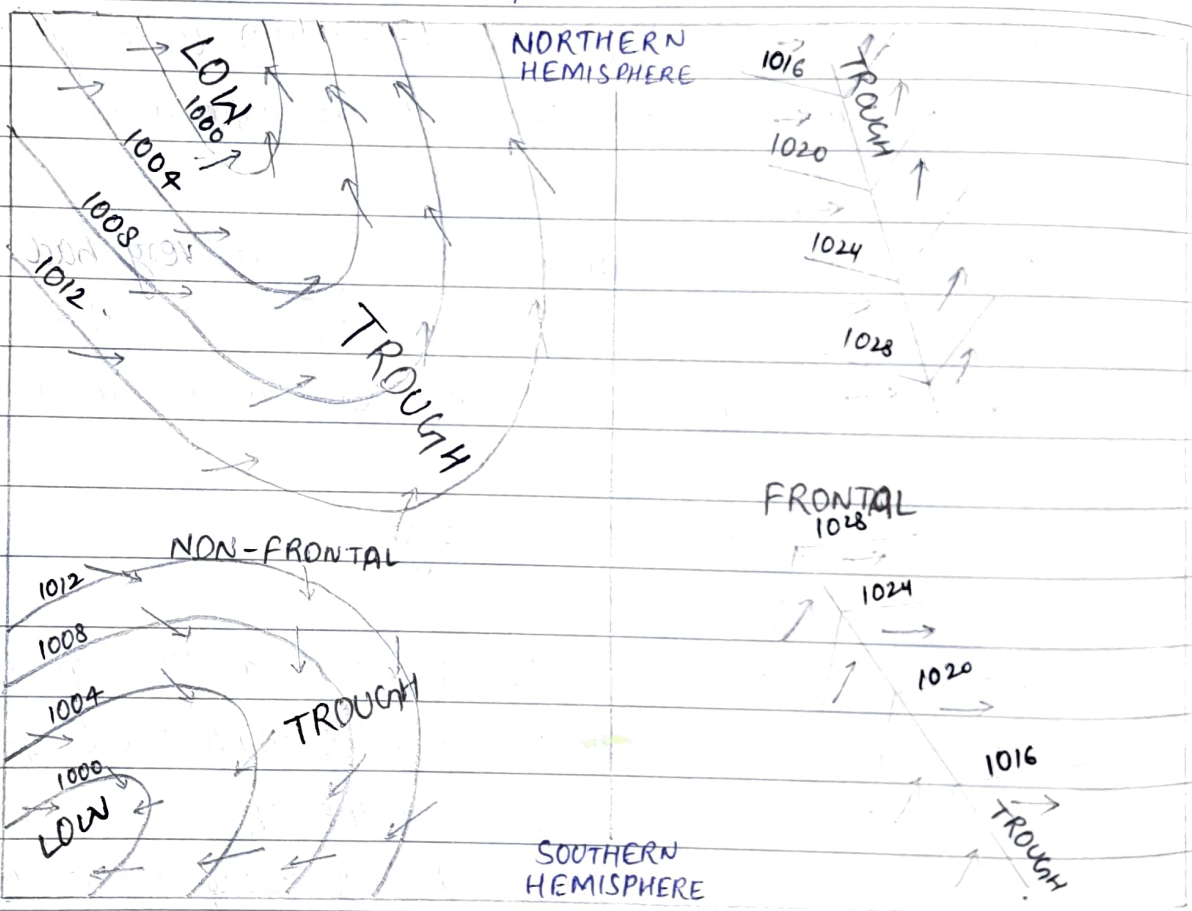
- In non-frontal trough, isobars change direction gradually.
- When it passes over an observer, the wind veers gradually in the NH & backs gradually in the SH.
- The 'U' of the non-frontal trough always points towards the equator.

Frontal trough:

- A frontal trough exists at the boundary beetween two different air masses.
- On crossing frontal trough, the isobars change direction

Suddenly by 90°.

- When it passes over an observer, wind veers in the NH and backs in the SH.
- The 'V' formed by the isobars always points towards the equator.
- Since one air mass is replaced by another, change in temperature is also experienced.

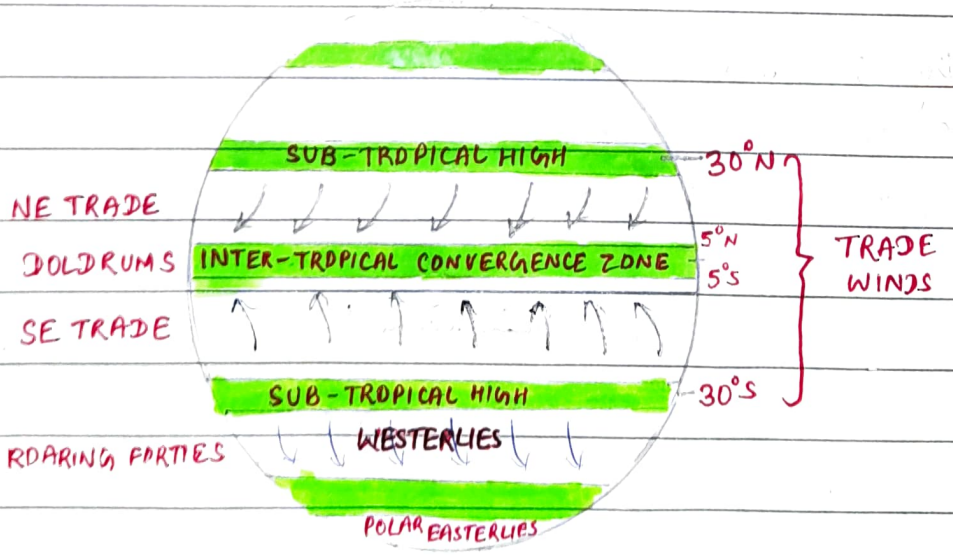


(8) Write short notes on

(a) Doldrums, Intertropical convergence zone (ITCZ)

Ans:-

- Doldrums are zone of light ocean currents and winds, The weather associated with doldrum are low atmospheric pressure, heavy rain or thunderstorm
- They occur along the equitorial region in the Indian and wes -tern pacific oceans.
- This zone or region are often known as Intertropical convergence zone. It is an oceanic belt around the earth extending approximately 5°N & 5°S of equator.
- Here, the north-easterly & south-easterly trade wind converge together and the intense heating over the equitorial region causes warm moist air to rise. As air rises, it cools adiabatically resulting in heavy rain or thunderstorm.
- Doldrums was dreaded for crew of sailing ship because it can becalm sailing ship for weeks.



(b) Westerlies

- The westerlies, anti-trades are the permanent wind that blows from west towards east in the middle latitudes beetween 30° & 60° latitude.
- In these zones, gales are frequent, especially in winter.
- Grales are so frequent in Southern Hemisphere at 40°s, that it is named as the Roaring Forties.
- The weather changes rapidly & prolong fine weather are rare (uncommon).

Diagram same as of in 46(1)

(g) Sketch and explain mean surface distribution of pressure on oceans during summer and winter months.

Ans:- During summer, the temperature of land is high, hence ~~the temperature of~~ air in contact with them also get high, resulting in low pressure over them.

During winter, the temperature of land is low, hence the temperature of air in contact with them also get low, resulting in high pressure over them.

In short, over land, there is low pressure in summer and high pressure in winter. The wind force & direction become modified accordingly.

But over sea, there is not much change in temperature between summer and winter and there is

- A permanent low over the equator called the doldrums or Inter Tropical convergence zone (ITCZ)
- Permanent highs at about 30°N & 30°S
- Permanent lows at about 60°N & 60°S.

Diagram is same as in previous page 46(1)

Q.5 CLOUDS/VISIBILITY/CLIMATOLOGY

(1) Front

(b) ~~Define front? or what is a front?~~

The boundary beetween two adjacent air mass of different characteristics is called as a front.

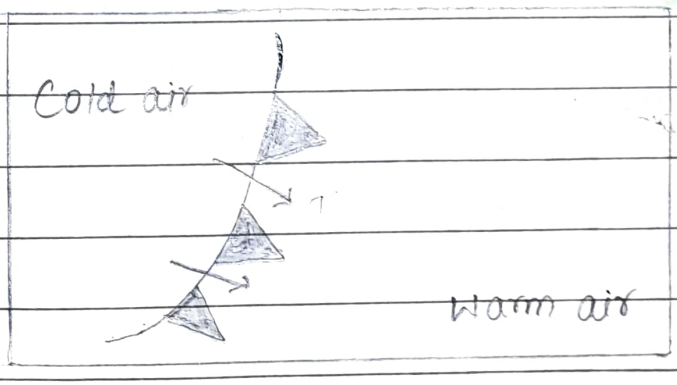
Hence tropical air is warmer and less dense than polar air, it will climb over the polar air at front. And that is why, front is not vertical, it is always be inclined towards the colder air mass.

(ii) @ Explain cold front, warm front, stationary front and occluded front and how these fronts are formed?

(b) Explain weather associated with these front

(c) Give necessary diagram

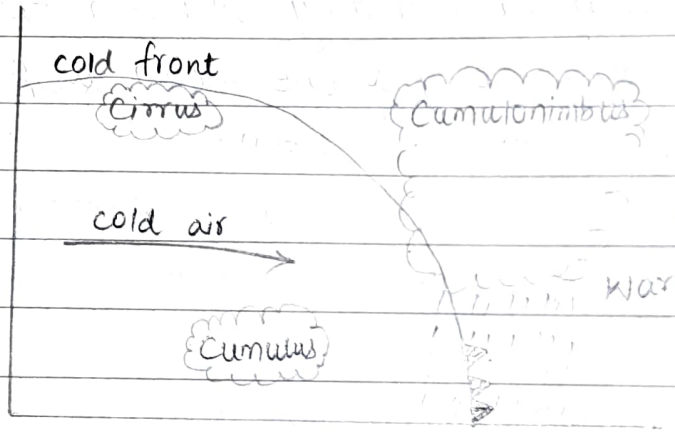
ns :- **Cold front** :- A changeover region where a cold air masses is replacing a warm air mass is known as cold front. Also when a front passes through a place, the atmospheric temperature gets lower than it was before, that front is known as cold front.



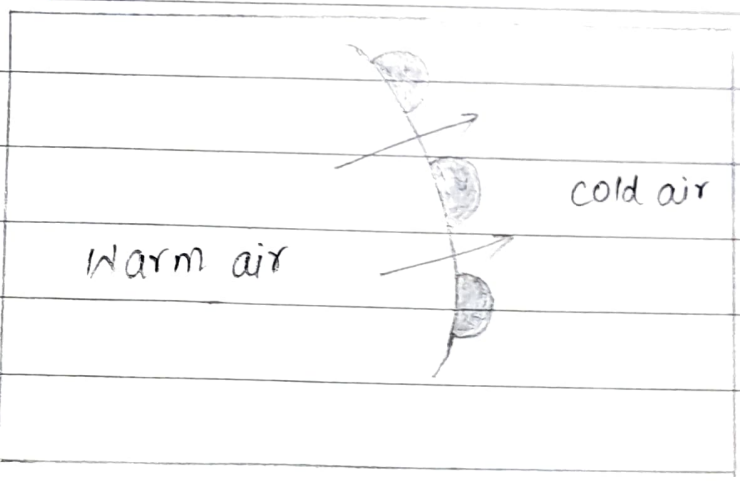
P.T.O

Weather associated with cold front :-

Elements	In Advance	At cold front	In rear
Pressure	Little change	Rapid increase	Increase
Wind	Steady	Veers, squally	decreases
Temperature	Steady	Decreases	Steady
Cloud	St	Cu, Cb	Cu, Cb
Weather	Cloudy, drizzle	Thunderstorms	Showers
visibility	Poor	Poor	Good



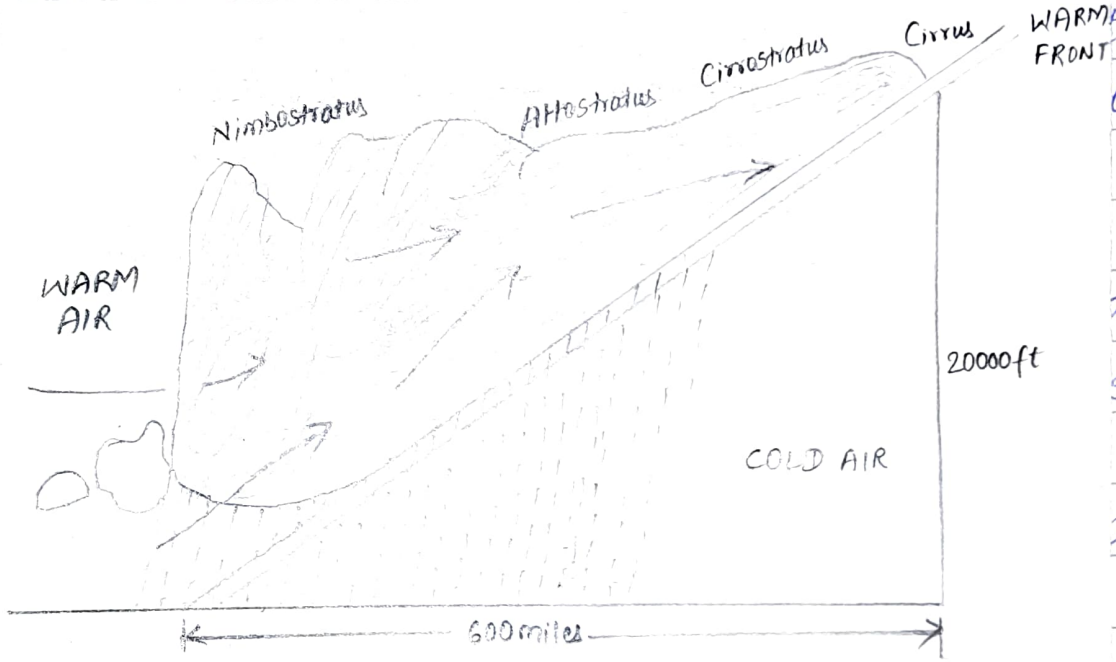
Warm front :- A change over region when a warm air masses replaces a cold air mass is known as warm also Also, when a front passes through a place, the atmospheric temperature gets higher than it was before, that front is known as warm front

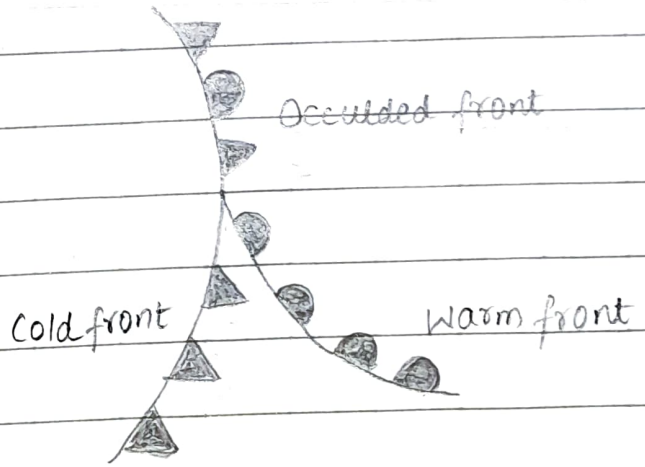


Weather associated with warm front :-

Elements	In advance	At Warm front	In rear
Pressure	Fall	Steady	Slow fall
Wind	Increasing	Steady	Steady
Temperature	Slow rise	Rise	
Cloud	Ci, Cs, As, Ns	Low Ns	St or Sc
Weather	Continuos rain	Stops	Cloudy, drizzle
Visibility	very good	poor	poor

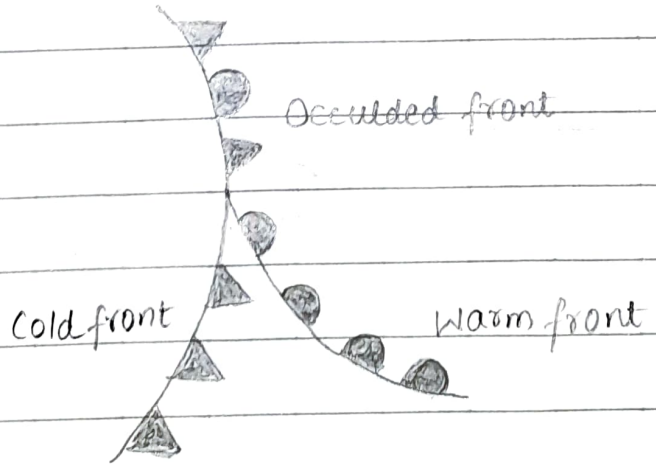
* WARM FRONT





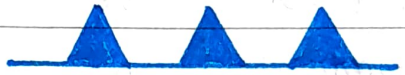
Stationary front :- If the front is not moving (i.e. the two air masses on the either side are not moving), it is called as a stationary front.

Occluded front :- An occluded front is formed when a cold front meets a warm front that was moving ahead of it (Typically cold fronts move faster than warm fronts). OR, we can say, an occluded front is form when cold front overtakes a warm front.



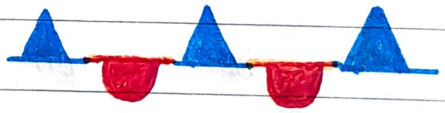
(iii) How fronts are depicted on a weather map.

Ans:- Cold fronts:- Cold fronts are depicted by blue line with traingles pointing in direction of motion.

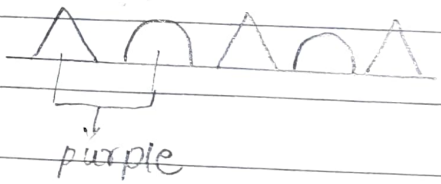


Warm front:- Warm fronts are depicted by red line with half moons pointing in direction of motion.

Stationary fronts:- Stationary front is depicted by alternating blue and red line with traingle on blue and half moon on red in opposite sides.



Occulded fronts:- Occulded front is depicted by purple line with alternating traingle and half moon in direction of motion



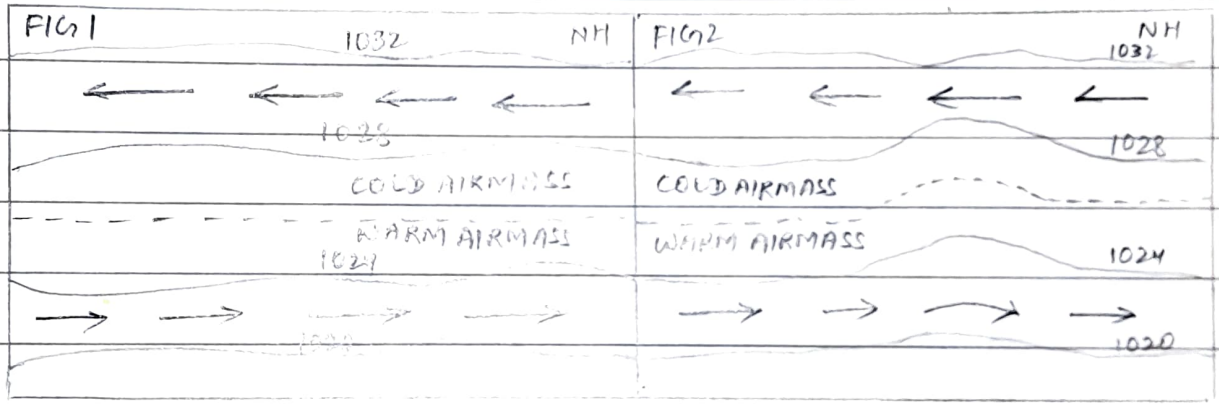
(2) Frontal depression

(i) Short Note on frontal depression

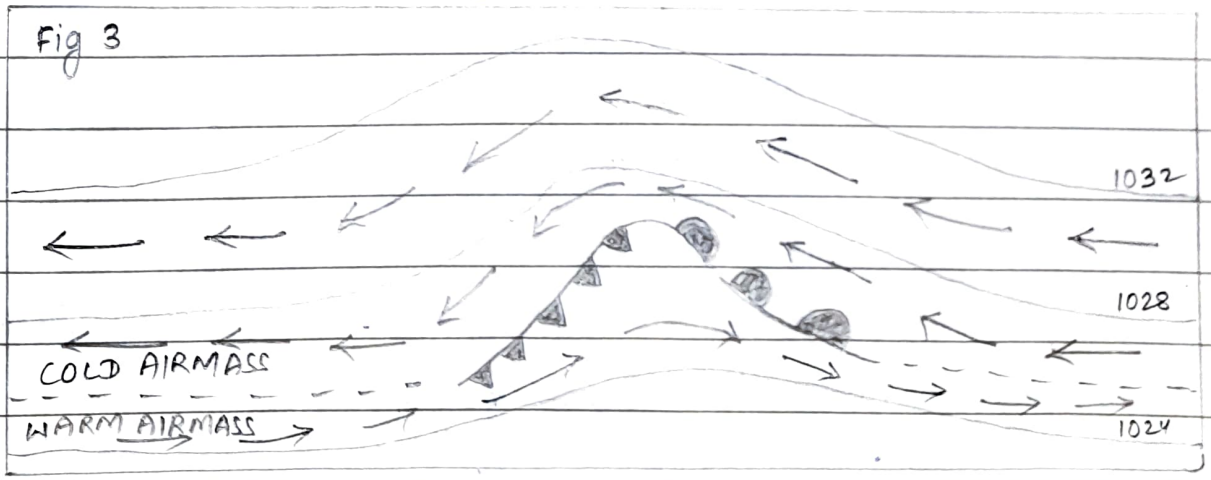
Ans:- A frontal depression is a low pressure area formed at the boundary beetween two different air masses. Frontal depression occur in middle or high latitude.

The formation of frontal depression is assisted by a large temperature difference beetween warm and cold air masses known as Frontogenesis.

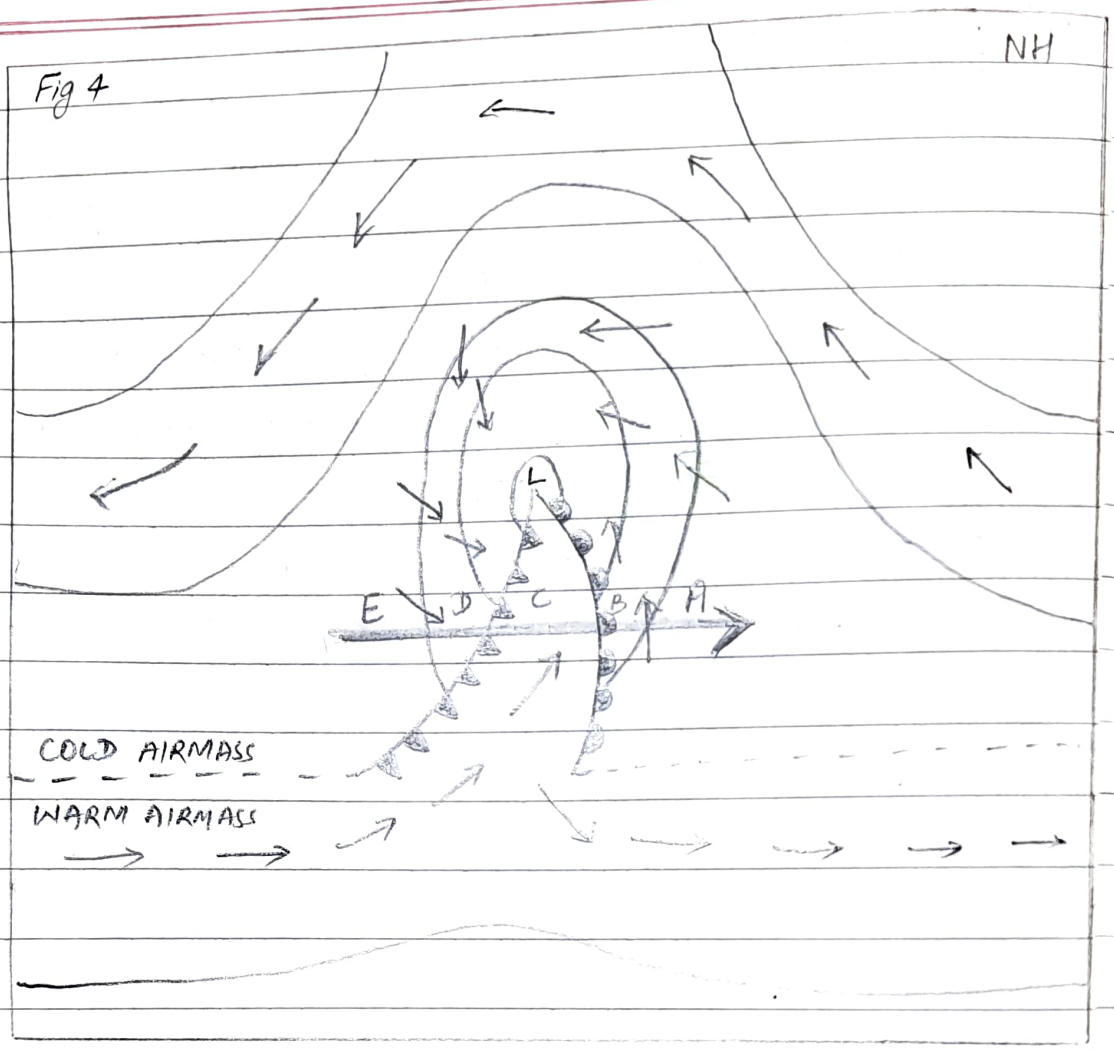
The frontal depression begins as a small bulge of warm air in cold air. (As we can see in fig 1 & 2)



The bulge increase in size and the isobars in the cold air bend accordingly. (Fig 3)



The bend isobars then take closed shapes and wind starts blowing inward, anticlockwise in the NH (Fig 4)



A - before warmfront

B - At warm front

C - Warm sector

D - At cold front

E - Afterwards

Frontolysis is the weakening & final dissipation of frontal depression The first step is the formation of occlusion. The cold air in front of & behind the warm sector of frontol depression undercut the warm air and lift it completly above sea level. The depression is then said to be occluded

middle lat - between 30° & 60°
high lat - above 60° upto pole i.e. 90°

classmate
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(ii) Describe with sketch the features of middle/ high latitude depression.

Middle latitude depression

Ans:-
- A depression is a large mass of warm rising air forming low pressure surrounded by high pressure area with cold descending air. The mid-latitude is one such area.
- It occurs beetween 30° and 60° Nth and south of equator.
- Here the warm tropical air mass meets the cold polar air mass. & when they meet, they form fronts in mid-latitude areas.
- Because tropical air is warmer and hence less dense than polar air; so tropical (warm) air climb over the polar (cold) air at the front.
- The frontal depression begins as a small bulge of warm air in cold air (see in Fig 1 & Fig 2 of page-51)
- As the cold front moves into the warm front (cold air replace warm air), it wants to wrap itself around the warm air. It pushes the warm air up creating an area of low pressure at centre forming a depression. (warm air replace cold air)

Weather associated with it are as follows:-
- As warm front approaches, high cirrus cloud appear. The cloud then thickens and lowers, (cumulus and then stratus) and rain falls. As the warm sector passes over, skies clear and the temperature rises.
- As cold front approaches, the stratus cloud clear and cumulonimbus cloud appear, which bring gusty winds and showers. At the cold front, heavy rainfall and strong breeze can occur, temperature drops and visiblity improves.

(3) Write short note on :-

(a) **Dew**

Ans:-
- Dew is a type of percipitation where water vapour condenses into droplets of water and get deposited on or near the ground
- On clear night, land gives off heat & get cooled. At the end of clear nights (early morning), surface of the land get cooled & the air in contact with the ground also cools to or below its dew point resulting in formation of tiny droplets of water known as dew.
- Dew can also be formed if a warm moist wind blows over a cold land surface
- Rest, presence of water on the surface (like leaves, grasses etc.) speeds up formation of dew.

(b) **Hoarfrost**

Ans:-
- Hoarfrost is (a also a type of percipitation) where water vapour directly turns into ice without becoming water & get deposited on or near the ground.
- When the ground temperature is much lower than freezing point, it result in formation of soft ice crystals known as hoarfrost
- Rest, presence of ice-particles on the surface quickens the formation of hoarfrost.

Note :- When water vapour turns into solid without becoming liquid, it is also denied as sublimation.

- Hoarfrost must not be confused with frozen dew. In case of frozen dew, water vapour becomes water and then freezes. But in hoarfrost, water vapour directly becomes ice.

(c) **Glazed frost**

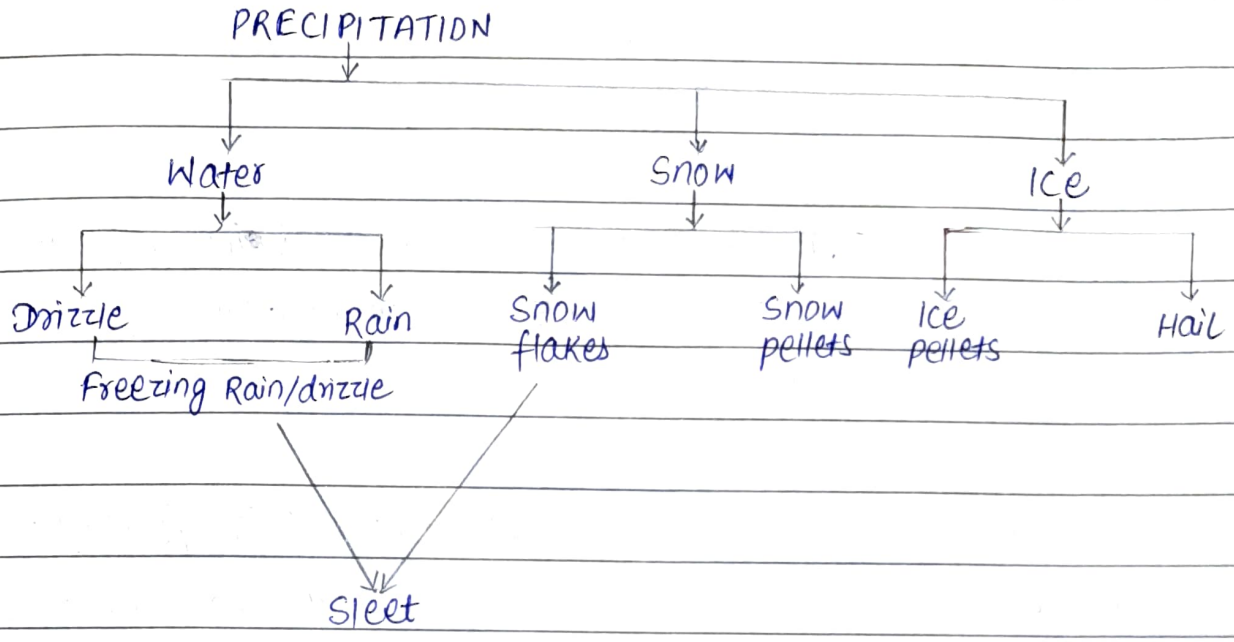
- It is a thin, transparent, smooth layer of ice formed when rain/drizzle falls on a surface whose temperature is below freezing point.
- Glazed frost can also be formed if warm moist air blows over a cold surface.
- In the UK, glazed frost is also known as "Black ice" because it cannot be distinguished against black road. It is dangerous to walk or drive on it, as they are very smooth and slippery.

(d) **RIME**

- If the temperature of the water particle in a fog/cloud is below 0°C, it is known as supercooled droplets of water.
- When this supercooled water droplets come into contact of very cold solid object such as ship's masts, superstructure etc whose temperature is below 0°C, they freeze immediately and stuck to the solid object in the form of ice.
- This white deposit of ice is called **RIME**
- It forms only on the windward side of the object.
- RIME should not be confused with hoarfrost.

(4) What are the various forms of percipitation.

Ans:- Percipitation is the process behind the condensation of water vapour in the atmosphere which falls down to the earth surface in the form of solid or liquid. While faling through different layers of atmosphere, water may freeze into a soft ice (snow) or into a hard ice (hail)



- **Drizzle** : Fine drops of water, diameter less than 0.5 mm diameter
  Termed heavy or light depending on intensity of precipitation.
  Clouds - St, Sc
- **Rain** : Water drops larger than 0.5 mm diameter
  Termed heavy or light depending on intensity of precipitation
  Clouds - Ns, As, Sc, Ac, Cu, Cb
- Freezing rain/drizzle : When water falls on a surface whose temperature is below freezing point.
  Clouds - Same as Rain/ Drizzle.
- Snow flakes - Soft ice crystals (which we love to watch)
  Clouds - Ns, As, Sc, Cb
- Snow pellets - White opaque grains of ice. Very soft. Sphere or conical in shape. Diameter beetween 2 and 5mm
  Clouds - Cb in cold weather.
- **Sleet** : Sometimes rain and snow fall together or partly melted snowflakes falls. This is known as sleet.
  Clouds - same as snowflakes.

- Ice pellets : Transparent pellets of ice, frozen hard
  Less than 0.5 mm diameter.
  Clouds - Ns, As, Cb
- Hail :- Hailstones are balls of hard ice with diameter ranging from 0.5 to 50 mm or more
  Clouds - Cb

(5) Define @ fog & mist and explain how it is formed.

Ans :- • When air is cooled below its dew point, air becomes saturated and gives off water. The water particles are so small that they remain suspended in the air which condenses on minute (मायनुट) particles of salt, dust etc. thereby reducing the visibility is known as **mist**.

If mist becomes dense and reduces visibility to 1 Km or less is known as **fog**.

- **Mist** can occur when relative humidity is as low as 80% - radius of water droplets is less than 1 micron
  Fog generally occur when relative humidity is 90% or more - the radius of water droplets is between 1 & 10 microns.
- Mist is always experienced before and after fog.

(b) Haze

If visibility is reduced by solid particles that are suspended in the air such as dust, sand, volcanic ash etc., **haze** is said to be exist

© Spray

The small droplets of water driven by wind from the top of waves is known as spray. Spray affects visibility when the wind force is 9 or more (wind speed of over 40 knots).

⑥ Write short notes on types of FOG

OR

List the different types of fog. Type and formation of fog occuring at Dover strait. Explain why there is persistent fog off the Grand Banks of Newfoundland?

Ans:- @ Radiation fog/Land fog

- It is also called land fog because it forms only over land not over sea.
- During the night, land gives off heat very quickly. Thus, the air in contact with the land gets cooled & if cooled below its dew point temperature, a large amount of dew is deposited.
- If a light breeze is blowing, turbulence causes the cold air from land surface to mix with air which is couples of metres above the ground caused land fog.
- If the wind is bit stronger, radiation fog may extend upto 150 metres or above from ground.
- If there is strong wind, it will cause too much turbulence resulting in low clouds (stratus type) and no fog.
- Radiation fog also drift towards rivers, lakes and other coastal region like fog on the thames river, Dover strait, sandheads of the Hooghly river etc.
- Radiation fog forms over land because of the large diurnal range of air temperature over land.

* (b) Advection fog / sea fog.

- It is also called sea fog because it forms mostly over sea but can form over land also.
- It is formed when a moist wind blows over a relatively cold surface of sea or land
- When moist air is cooled below its dew point, the excess water vapour condenses into small droplets of water on dust, minute particles of salt etc. causes advection fog
- If a light breeze is blowing, it will cause advection fog to form and also to spread.
- If the wind is bit stronger, it causes advection fog to form to considerable depth.
- If there is a strong wind, it will carry moisture too high resulting in low clouds (stratus type) and no fog.

Best examples of advection fog are:

- On the Grand Banks of new Foundland, where the warm moist westerlies blow over warm Gulf streass, cross over the cold Labrador current.
- On the east coast of Japan, where the warm moist westerlies blow over warm Kuro shio, cross over cold Oya shio.

* (c) Arctic sea smoke / Steam fog

- When a cold, dry air passes over a relatively warm sea surface, the water vapour evaporating from sea surface quickly condenses into water droplets.

- It appears as vertical streaks of smoke rising from sea surface. This is known as steam fog. or arctic sea smoke.
- It is most common in arctic, antartic waters.

(d) SMOG

It is a radiation fog mixed with industrial smoke

Smoke + Fog = SMOG

It is thick, black, oppresive blankets which not only wets all exposed surface but also make them black due to carbon particles.

(e) Orographic fog/ hill fog.

In hilly areas, when wind starts climbing over the hills, its temperature drops progressively. On ascending further, the air is cooled below its dew point causes the excess moisture to condense into water droplets forming hill fog or orographic fog.

(7) Describe the method of estimating visiblity at sea by day or by night.

Ans:- During day:

(i) By observing passing vessel and noting their RADAR range when they are just seen & last observed

(ii) While coasting, by observing lighthouse, buoys etc and noting their charted range when they are just seen and last observed.

(iii) By observing the horizon by experience can be used to estimate the visiblity.

During night:

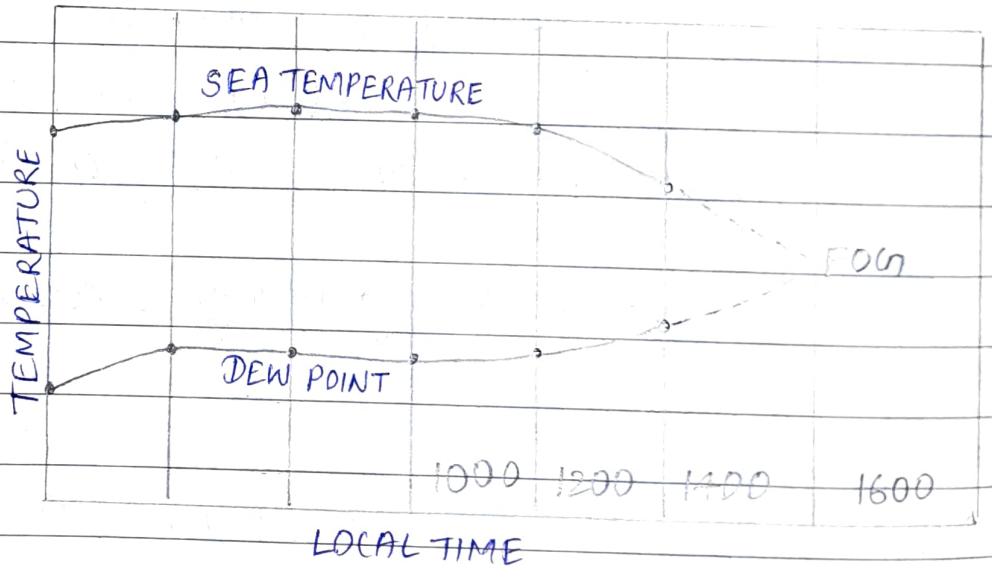
(i) If there is no meterological change before dark, the visibility after dark could be same as before dark.

(ii) By observing navigation lights of passing vessel and noting their RADAR range when they are just seen and last observed.

(iii) While coasting, by observing shore lights and noting their RADAR range when they are just seen and last observed.

(8) How will you predict fog at sea.

Ans:- • The possible time of occurrence of advection fog can be predicted by plotting the temperature of sea surface and the dew point temperature of air



• In the case above, it is observed that two curves appears to converge

• By extending it (dotted lines), it is observed that curves would intersect at about 1400 hrs, that means, we can expect advection fog at about 1400 hours.

(9) CLOUDS

(i) How clouds are formed? Explain classification of different types of clouds as per height from sea level?

Ans:- • When air is cooled below its dew point temperature, the excess water vapour condenses into very small droplets of water on dust, minute particles of salt, volcanic ash etc. which remain suspended in the air. Millions of such particles close together, which is visible as clouds.

• Clouds can form at any height from sea level to tropopause. They are hence grouped according to their height from sea level.

Low clouds consist entirely of water droplets. Their bases will be beetween sea level and 2Km above sea level.

Medium clouds have prefix "ALTO" in their names & consist of both water droplets and ice particles. Their bases will be beetween 2 Km and 6m above sea level.

High clouds have prefix "CIRRO" in their names & consist of ice particles. Their bases will be beetween 6 Km above sea level and the tropopause

High clouds	Medium clouds	Low clouds	Special clouds
Bases beetween 6Km-tropopause	bases beetween 2Km and 6Km	bases beetween sea level and 2Km	From near ground to 14 Km
Cirrus (Ci)		Nimbostratus (Ns)	
Cirrocumulus (Cc)	Altocumulus (AC)	Stratus (St)	Cumulus (Cu)
Cirrostratus (Cs)	Altostratus (As)	Stratocumulus (Sc)	Cumulonimbus (Cb)

(ii) Explain various types of clouds.

Ans:- Clouds forms are divided into 10 groups. All those are explained below:-

1) Cirrus (Ci)

Silvery or fibrous (hair like) appearence or both

Being so high up, they always have a background of blue sky and during twilight, appears bright red or yellow. On dark nights, cirrus can be detected only by its dimming effect on stars.

2) Cirrocumulus

A high layer of cloud in form of small flakes or cauliflower, white in colour with no shading.

3) Cirrostratus

A thin whitish veil of fibrous (hair like) or smooth appearence through which sun & moon have watery look, totally or partly covering the sky. The outline of the sun and moon are sufficiently clear for altitude observation by sextant

(4) Altocumulus

Cloud in patch, layer or sheet form. White or grey or both in colour with shading. Have appearence of round masses, rolls etc.

(5) Altostratus

A thin greyish or bluish viel of fibrous (hair like) or uniform appearence through which sun or moon appears dim, totally or partly covering the sky. The outline of sun and moon are hazy and not enough clear for altitude observation by sextant.

LOW LEVEL CLOUDS

(6) **Nimbostratus**

A low, even layer of dark grey cloud of uniform and threatening appearence with no light colour patches. It has a wet look. If percipitation occurs, it is continuos not intermittent. It can completly obscure the sun and greatly weaken daylight.

(7) **Stratus**

A low, even layer of dark grey cloud with light and dark patches. It has a dry look & does not occur precipitation. It look like fog. It can completly obscure the sun and greatly weaken daylight.

(8) **Stratocumulus**

Clouds in patch, layer or sheet form. White or grey or both with dark shadows. Have appearence of round masses, rolls etc.

SPECIAL

(9) **Cumulus**

A thick white cloud with flat bases with rounded cauliflower-like tops with dark shadows in their base. Cumulus clouds may be in small patches with ragged edges & little vertical extend - called fair weather cumulus or great verticle sextant - called towering cumulus. If precipitation occurs, it is even.

(10) **Cumulonimbus**

A heavy and dense grey cloud with great vertical extent which base is in low cloud level & top is in high cloud level. The top of well developed cumulonimbus will attached to white cirrus forming a anvil shape. Cumulonimbus cloud generally produce shower of rain or snow, or sometimes hail or snow pellets & often thunderstorm as well.

convection ↓ Turbulence ↓

How cumulus & stratus clouds are formed & how they differ from each other?

* (iii) Discuss formation of clouds by turbulence, orographic lifting, convection and frontal lifting.

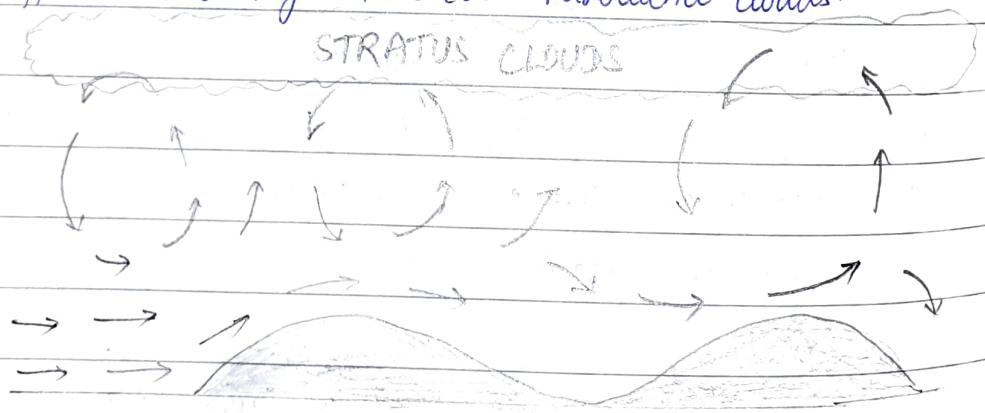
Ans:- Clouds are formed in four main ways:

(a) Turbulence:

- When wind blows over uneven surface, it strike against the various obstruction & get deflected upwards.
- This causes thorough mixing of the air & as the air rises, it get cools adiabatically.
- And if the air ~~get~~ is cooled below its dew point, clouds will form
- These clouds will be of even layer type (stratus) and their bases are not more than 600m high. (low level)

Not so imp

- Turbulence clouds will be formed in great quantities if wind blows over cold, uneven surface.
- At sea, wind speed of more than 13 knots can produce sufficient sea height to create turbulence clouds.



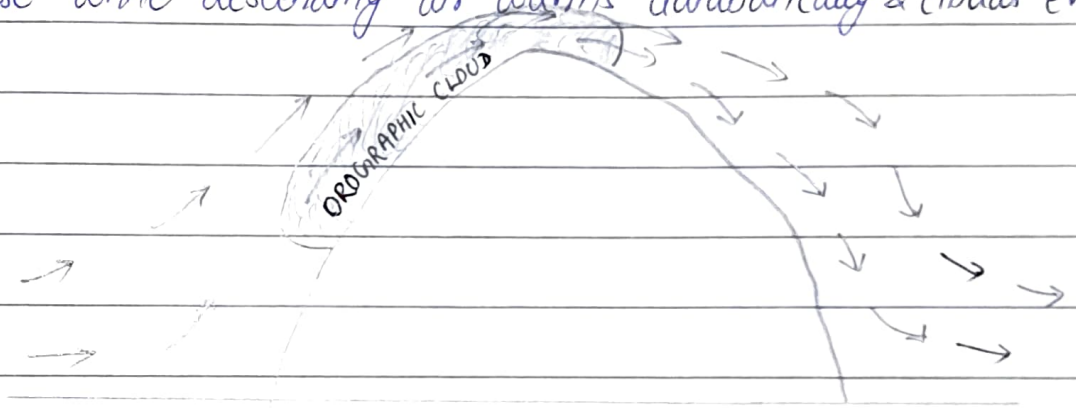
(b) Orographic lifting.

- When warm moist air blows against mountain range, it begins to climb up
- During the ascend, it get cools adiabatically.

- On ascending further, air is cooled below its dew point & the orographic clouds will form.
- These are of stratus type but if mountain is quite high, further ascend result in Nimbostratus and continues precipitation.

Not so imp

- On the windward side of the mountain, clouds are forming whereas on the leeward side, they are dissipating at the same rate because while descending air warms adiabatically & clouds evaporate.



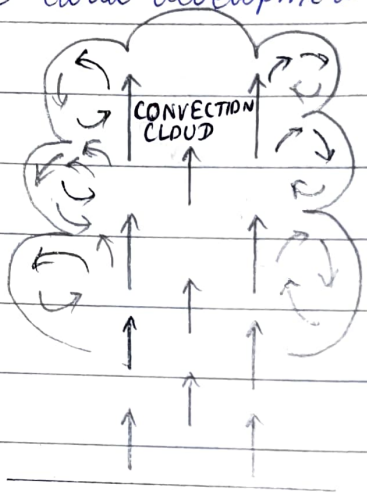
(C) Convection.

- When a parcel of air gets heated above the temperature of surrounding atmosphere due to any local cause like contact with warm sea or ground, it expands, becomes less dense than surrounding air and rises
- During the ascend, rising air cools adiabatically.
- On ascending further, air is cooled below its dew point, condensation take place & convection clouds will form.
- These are of cumulus type

Not so imp

- As air ascend more, it get cooled more progressively. The excess moisture condense into more and more cloud, resulting in great vertical extent of the cloud - towering cumulus.

- Over land, cumulus clouds begins to form in the morning after sunrise & reach their maximum quantity around late afternoon, when land temperature is highest & begins to dissipate after sunset as the land cools.
- Over sea, there is little change of air temperature during day and night, hence cloud development is very little.



(d) Frontal lifting

- The boundary beetween warm air mass & cold air mass is called a front. The boundary beetween them is not vertical. It is inclined towards colder air mass because cold air is denser, it acts as a wedge and lifts up the warm air.
- In the case of a warm front, the slope is gradual and the upsliding warm air forms: nimbostratus, altostratus, cirrostratus and finaly cirrus
- In the case of a cold front, the slope is very steep and the upsliding warm air forms: cumulonimbus and cumulus clouds.

(10) Write short notes on

(a) Sea and swell

Ans:- • Sea (waves) is the name given to waves, on the sea surface, formed by wind that is presently blowing. In open water, height of sea is directly related to the wind force (as per beaufort scale)

(a) • Swell is the name given to waves, on the sea surface, formed by wind that has stopped blowing or blowing at some other places quite far away. (b) Swell travels quickly & can be felt from 1000 miles away. (c) Swell travels radially outwards from center of storm & that is first indication of presence and bearing of TRS.

(b) Gust and squall

A gust of wind is the sudden increase of wind speed for a very short period of time. It is usually caused by terrestrial obstruction to the flow of wind.

A squall is the sudden increase of wind force by atleast three stages of beaufort scale (increase of atleast 16 knots wind speed), reaching upto atleast force 6 (22 knots) and lasting atleast 1 minute

A squall is different from gust of wind by its greater duration

(C) Veering and backing

Veering is a clockwise change of direction from which the wind is blowing e.g. from N to NE, from S to SW, from W to NW etc.

Backing is an anticlockwise change of direction from which the wind is blowing e.g. from N to NW, from S to SE, from SW to S etc.

(d) Tsunami

Ans:- • Tsunamis are series of giant waves caused by earthquakes or volcanic eruptions under the sea.

• It has very long wavelength wave of water which can be measured upto 500 kilometres.

• Tsunami wave height do not increase much in deep oceans, but as the wave travel inland, height gets increasing as depth of the ocean decreases.

• Tsunami have wave velocity (i.e. speed of the wave) upto 950 Km/hr whereas wave velocity of normal ocean waves are about 90 Km/hr which slow down when reaching shallow water.

Few causes of tsunami are as below:

(i) Earthquake: It causes tsunami by causing a disturbance of the seafloor.

(ii) Volcanic Eruptions: It occurs along coastal zones like Japan etc. which causes several effect that might generate a tsunami.

(iii) Landslides: Landslides moving into ocean, bays or lakes can also generate tsunami.

(iv) Underwater explosions: Nuclear testing by United states in the Marshal Island in 1940 & 1950 generated tsunami.

(e) Tidal Bore

A tidal bore is a tidal phenomenon in which the leading edge of the incoming tide forms a wave of water that travels upriver or narrow bay against the direction of the river

or bay's current. It is a true tidal wave and not to be confused with tsunami.

Bores occurs in few locations worldwide, usually in areas with a large tidal range, where incoming tides are funneled into a shallow, narrowing river or lake via a broad way.

Q. 6. WEATHER SYSTEM / SEA AND SWELL / WEATHER FORECASTING

(1)(i) What is facsimile recorder? Describe various type of information recieved by fascimile reciever.

Ans:- The facsimile recorder is an instrument which reproduces on board ship, an exact copy of weather map drawn by meteorologist ashore in meteorological center.

The meteorological center recieves weather report from different station and meteorologist draws a weather map. The map is then scanned electronicaly and transmitted to the ship via satellite communication.

The various information recieved by fascimile reciever are:

The informations are presented as a chart showing:

(i) Barometric pressure (at sea level)
(ii) Barometric tendancy
(iii) Pressure gradient
(iv) wind speed & direction
(v) temperature
(vi) type of low/medium/high cloud
(vii) Present weather.

Fascimile charts fall into two basic categories:

(a) Analysis: is the actual situation existent at a given time, over a particular region, based on actual report recieved by the radio station.

(b) Prognosis: is the predicted situation at a specified future time, based on the present indication, as deduced (calculated) by meteorologist using his knowledge & skill.

Difference between synoptic and prognostic chart.

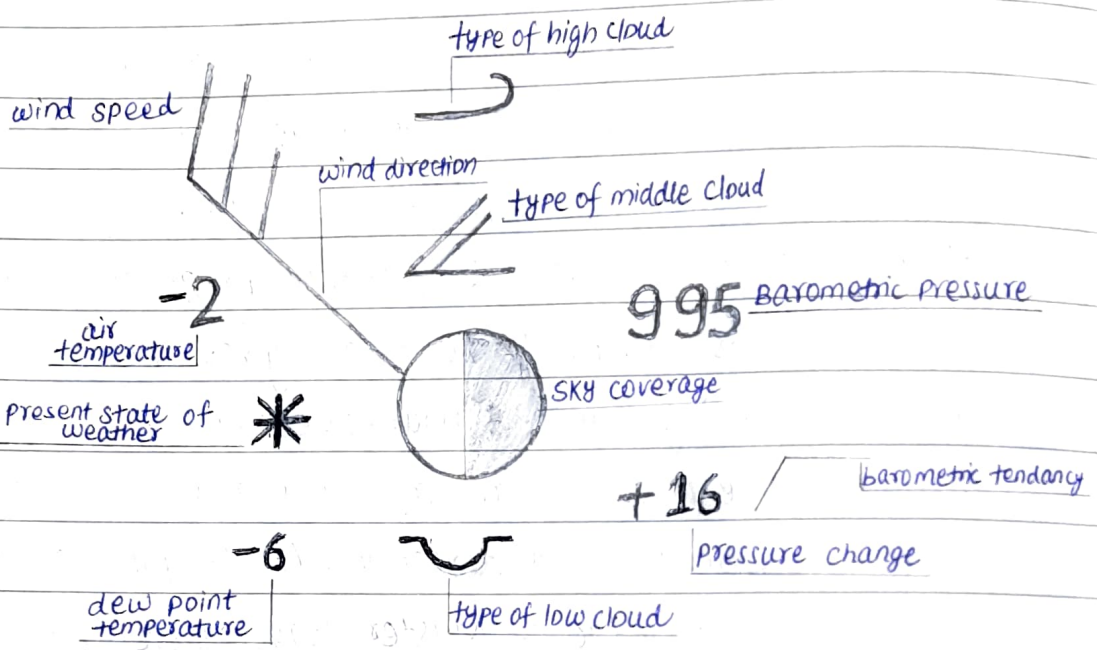
(iii) What is weather analysis & weather prognosis chart?

Ans: Weather analysis chart: These chart gives the weather situation, at the preceding synoptic hour, over the entire area. They show the weather experienced at each land and ship stations, pressure systems, isobars, wind direction, fronts, frontal depression etc. With good knowledge of meteorology, Master can size up the overall situation and take any steps that are necessary to ensure safety of ship.

Weather prognosis chart: These charts contain same type of information as in weather analysis chart but predicted for specified future time. They may be made 12hr, 18hr, 1day, 3day or 5 days before the specified time, so the Master can route the vessel accordingly.

A weather prognosis chart is made by professional meteorologist after taking various factors into account. The construction of prognosis chart needs deep knowledge in weather prediction and expertise gained over several years.

(iii) Sketch and describe the symbols shown in weather charts & synoptic charts.



Note:- In question if also ask to draw isobaric pattern draw isobars all around by taking 995 a center.

(2) Weather routeing

(i) What is the advantage of shore based weather routeing.

Ans: The advantages of shore based weather routeing are:

- It add up greater safety and more economy in ship operation
- Less chances of heavy weather damage.
- Less chances of shift of cargo & least damage to cargo
- More comfort for people on-board.
- Faster passage resulting in time and fuel savings.
- Schedules demanded by charterer can be fulfilled.

(ii) Explain the factors to be considered by ship's officer for weather routeing of his ship.

Ans: The following factors is to be considered for weather routeing :-

(a) Weather
- Check for any proximity of TRS & depressions.
- Any adverse wind direction and Beaufort wind scale
- Swell direction and wave height.

(b) Ocean currents and tidal streams

(c) Proximity of any icebergs.

(d) Nature of cargo carried

(e) Stowage & securing of cargo

(f) Ballast or loaded

(g) Vessel transit speed

(h) Geographical consideration.

(i) Deviation points

(j) Load line zones and seasonal areas.

(K) Ship's permormance curve

In exam, ellaborate all these points by own.

(iii) Describe the information contained in coastal weather bulletin.

Ans:- Coastal weather bulletin are weather warnings issued by meteorological department for all the coast and coastal sea area of that particular country.

The information contained in coastal weather bulletin are :

(a) Fisherman warning : It is a weather warning for fishermans. It is issued seperatey for all coast where fishing activities are allowed. It is issued for next 5 days.

(b) Port warnings: It is weather warning issued by meteorological department for all the major seaports. It contains the information like storm warning (if any), any low pressure creating in nearby sea & its movement during next 12 hours. Advice for hoisting port warning signals (if required).

(c) Sea Area bulletins: It is weather warning issue by country's meteorological department for seas like Bay of bengal, Arabian sea etc. It contains the information like wind predicted speed & direction, weather condition (rain, thunderstorms etc.), expected visibity and sea condition (slight, moderate etc.). It is valid for 12 hours from the start time mentioned in the bulletin.

(d) Coastal weather forecast: It is issued by meteorological department for all the coastal areas of that country. It contains these parameters :- wind speed, rainfall intensity, rainfall distribution, wave height, visibity. It is issue & valid for next 5 days.

(3) How are weather warnings recieved on-board?

Ans:-

- On-board ship, we have NAVTEX system to recieve weather warnings as well as Navigational, safety & security warnings.
- Navtex means navigational telex (text message) which allows reception & forecasts of navigational and meteorological warnings.
- It is a mandatory equipment that all type of vessel is required to carry it.
- The concept is that, the entire world is divided into 21 NAVAREAS

for the purpose of distributing this information. Each NAVAREA has multiple nautex stations which helps in transmitting the messages.

- The NAVTEX recievers are programmable to allow navigators to recieve message only from selected Nautex stations.
- The "station selection" can be manual or automatically. On automatic selection, the ship's position is fed by GPS & the Nautex will automatically decide in which area the ship is navigating presently and thus select the appropriate Nautex station.
- When the weather forecast comes the Nautex reciever starts to print it off, so that officer can look to it & refer it for their passage.

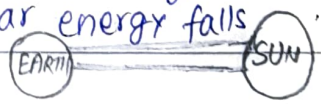
Apart from Nautex,

- Some shipping forecast, the normal radio stations and the coast guard do read it out.
- On-board ship, SAT-C is also used to broadcast & recieve weather warnings.

Why the lower latitude areas are warmer than higher latitude areas.

(A) Why polar regions are colder than equitorial region.

Ans:- • Firstly, around the equator the sun rays hits the ground at a 90 degree angle. Thus, more solar energy falls in the equitorial region making its hotter.



At or near the poles, sunrays hits the ground at a lower angles & Spread. Thus, less solar energy falls in the polar region making its colder.

- Secondly, due to earth's axial tilt. Poles don't recieve sunlight for many month during the year.
- Thirdly, as sunlight takes a long path to reach the poles. It has to deal with different atmospheric particles which absorbs heat. Thus,

less sunlight reaches the poles.

- Lastly, snow at the poles reflects about 75 to 90 % of sunlight, which causes cold temperature in polar regions.

(5) Explain fetch and significant wave height (2 times)

Ans:- **Fetch:** Since the waves are formed by wind blowing over the sea. The distance the wind blows across the water is called fetch. The longer the fetch the more powerful the wave is.

(OR) we can say

Fetch is the uninterrupted distance where wind blows without much change in direction.

Significant wave height: The significant wave height is the average height of the highest 1/3rd of all waves measured which is equivalent to the estimate that visual observer would made.

This is measured because the larger waves are usually significant than the smaller waves.

As a general rule, a highest individual wave is approximately twice as the Significant wave height.

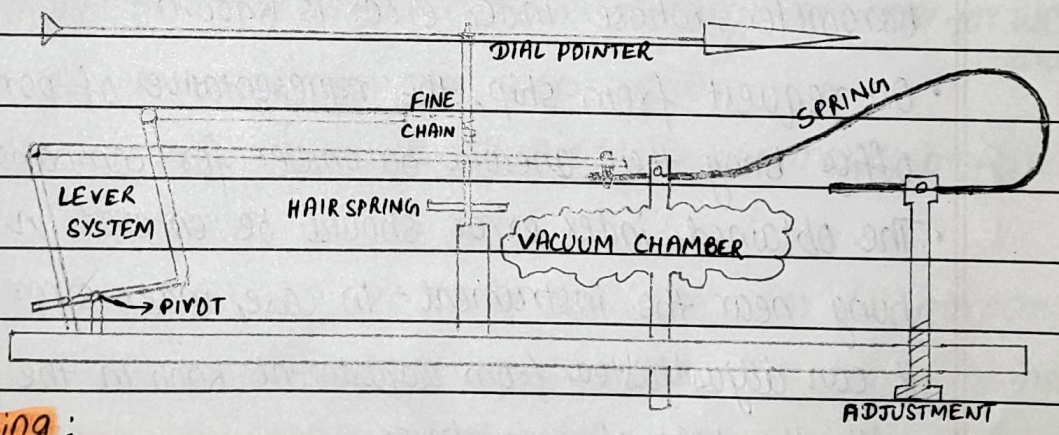
Q.3. SHIP BORNE METEORDLOGICAL INSTRUMENTS

(1) Aneroid Barometer

** (i) State the principle and describe the working of an aneroid barometer with suitable sketch. (7 times)

Ans:- Principle :

- Aneroid (name came from Greece) which means no liquid.
- Like mercury barometer, aneroid barometer does not need any liquid for reading.
- A sealed chamber made of very thin corrugated plate metal, having a partial vacuum inside it.
- This vacuum chamber is connected to a pointer by a system of levers and springs. The pointer is fitted over a circular graduated scale so that we can take reading directly.
- The thin metal has an elastic effect.



Working :

- If the atmospheric pressure increases, the chamber gets compressed. The inward movement of its wall is transmitted to the pointer by the levers and springs. The pointer thenshows higher reading on the scale.

- If the atmospheric pressure decreases, the opposite happens & the pointer then shows lower reading on the scale.

(ii) What are the corrections to be applied to its reading before making entries in Deck Log Book.

Ans:- What we get reading is at bridge level. But for sake of uniformity of climatic records, it is necessary to convert the reading to that of sea level. For that, we need to apply corrections to the reading. There are two corrections:

(i) Index error:

- It is caused by imperfect elasticity of vaccum chamber. It changes with time & hence required to obtain atleast once in three month.
- The index error is obtained by comparing with another aneroid barometer, whose index error is known. (can also be done by mercury barometer)
- On request from ship, the representative of port meteorological office bring their aneroid barometer for comparision free of cost.
- The obtained index error should be entered in special card hung near the instrument. In case, index error is quite high, it can be adjusted from adjustment knob in the back of instrument with the help of screwdriver.

(ii) Height correction:

Since atmospheric pressure over sea level decreases by 1mb for every 10 mtr. increase of height. So, correction is calculated by

Formula Correction (in mb) = Height above sea level (in mtr) ÷ 10

we will add the correction in our reading to get atmospheric pressure at sea level.

(iii) What are the care & maintenance precautions necessary for an Aneroid Barometer

Ans:-
- The index error is required to obtain atleast once in a three month by comparing with another aneroid barometer whose index error is known.

  The obtained index error should be entered in special card hung near the instrument. In case Index error is quite high, it may be minimized by adjusting the screw at back.
- The intrument should be placed at such a place where there is no sudden jerks & no rapid change of temperature
- Protect the instrument from direct sunlight.
- Do not move the instrument unnecessarily.
- Keep the instrument as close to the centre line of the ship.
- Tap the face of the instrument gently before taking reading as pointers and levers are liable to stick.

(IV) Why aneroid barometer is preferred over mercury barometer for use on-board ship.

Ans:
- It is durable and compact instrument,
- It does not need any liquid for reading, hence making preferred for use on-board ship.
- Changes of pressure are easily detactable. For this purpose, a fixed pointer is provided, attached to the glass face of the instrument. After tapping the instrument, the fixed pointer is aligned with the dial pointer which help us to avoid parallax error.
- After sometime (about half an hour), tap the instrument gently again. If the dial pointer now lies to the right of fixed pointer that means pressure has risen & vice versa. So the amount of rise or fall can also be noted in aneroid barometer

(V) Compare mercury barometer with aneroid barometer.

Ans:-

Aneroid Barometer	Mercury barometer
a) It does not require any liquid	a) It required liquid.
b) Aneroid barometer is a barometer that uses a vaccum chamber of very thin metal plate to measure the atmospheric pressure.	b) Mercury barometer is a simple barometer that uses mercury to measure the atmospheric pressure.
c) It measures the atmospheric pressure using expansion or contraction of a flexible metal plate which leads to moving a pointer on pressure scale.	c) It measures the atmospheric pressure by measuring the height of mercury inside a vertical glass tube
d) Solid & compact, easy to handle	d) Large & fragile, hard to handle.
e) It is easy to take measurement as it directly gives a value	e) It is hard to take measurement as height should be measured accurately after it gets balanced

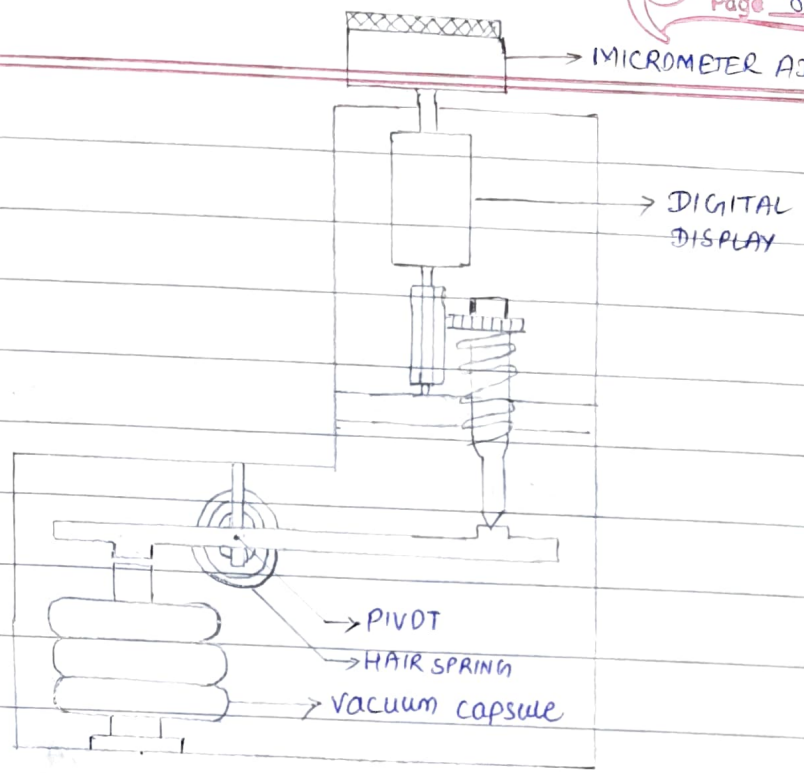
(2) Precision Aneroid Barometer.

(i) Describe the working of an precision aneroid barometer with sketch.

Ans:- This is compact(small), robust(strong) and accurate aneroid barometer which shows very accurate reading to 0.1 of a millibar on a digital display.

Construction & working:

- Its vaccum chamber consist of three metal chamber which are attached together.



- The shorter end of pivoted lever rests lightly on the top of vacuum capsule with the help of hair spring.
- Increase or decrease in atmospheric pressure causes top of vaccum capsule to move in or out which leads the longer end of the leves to move up & down.
- This movement can be measured by a micrometer arrangement which shows the reading on a digital display in millibars and decimal of millibars.

(ii) What are the procedure for reading the precision aneroid barometer.

Ans:- (a) Press the switch and hold it there.

(b) Increase the reading (by slowly rotating the micrometer-head) until the magic eye shows a continuos line.

(c) Decrease the reading very slowly until the magic eye

just about to show a broken line.

(d) Release the switch and read off the pressure in millibars and decimal of a millibar.

(iii) What are the correction to be applied on reading obtained from Precision Aneroid Barometer

Ans:- (a) Index error.

- It can caused due to imperfect elasticity of vacuum chamber.
- The error needs to be applied to the reading each time
- The error should be obtained once in every three months.
- The obtained index error should be entered in a special card and hung near the instrument.

(b) Height correction

Same as in ordinary aneroid barometer, we need to convert the reading at bridge level to sea level.

So, as we know, the pressure decrease by 1 mb for every 10m increase of height & vice versa.

So we calculate the correction by

Formula Correction (in mb) = Height above sea level (in mtr) ÷ 10

& apply the correction to make entry in deck log book.

(3) Barograph

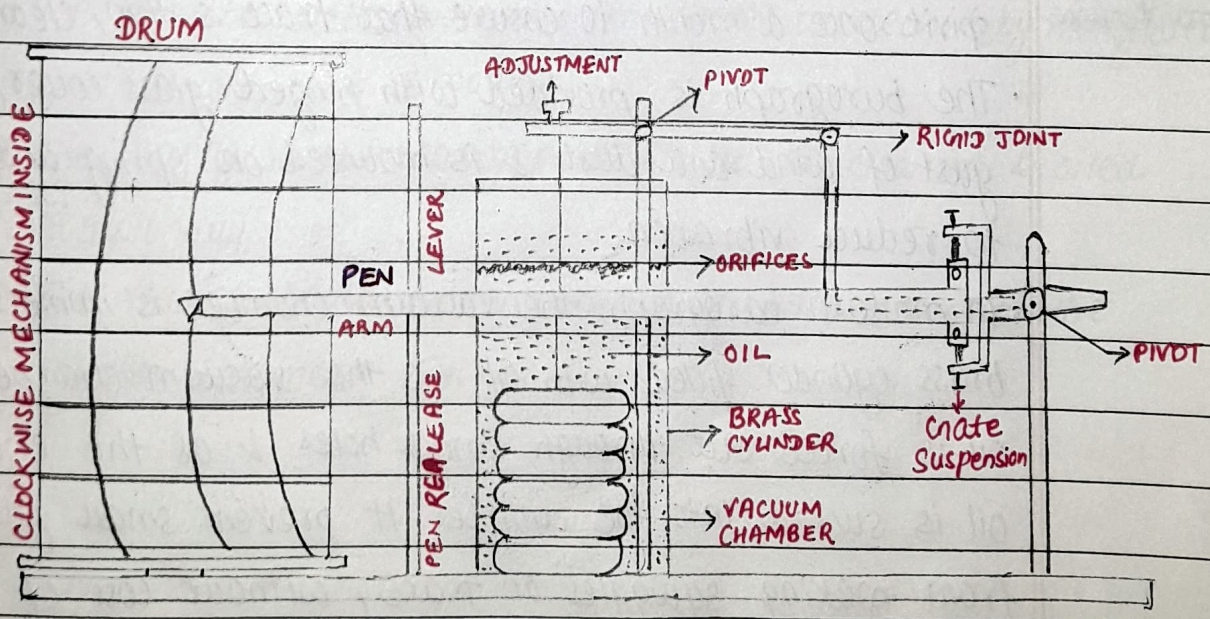
(i) Describe the use, construction and working of barograph with suitable sketch.

Ans:-

- A barograph is a recording type instrument that provides a continuos record of pressure on a paper chart.

That paper chart having a continuos barograph trace on it is known as barogram.

- A barograph uses an aneroid barometer mechanism for movement of pen on suitable chart. The pen are attached to drum which moves by a clockwork.
- The barograph is adjusted to allow index error and height correction. The reading must be compared once a week.
- For sake of uniformity of climatic records, the barograph should always set to GMT



THE BARDGRAPH

Construction & working:

- Its vacuum chamber consists of a series of metal box arranged vertically. which are attached together.
- Increase or decrease in atmospheric pressure causes the top of the vacuum chamber to ascend or descend & this movement lead the stylus to move up or down on the chart by a lever system
- The chart is fixed on a cylindrical drum that rotates at a uniform speed of one rotation per week.
- The tip of the stylus has a detachable pen that contains one drop of slow drying ink (specially made for this purpose)
- The pen needs to refill once a week by a dropper and inkbottle provided.

Care & maintenance

- The pen should be washed with water or cleaned by methylated spirit once a month to ensure that trace is thin, clear and even.
- The barograph is provided with hinged glass cover, to keep out gust of wind and dust & is mounted on spring and rubber pad to reduce vibration.
- In modern barograph, the vacuum chamber is immersed in a brass cylinder filled with oil. As the vacuum chamber expands, oil is forced out through small holes & as the chamber contracts oil is sucked into the cylinder. It prevent small gusts & vibration from making squiggles on trace, without loss of accuracy of the barograph.

(ii) What are the care & maintenance required for a barometer.

Ans:- (a) It is a fragile instrument and must be handled carefully.

(b) It should be fitted in a position where it will be least affected by the vibration or movement of the ship

(c) The following should be done weekly :-

- Renew the chart
- Wind the clockwork mechanism
- Refill the ink
- Compare the reading & adjust if required to eliminate index error & height correction.

(d) When chart is renewed, rotate the drum till pen records the correct GMT and day.

(e) The pressure of pen on the paper should be reduced to the minimum by adjusting the gate suspension holding the pen arm which carries the pen

(f) The pen should be washed with water or cleaned by methylated sprit atleast once a month

(g) The bearing of the moving parts should be cleaned & oiled occasionally.

(h) The reading should be compared and adjusted with the reliable barometer ashore.

(4) Hygrometer (or psychrometer)

(i) Describe the working principle of hygrometer.

Ans:-
- The hygrometer is an instrument used for obtaining relative humidity & dew point temperature of air.
- The type of hygrometer used on-board ship is known as Mason's hygrometer or psychrometer.
- It consist of two thermometers mounted side by side in a stevenson's screen, one is a dry bulb thermometer, the other is a wet bulb thermometer.
- Cambric or muslin is wrapped around the bulb of wet bulb & it is kept moist by means of wick leading to container of distilled water.
- If the atmosphere is dry, the rapid evaporation takes place from muslin. Since evaporation causes cooling, the wet bulb thermometer will show lower reading than dry bulb thermometer.
- If the atmosphere is humid, the evaporation from the muslin will be slow and less cooling will take place. The reading of wet bulb thermometer will be not much lower than dry bulb thermometer.
- The difference beetween the reading of dry bulb and wet bulb thermometer gives the indication of relative humidity in the air. The greater the difference, lower the relative humidity & rice versa.

(ii) What are the precautions required in its use?

Ans:- (a) The stevenson's screen should be hung up on the windward side away from artificial source of heat (funnel, blowers, ventilators etc.)

(b) It should be hung 1.5m above the deck for the convenience of the observer

(c) It should not be placed in an enclosed room

(d) Sunlight falling on stevenson screen is permitted but not directly.

(e) The muslin should be clean - free of dust and salt particles.

(f) The muslin and strands of wick should be changed once a week because solid particles are left behind the evaporating water that gives higher reading.

(g) The muslin should be just moist. Too much or little water on it shows incorrect reading.

(h) The dry bulb thermometer should be clean and clear of drops of condensed water.

(5) **Stevenson's screen**

(i) Describe stevenson screen

Ans:
- This is a wooden box specially constructed to house a hygrometer
- It is a wooden cupboard fitted with a hinged door.
- The door, back and the two sides are all fitted with "louvers" which allows air to circulate freely & does not let direct heat radiation to get in.
- If the sunlight falls on the thermometer directly, it will get very hot and then it will show temperature of instrument itself, not that of atmosphere. It shows temperature of atmosphere because of shade and free circulation of air.
- If the instrument is out in the open, during the night, its bulb

would radiate the heat very quickly, quicker than air and then it will show temperature of instrument itself, not that of atmosphere. By using the stevenson screen, the head radiates slowly and thus shows correct reading.

- Its purpose is to provide standarised environment in which the temperature and relative humidity can be measured.

(ii) List the precautions necessary for sitting of Stevenson screen.

Ans:-
- The stevenson screen should be hung up on the windward side away from the artificial source of heat (funnels, blowers, ventilator etc)
- It should be hung 1.5m above the deck for the convenience of the observer.
- It should not be placed in a enclosed room
- Sunlight falling on stevens on screen is permitted but not directly.
- It should be always hung vertically

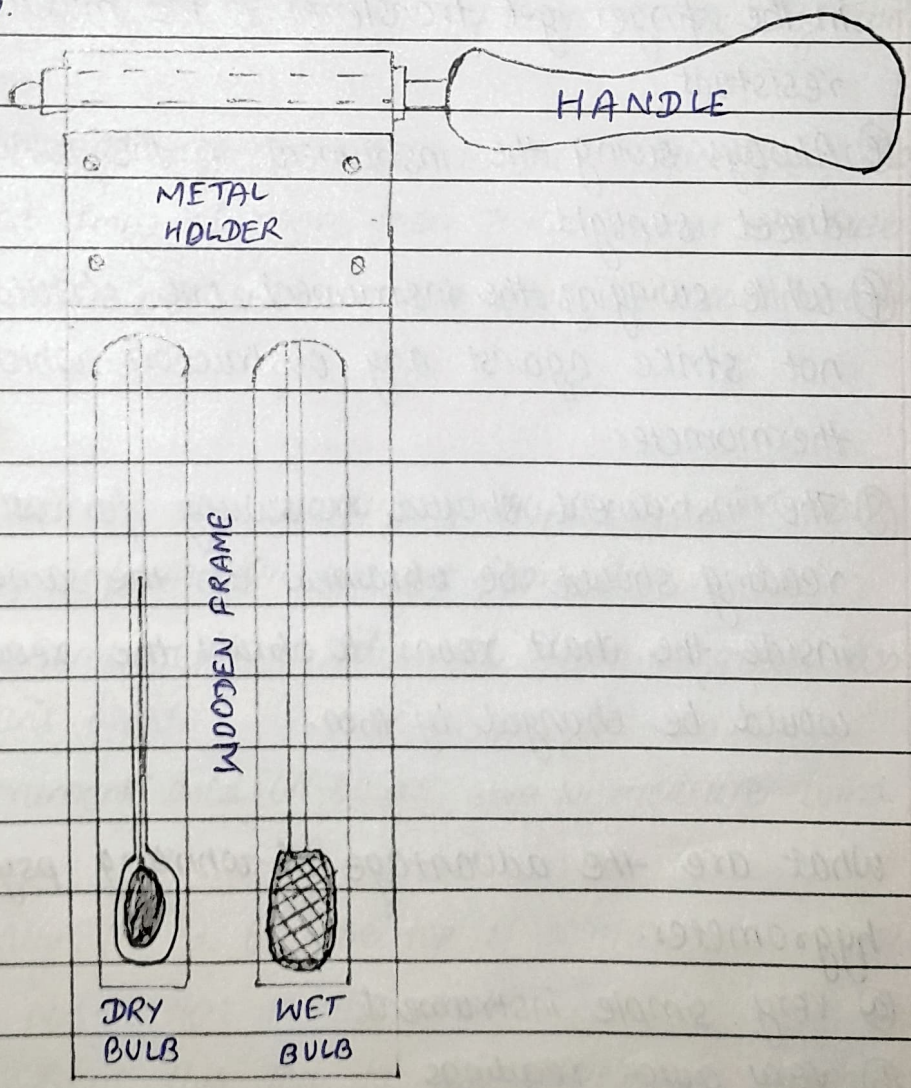
(6) Whirling psychrometer

(i) Sketch and describe the working principle of whirling psychrometer & its use.

Ans:-
- It consist of a light wooden frame, pivoted to revolve smoothly around the handle
- The frame consist of two identical celcius thermometer, one is a dry bulb thermometer, the other is a wet bulb thermometer.
- A wet bulb thermometer consist of a single layer of thin

muslin tied firmly around the bulb with string.

- When required, the frame is held horizontal, one drop of distilled water is then dropped on muslin using dropper to make it damp (moist)
- The frame is then whirled in open air before taking the reading
- From referring to the meterological table, we can obtain dew point and relative humidity.
- There are different table for whirling psychrometer and hygrometer in the Stevenson's screen because of their different rate of evaporation.



(ii) What are the precautions required in its use.

Ans:- (a) The muslin should be clean, free of dust and salt particles

(b) The muslin and strands of wick should be changed once a week because solid particles are left behind the evaporating water and does not allow free evaporation which gives higher reading than actual.

(c) The muslin should be just moist. Too much or little water shows incorrect reading.

(d) Never touch the muslin with a finger. If touched, body oil present in the finger get transferred to the muslin and make it water resistant

(e) Always swing the instrument in the windward side away from direct sunlight

(f) While swinging the instrument, one should ensure that it does not strike against any obstruction which results in broken thermometer.

(g) The instrument should be swung for atleast two minutes & the reading should be obtained at the same place. If brought inside the chart room to obtain the reading, the reading would be changed by then.

(iii) What are the advantage of whirling psychrometer over the hygrometer.

Ans:- (a) very simple instrument

(b) very quick readings

© Very accurate.

It has been observed that rate of evaporation depends on speed of air flowing past the bulb. The rate of evaporation reaches maximum at about seven knots wind speed and further increase of wind speed does not make any appreciable change. So when the wind speed of seven knots or more passes the bulb, the reading will be more accurate.

In case of hygrometer inside the stevenson screen, the evaporation depends entirly upon direction and force of wind outside the screen. If wind speed is less than 7 knots, the reading will not be so accurate.

In case of whirling psychrometer, a one rotation per second is equal to wind flow of more than 7 knots past the bulb. So, one or two rotation per second will give accurate reading.

(7) Anemometer

(i) Sketch and describe the working principle of wind vane anemometer. What kind of information we get from it.

Ans:-

- The term anemometer is derived from a greek word "Anemo" which means wind.
- It is an instrument used on-board ship to measure wind speed and direction.
- It is generaley fitted on the top of a mast or a place where there is no obstruction to the wind
- The signals from this led to the wheelhouse repeators by cables.

- When a ship is moving, anemometer shows apparent wind which is combination of true wind & ship's speed.
- However the modern anemometer can also give true wind as they are interfaced with a gyro and speed log.

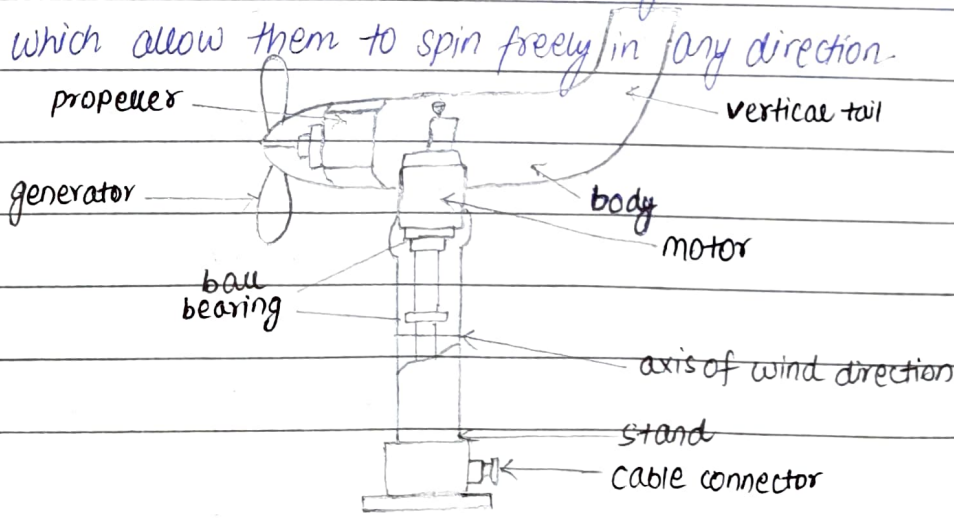
Working principle:

- A vane anemometer consist of two element : a wind vane and an anemometer
- The anemometer portion of vane anemometer is usauy of the propeller type. It is calibrated in such a way that it measure wind speed by measuring the speed at which the wind causes the propeller to spin.

It may use mechanical and electronic means to record and calculate this data.

- The wind vane element of vane anemometer is used to determine wind direction. It is a simple device that always faces into any wind. Due to aerodynamic principle and the design of the vane, it always turns to face any wind, regardless of wind strength or direction.

It is like a aeroplane with no wings, mounted on a swivel base which allow them to spin freely in any direction.

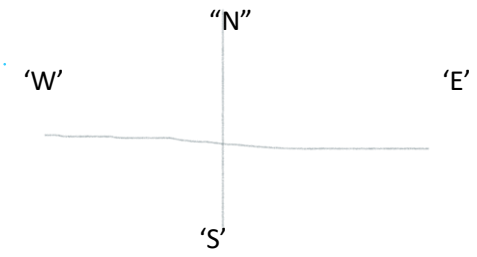


(ii) What are the care & maintenance required for a anemometer.

Ans :-

- Weekly maintenance: Calculate the true wind & compare it with sea state card
- Monthly maintenance: Cables to be checked visually. Check weather all moving parts are rotating freely. and the displayed wind speed is reasonable.
- Annual maintenance: Overhaul the anemometer. Clean gently with brushes and lubricate all the moving parts.
- And throughout the year, make sure that the anemometer are rotating freely by observing it during light wind condition.
- Also check closely that it is not making any grinding sound as it is a sign of damaged bearing.
- Ensure there is no loose halliyard rope which may entangle the propeller.
- The latest inventory of all the spares of anemometer should be available.

1. FIRST DRAW A CROSS AND INDICATE ‘N’, ‘E’, ‘S’ & ‘W’. THIS WILL HELP DIRECTIONAL ORIENTATION.

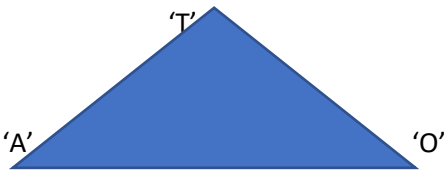


2. SECOND WRITE THE INFORMATION GIVEN, AS (I) COURSE, (II) SPEED, (III) DIRECTIONS, etc.

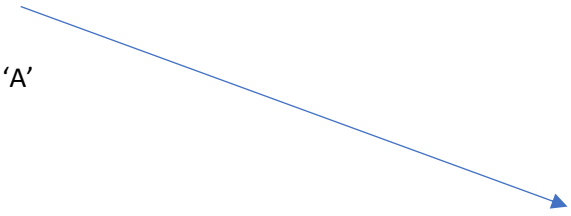
3. SELECT A SCALE OF SAY 2CMS = 1 KNOT, THEN 20 CMS= 10 KNOTS, 24 CMS=12 KNOTS, AS APPLICABLE.

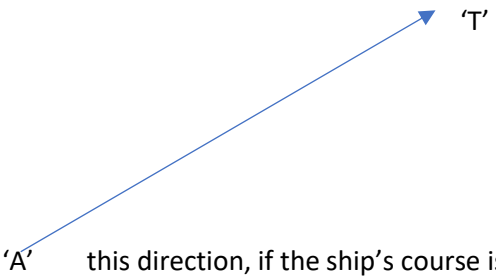
4. ENSURE YOUR TRIANGLE FITS THE PAPER SIZE.

5. DRAW A ROUGH TRIANGLE, BASED ON THE INFORMATION GIVEN IN THE QUESTION, TOWARDS UNDERSTANDING WHAT NEEDS TO BE FOUND OUT.

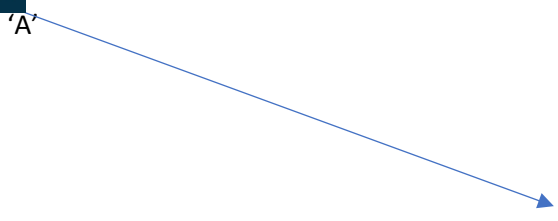


6. WITH ‘A’-‘T’ AS OWN SHIP’S COURSE AND SPEED. DRAW SHIPS COURSE AND SPEED, PUT AN ARROW IN THE DIRECTION OF SHIP’S MOTION.

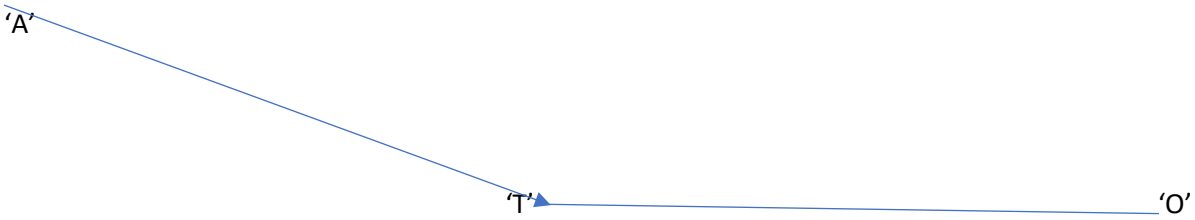




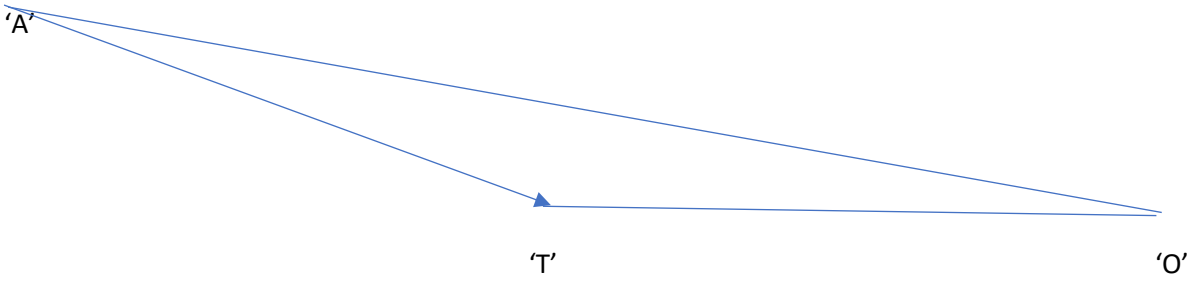
7. APPLY TRUE WIND AT ‘T’



IF TRUE WIND IS GIVEN AS 090° TRUE, THEN,

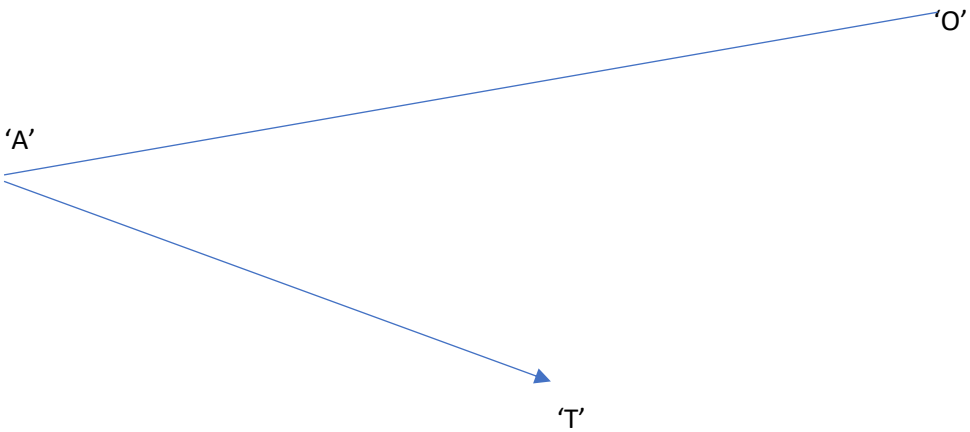


JOIN 'O'-'A'



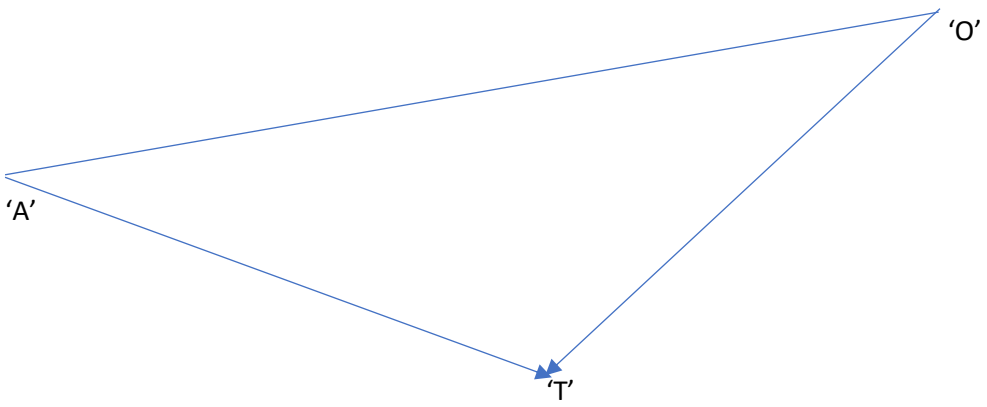
IN THE ABOVE TRIANGLE, THE 'O'-'A' WILL BE THE "APPARENT WIND TO BE EXPERIENCED BY THE OWN VESSEL BLOWING ROUGHLY 118° OR SO.

8. IF APPARENT WIND IS GIVEN, THEN PLEASE APPLY IT AT 'A', such as below:



9. PLEASE JOIN 'O' WITH 'T'

'OT' WILL BE REPRESENTING THE TRUE WIND TO BE EXPERIENCED BY THE VESSEL AT 'T', HERE IT CAN BE ASSUMED TO BE, SAY, 040° TRUE.



10. PLEASE ENSURE THAT WIND IS ALWAYS APPLIED AS BLOWING FROM. (and never drawn as blowing to, that's a rule to be followed)

11. THE THIRD CORNER OF TRIANGLE TO BE 'O', WITH 'OA' REPRESENTING APPARENT WIND SPEED AND DIRECTION. AND 'OT' REPRESENTS TRUE WIND SPEED AND DIRECTION.

12. ANY TIME IN DOUBT, PLEASE RE-DRAW THE TRIANGLE, FROM THE BASICS AGAIN.

13. MAKE A BOLD STATEMENT AS TO WHAT IS FOUND?

(a) TRUE WIND SPEED FROM…….. DEGREES, AT ……KNOTS,
(b) APPARENT WIND SPEED FROM……DEGREES, AT ……KNOTS,
(c) BEAUFORT FORCE……..AS PER PAGE NO:……OF SHIP'S WEATHER CODE.

WIND TRIANGLE (15 Marks)

Consider a vessel heading 000°(N) at 20 Kts

If True wind is(↓) then, apparent wind is(↓)

0 Kts	N'ly 20 Kts
N'ly 10 Kts	N'ly 30 Kts
S'ly 12 Kts	N'ly 8 Kts
S'ly 20 Kts	0 Kts
S'ly 24 Kts	S 4 Kts

* Thumb rule

(a) Consider a ΔOAT

AT - co & speed of vessel

OT - direction & speed of true wind

OA - direction & speed of apparent wind

* (b) vessel co & spd is always given, so first draw AT

If true wind is given, draw true wind at T

If apparent wind is given, draw apparent wind at A

(c) write true wind direction like XXX°(T)

(d) Prefer doing it on 1cm = 1 Knot scale

(e) On A, draw a cross (+) first, then proceed ahead (1st step)

(f) On left top corner, put a symbol 

ed example 1

Step ① :- Draw a straight line and point A anywhere on it

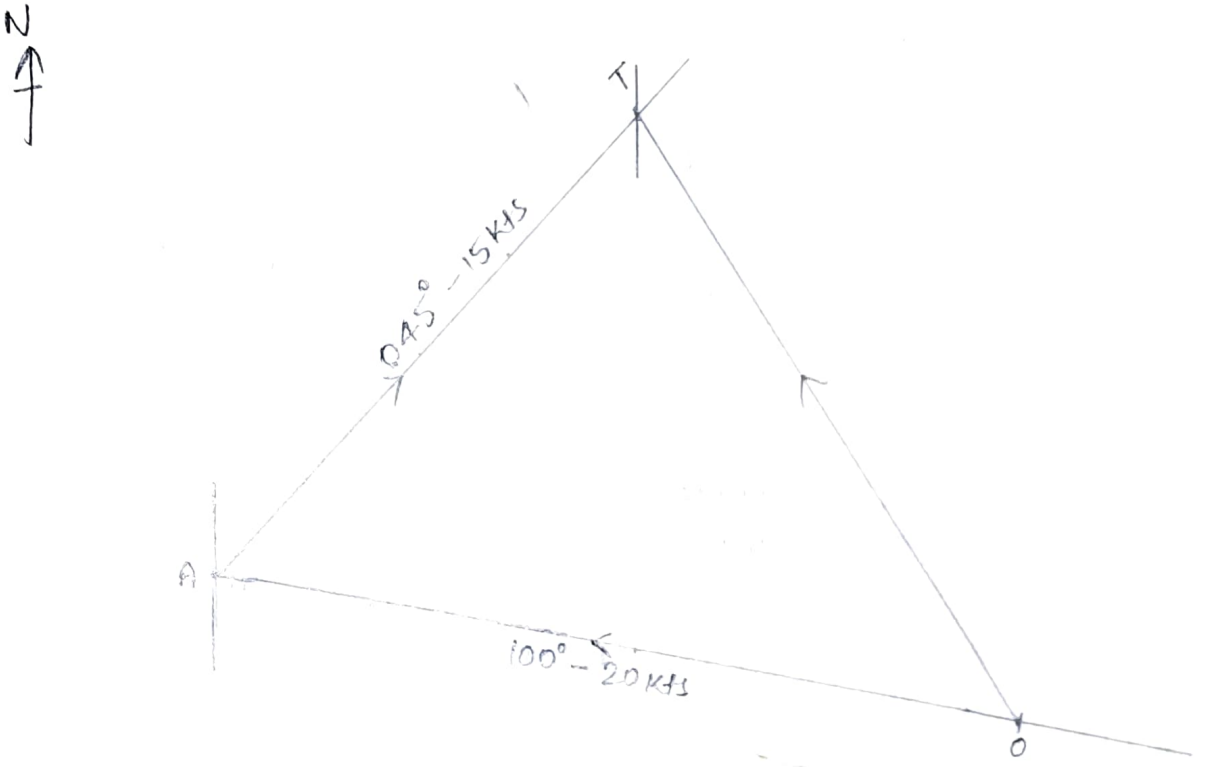
② :- draw an angle equal to 045° & cut at 15 Kts & name it T (I use:- 1 Kt = 0.5 cm)

Now we get AT i.e. Co & spd of vessel

③ At A, draw an angle equal to 100° & cut at 20 Kts & name it O

Now we get OA - direction & speed of apparent wind.

④ Connect O & T, we will get direction & spd of true wind



OT - direction & spd of true wind

i.e. 147°

17 Kts.

** Always draw True wind at T

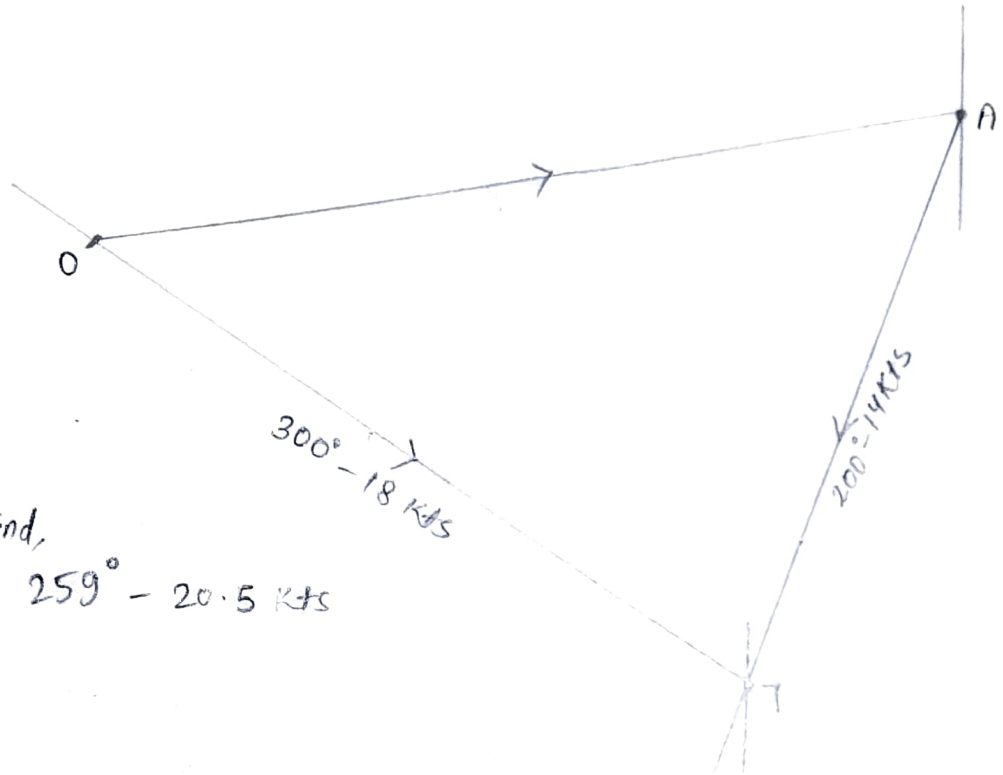
" " Apparent " " A

ed example 2

Ship speed & co - 14Kts - 200°

OT True wind co & spd - 18 Kts - 300°

* never draw NS line on O



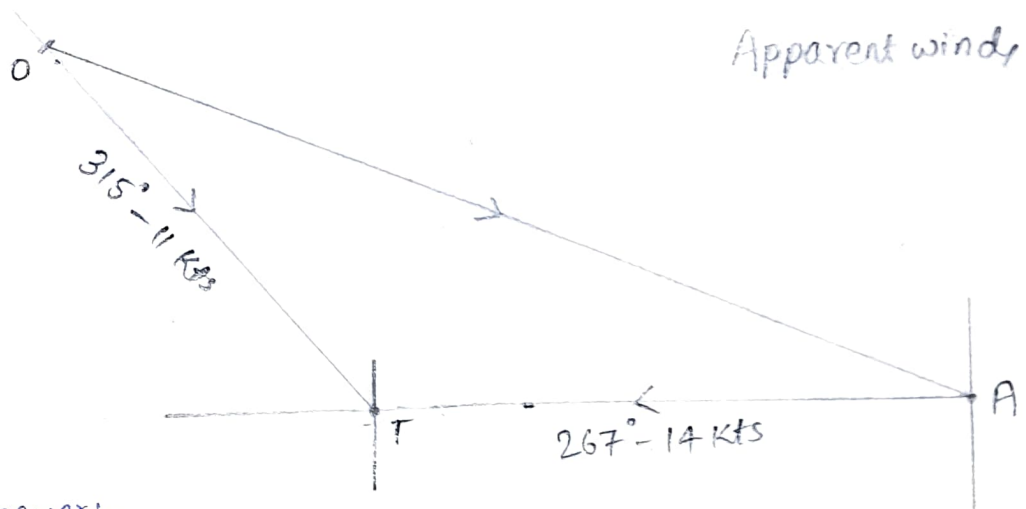
Apparent wind,

OA = 259° - 20.5 Kts

Ship's course, AT = 267° @ 14 Kts

True wind, OT = 315° @ 11 Kts

scale used : 1cm = 2 Knots



Apparent wind, OA = 289° @ 22.6 Kts

Answer:-

Apparent wind, OA = 289° @ 22.6 Knots

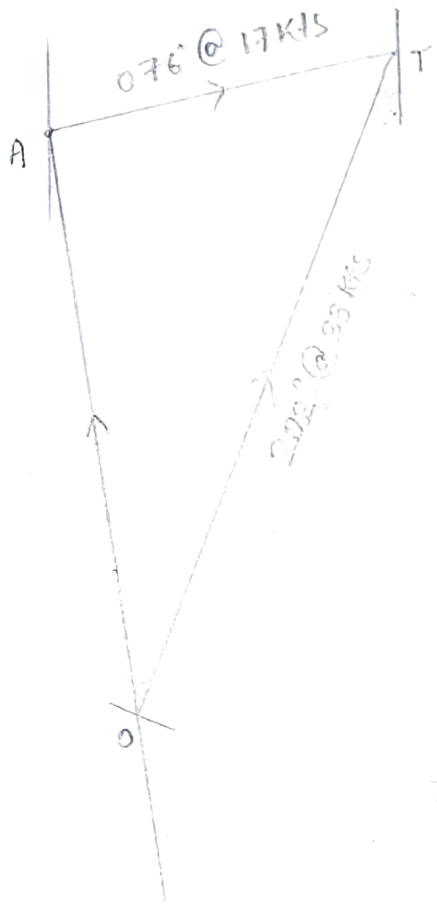
co & spd: AT :- 076° @ 17 Kts

True wind spd: 33 Kts OT

Apparent wind direction: 352° - 180° OA

= 172°

scale used:
1 cm = 4 Kts



True wind, OT = 202° @ 33 Kts

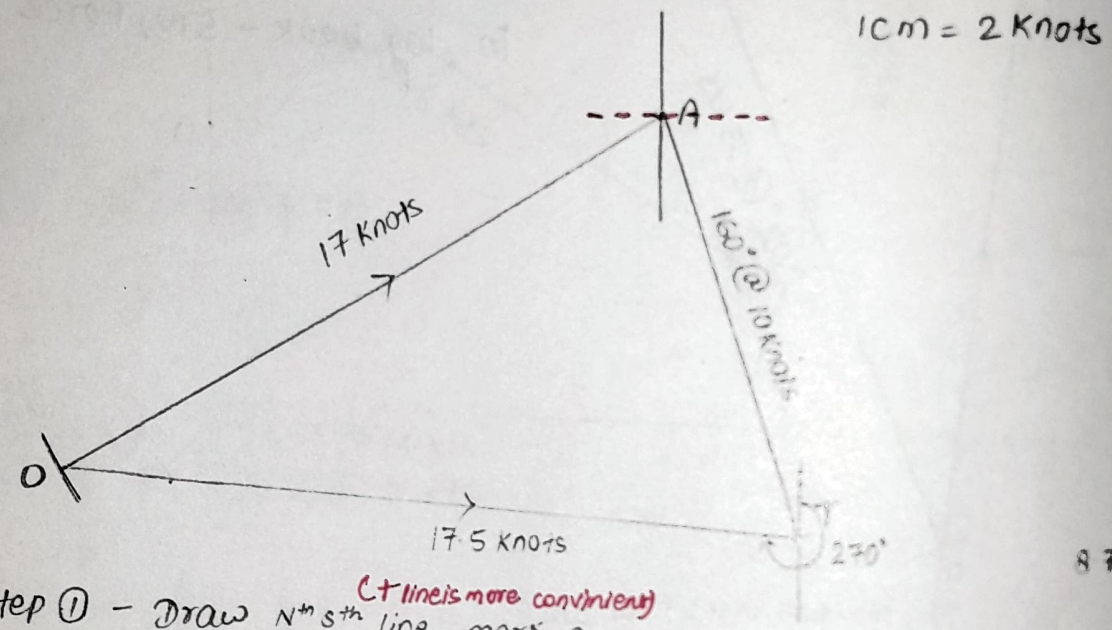
In log book - SW, Force 7

Course 160° speed 10 knots. Direction of wind (obtained by obs
line of waves) was 270°. Wind speed by shipboard anemometer
17 knots. What direction and force of wind is to be entere
into the ship's log book:

Soln:- Consider a ΔOAT,

AT - co & spd of vessel
OT - direction & speed of true wind
OA - direction & speed of apparent wind

① VSI co & speed - 160° @ 10 knots
② Apparent wind speed - 17 knots
③ True wind direction - 270°(T)



(T line is more convinient)

Step ① - Draw N^th S^th line, mark a point A anywhere on it
Step ② - draw a line from A at course 160° & cut at T (5cm=1
Step ③ - draw N^th S^th line on T & draw a true wind direction (27
Step ④ - Take compass at (8.5 cm = 17 knots). Put a pointer on A
on 270° line. & where it cuts. Point it as O
Step ⑤ - Join O & A.
Step ⑥ - Measure OT distance i.e 8.75 cm = 17.5 knots

Answer :- Since in deck log book, we write true speed & dir
In log book, wind direction - Westerly
wind speed - Force 5 (i.e. 17.5 knots)