7th INTERNATIONAL EARTH SCIENCE OLYMPIAD

वसुधैव कुटुम्बकम्
The Earth is indeed a family

HYDROSPHERE

+

ATMOSPHERE

WRITTEN TEST

Student's Name and Code:

Instructions:

1. Please write your name and nationality in English on the cover page.

2. The time allocated for this examination is 75 minutes.

3. Please write your answer legibly, illegible answer will be counted as incorrect.

4. Please write your answer only on **this test booklet (English version only)**. For countries needing translation, additional question paper in their mother tongue is provided for reference only.

5. Please circle the most appropriate answer/answers among the given options.

6. Read the entire question group carefully before starting to answer. Marks for each sub-question are indicated on the right.

7. Some questions need the correct answer/s to be picked, some are true/false type, some are fill in blanks, and some expect short answers. Answer appropriately.

8. Any inappropriate examination behavior will result in disqualification.

Time allotted: 75 minutes   Total Marks: 61

1. The figure below shows global freshwater withdrawal as a percentage of total available (see legend for color code) in the year 1995 and a model projection for the year 2025CE.
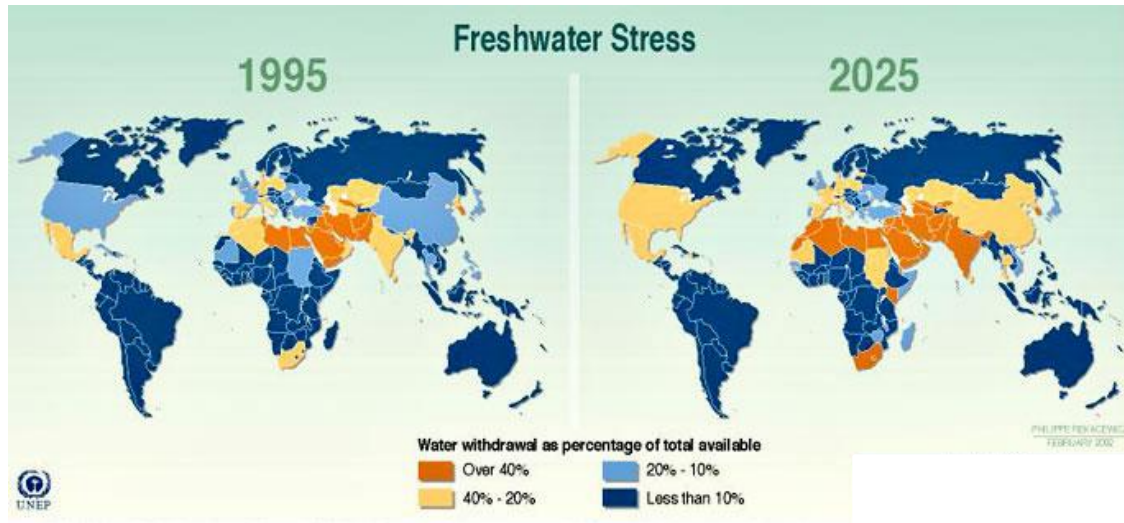
Answer the following questions by choosing the correct option: **(5 min)**

(i) One of the countries in which there is no significant change in water stress between 1995 and 2025 CE is

    A. Egypt.   **1 mark**

    B. USA.

    C. India.

    D. China.

(ii) The reason for the answer of (i) above is   2 marks

    A. This country is located near the equator.

    B. This country has already limited water resources.

C. This country has the largest population in the world.

D. This country has a relatively higher growth rate of population.

(iii) Out of the three continents in the southern hemisphere, the most affected is Africa, the reason being, the continent as a whole **2 marks**

A. has the largest fraction of desert area among the three.

B. receives the least rainfall among the three.

C. has the highest population among the three.

D. has more runoff through rivers such as Nile and Congo.

2. Weathering of rocks increases with temperature when more CO_2 is added to the Earth's atmosphere. What would happen when there is no volcanic eruption on the Earth for millions of years: **5 min**

(i) In addition to the long term climate change caused by changes in the Earth's orbital parameters, **2 marks**

A. the Earth would gradually become warmer because of CO_2 accumulation.

B. the Earth would gradually cool because of consumption of CO_2 for weathering of rocks.

C. there would be no additional change in the Earth's temperature.

(ii) Water is able to weather rocks because **2 marks**

A. it is present in all the three states of matter (i.e., solid ice, liquid water and water vapour) on the Earth.

B. it is the most abundant compound on the Earth's surface.

C. it can dissolve silicates, when it is pure.

D. it is a polar molecule, and in addition, dissolved carbon dioxide makes it acidic.

(iii) In the past (Neoproterozoic times), the whole Earth is believed to have cooled into a 'snowball'. A possible reason could be that **1 mark**

A. there were more frequent solar eclipses reducing incoming solar radiation.

B. there were frequent volcanic eruptions throwing aerosols into Earth's atmosphere, cooling the Earth.

C. changes in the orbital parameters of the Earth were more severe.

D. there were no volcanic eruptions for a long time, while weathering continued to consume the atmospheric carbon dioxide.

3. At present the Earth's surface is 70% oceans and 30 % land. If it were 100% oceans and no land, mark the following sentences as True (**T**) or False (**F**)   **4 x 1.25 = 5 marks; 5 min**

(i) There will be no land breeze and sea breeze (**T** / **F**)

(ii) There will be sea breeze, but no land breeze   (**T** / **F**)

(iii) There will be seasonal rainfall in the tropics, but much weaker than at present   (**T** / **F**)

(iv) Both hemispheres will have the same season (e.g. summer) at the same time   (**T** / **F**)

4. Nansen observed that ice floating in the Arctic Ocean moves at an angle of 45° to the right of the wind and not along the direction of the wind. Which forces in balance govern the movement of ice?

2 marks ;2 min

A. attraction of sun, moon and earth

B. wind force, friction and Coriolis force

C. pressure gradient, gravity and Coriolis force

D. winds, molecular friction and gravity

5. The figure below shows the variation of temperature with height. **6 x 1 = 6 marks; 5 min**
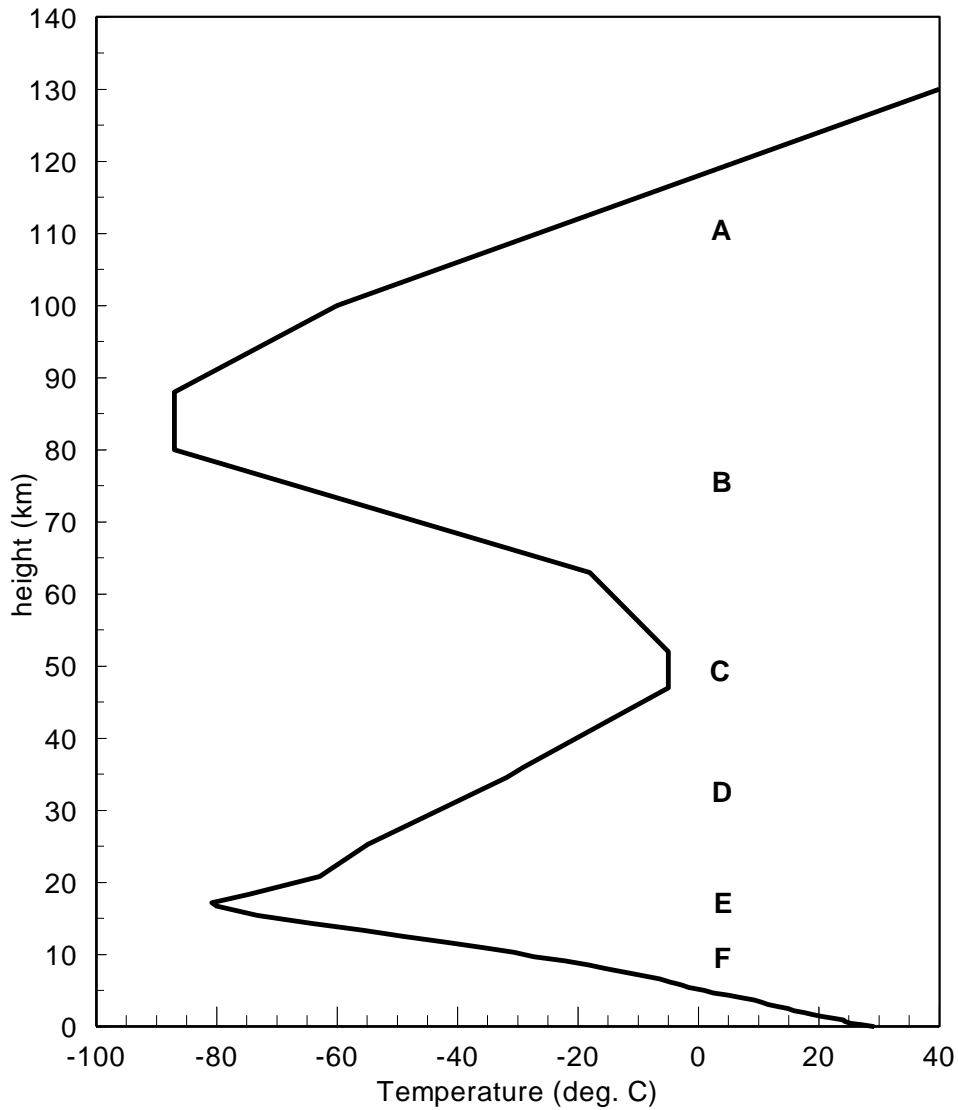
Write the names of the various layers (as marked A to F in the figure above and Column I in Table in the next page) such as troposphere, stratosphere, ionosphere, mesosphere, stratopause and tropopause, in Column II. Fill each row in column III with one or more of the following (you can leave it blank if there is
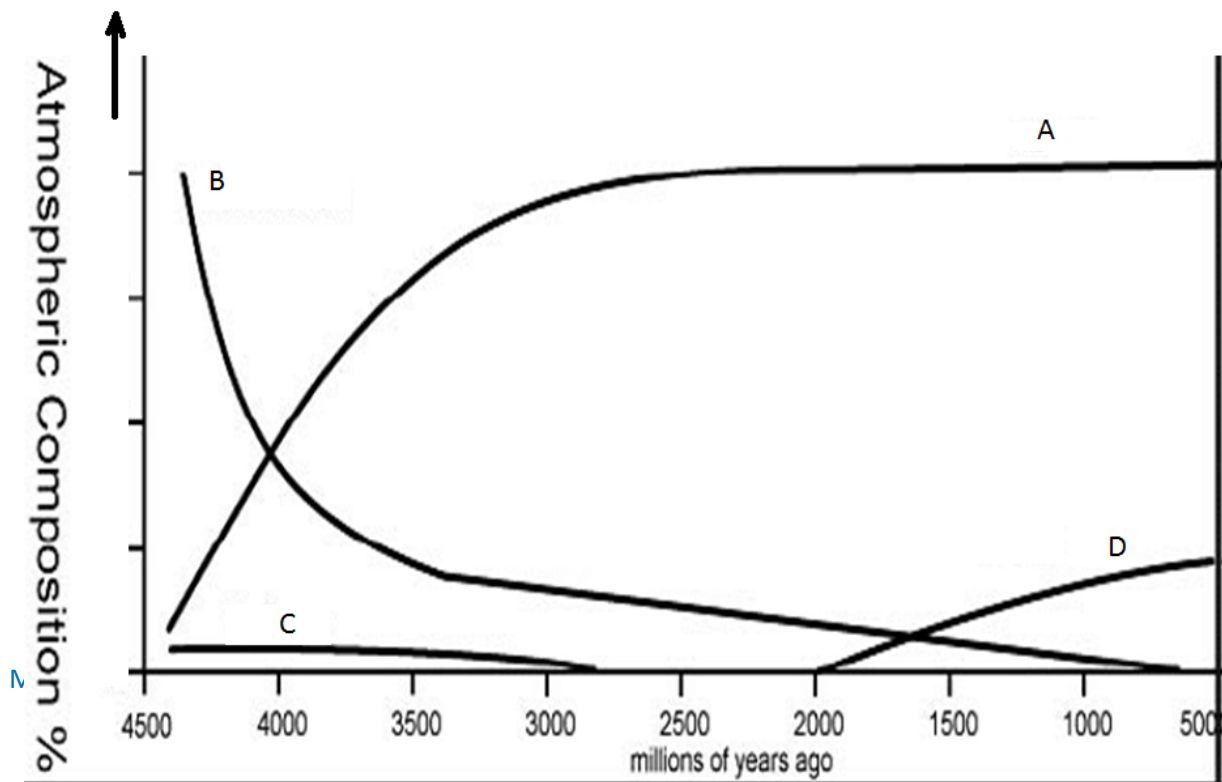
no appropriate option given): Cumulus clouds, cirrus clouds, top of cumulonimbus clouds, noctilucent clouds, aurorae, and UV absorption by ozone.

I	II	III
A		
B		
C		
D		
E		
F		

6. (i) The graph below shows a schematic of the evolution of gases H_2, O_2, N_2 and CO_2 in the Earth's atmosphere. Match the curves against the gases in the Table in the next page.

4 x 1 = 4 marks; 7 min

A	
B	
C	
D	

(ii)   **Fill in the blank:**
According to this, banded iron formation (deposition of iron oxide in the form of bands) in the Earth's History started after around .... million years ago   **1 mark**

7. **The mean temperature of the Earth is governed by the overall radiation energy balance, i.e., net solar radiation absorbed equals the radiation back to space. If S_o is the solar constant, T the mean temperature, α the albedo, and σ the Stefan-Boltzmann constant, then, which of the following is the correct representation of this?**   **2 marks; 3 min**

A. $(1-\alpha) S_o = \sigma T^4$

B. $S_o = 4 \sigma (1-\alpha) T^4$

C. $(1-\alpha) S_o = 2 \sigma T^4$

D. $(1-\alpha) S_o = 4 \sigma T^4$

8. The Rainfall distribution in two regions P and Q is shown in the Table. **4 min**

Monthly Rainfall (mm)

Region	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
P	2	0	1	0	0	125	300	450	250	75	10	7
Q	98	99	102	101	100	115	100	95	105	99	101	105

Pick out the correct statement/s.   **2 marks**

A. The interannual variability of rainfall is more at P than at Q.

B. The intra-annual variability of rainfall is more at P than at Q.

C. The average monthly rainfall is about 120 mm at Q.

D. The averages of monthly rainfall over one year at P and Q are the same.

9. Earth is warming due to CO_2 increase. In the tropical belt 30^oS to 30^oN, which among the following statements are true?   **2 x 2 = 4 marks; 5 min**

   A. Largest warming occurs in the atmospheric layer 10-14 km above the surface.

   B. Largest warming occurs in the stratosphere.

   C. The entire atmospheric column from surface to 50 km height warms.

   D. Lower troposphere warms and stratosphere cools.

   E. Warming is at the surface and rest of the atmosphere is unaffected.

10. **Write the name the clouds shown below in the Table below**   **4 x 0.5 = 2 marks; 2 min**

A   B

C   D
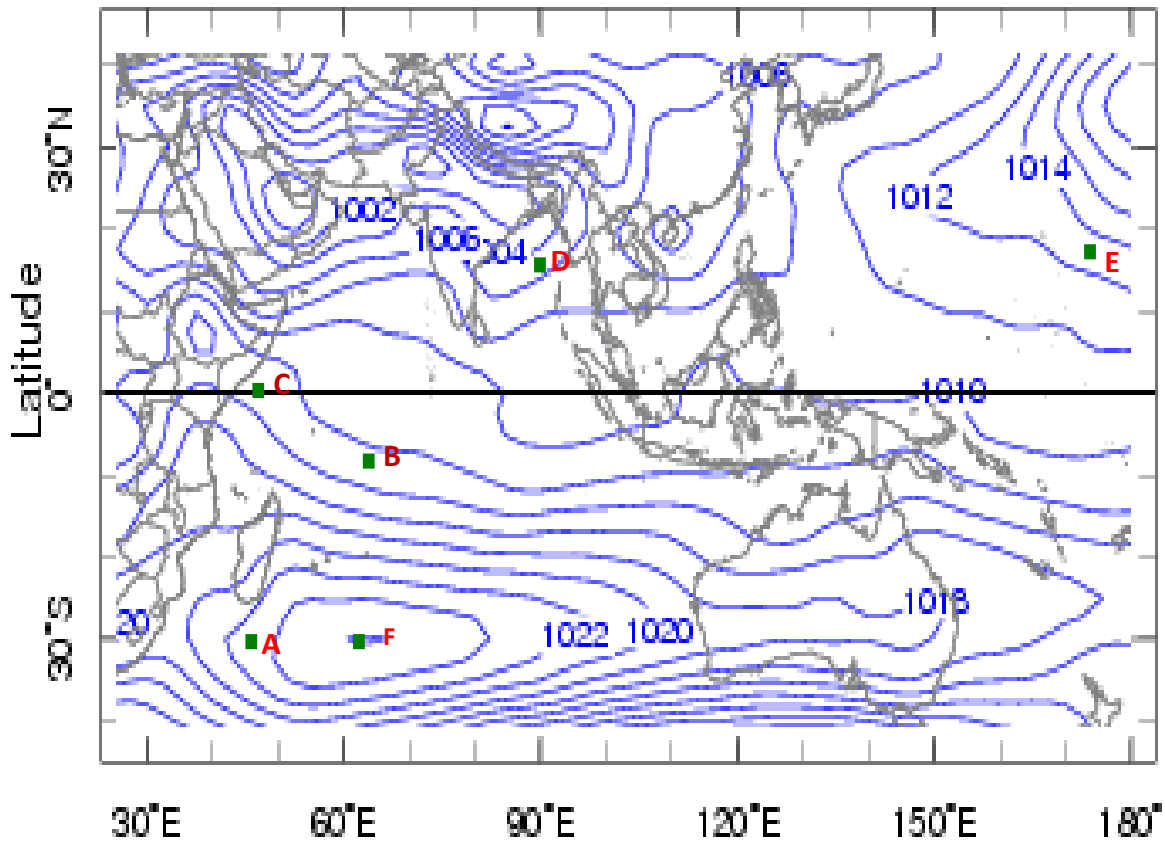
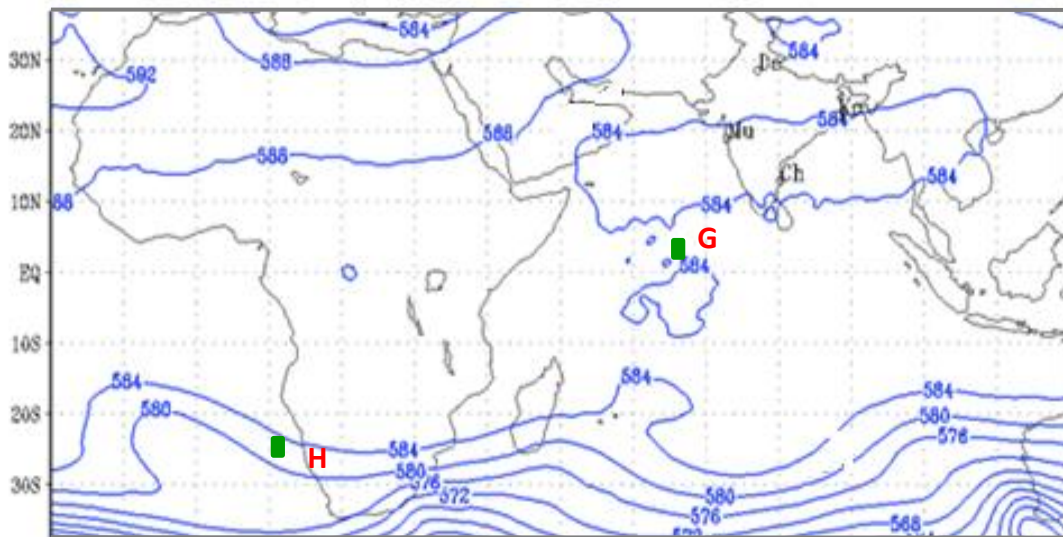| A	
B	
C	
D	

11. **The figure below shows the sea level pressure chart and the figure in the next page, the geopotential height of 500 hPa level (arbitrary units). Indicate the wind directions *by marking arrows* at locations A, B, C, D, and E in the figure below, and G and H in figure in the next page.**

8 x 0.5 = 4 marks; 7 min

Sea level pressure (hPa)

500 hPa geopotential

12. **If the rise in global mean sea level is 55 m due to the melting of Antarctic ice, estimate the approximate volume of ice. Take the radius of Earth to be ~6720 km. (Assume that the area of the oceans does not change with sea level and ignore the small difference in densities of ice and water)**   **5 marks 10 min**

13. **In an ocean where the temperature of the water column increases only by solar radiation, by what amount the temperature of a uniformly mixed column of water of depth 100 m would increase for 50 W m^{-2} of radiation incident for a period of 10 hours? The specific heat of water is 4200 J/kg and density is 1025 kg/m^3**   **2 marks; 3 min**

14. **Cricket or baseball players are not concerned about Coriolis force deflecting the ball. But an ocean current flowing from the equator to mid-latitude is deflected by the Coriolis force because:**

2 marks; 2 min

A. the cricket ball or baseball is smaller than the Earth.

B. the time of flight of the ball is much shorter than the period of Earth's rotation.

C. the Earth is attracted by the sun and the moon, but the cricket ball or baseball is not.

D. the shape of the Earth is not exactly spherical, but the ball is almost spherical.

15. **A tropical cyclone, when moving over tropical ocean becomes more intense, whereas when it moves over land, it becomes weaker mainly because:**   **1 mark; 1 min**

    A. trees and buildings obstruct cyclone movement.

    B. evaporation from the sea surface is higher.

    C. of higher wind speed over land.

    D. of higher precipitation over land.

16. Consider an ocean current that is 200 km wide and 200 m deep flowing with a uniform speed of 1 m s^{-1}. How much water is carried by this current in one year?   **2 marks; 3 min**

17. **Given below two zonal distributions of vertical thermal structure of the equatorial Pacific.**
(figures on left and right). Identify which figure corresponds to an El Nino and which is a non-El
Nino year.   **2 marks;, 2 min**

temperature [degc]   temperature [degc]
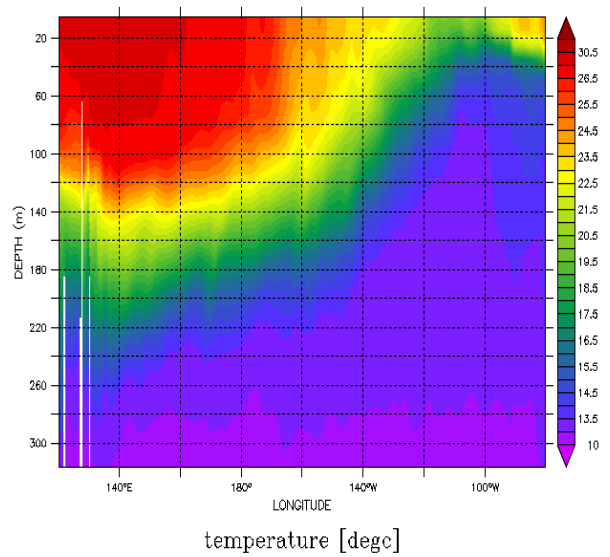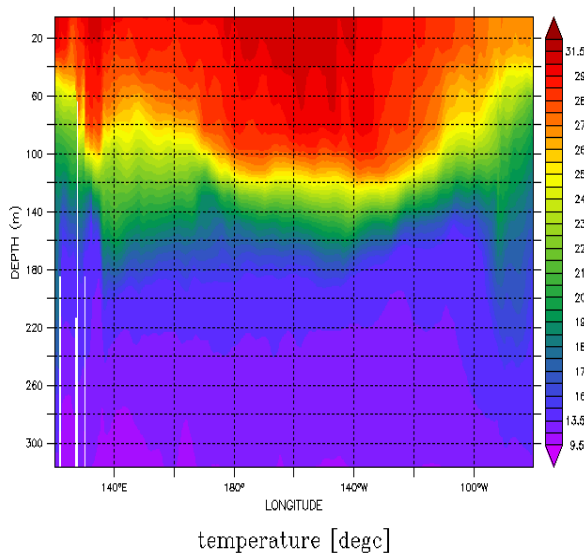
Left Panel	
Right panel	

18. Interactions of the atmosphere, cryosphere, hydrosphere, lithosphere and the biosphere among them lead to many positive and negative feedbacks in the climate system. A positive feedback is one which helps the agent which caused it to increase and a negative feedback is one which works against the agent which caused it. Identify the following observations into positive (+), negative (–) feedback and no feedback (0).   3 x 1 = 3 marks; 3 min

(i) Higher temperature leading to higher evaporation and so more water vapour in the troposphere (**+** / **–** / **0**)

(ii) Additional ice formation in the polar regions, increasing Earth's albedo. (**+** / **–** / **0**)

(iii) Addition of CO_2 to the Earth's atmosphere (e.g., by volcanism), and increasing the temperature and weathering rate of rocks.   (**+** / **–**/ **0**)

19. The CO_2 that reaches deep parts of the ocean takes about /_____ / to return to atmosphere because_____\   2 marks; 2 min

A. /10 years/, \of El Nino and La Nina\

B. /6 months to one year/, \of monsoons\

C. /10000 years/, \there are no currents in the deep ocean\

D. /1000 years/, \deep ocean circulation is slow\