INDIAN INSTITUTE OF SCIENCE
BANGALORE - 560012

ENTRANCE TEST FOR ADMISSIONS - 2009

Program : Research

Entrance Paper : Atrnospheric Sciences

Paper Code : AS

Day & Date

SUNDAY, 26TH APRIL 2009

Time

9.00 A.M. TO 12.00 NOON

GENERAL INSTRUCTIONS

1. The question paper consists of two parts, Part A and Part B.
2. There are 20 questions in PART A. Each question is followed by four answers, out of which only one is the correct answer.

Answer all questions in Part A.

3. Answers to Part A are to be marked in the OMR sheet provided.
4. For each quesiion darken the appropriate bubble to indicaie your answer.
5. Use only HB pencils for bubbling answers.
6. Mark only one bubble per question. If you mark more than one bubble, the question will be evaluated as incorrect.
   If you wish *to* change your answer, please erase the exisiing mark completely before marking the other bubble.
8. Answers to Part B are to be written in the separate answer book provided.
9. There are 8 questions in PART B.

Answer any SIX questions in Part B

10. Candidates are asked to fill in the required fields on the sheet attached to the answer book.
11. There is no negative marking.

PART A

Answer all questions. All questions carry equal ~ e i g h t (20 x 2 = 40 marks)

1. The differential of $\log_e(x)$ is:
   (A) e^x
   (B) 1/x
   (C) $\log_{10}(x)$
   (D) x^2

2. The dimension of energy per unit time is
   (A) $M L^{-2} T^{-2}$
   (B) $M L^2 T^{-1}$
   (C) $M L T^{-1}$
   (D) $M L^2 T^{-3}$

3. P(x) is the probability density function of a uniform distribution on the interval [a, b]. The value of P(x) at (a+b)/2 is
   (A) 1/(b-a)
   (B) 1/(a+b)
   (C) 0.0
   (D) 0.5

4. The mean of a standard normal distribution is
   (A) 1.0
   (B) 0.5
   (C) 0.0
   (D) None of the above

5. Aerosol is required in the atmosphere to:
   (A) Cause rain to fall
   (B) Give clouds their white color
   (C) Provide a solid surface for condensation
   (D) Collect heat for the evaporation of water

6. The Sun can be assumed as a black body at:
   (A) 1,000K
   (B) 3,000K
   (C) 6,000K
   (D) 1,0000K

7. The wavelength of the maximum intensity of radiation from a blackbody of absolute temperature T is
   (A) Independent of its ternperature
   (B) Proportional to T
   (C) Proportional to T^4
   (D) Inversely proportional to T

8. If pressure above water is increased keeping all other conditions unchanged, the boiling point of water will

(A) increase
(B) decrease
(C) remain unchanged
(D) none of the above

9. Which of the following is NOT a means of heat transfer in the Earth system?
(A) conduction
(B) convection
(C) contraction
(D) radiation

10. The blue colour of the sky is due to:
(A) scattering
(B) absorption
(C) emission
(D) diffraction

11. The atmosphere is absolutely stable when:
(A) lapse rate is less than wet adiabatic rate
(B) lapse rate is larger than wet adiabatic rate
(C) lapse rate is between wet and dry rates
(D) lapse rate larger than dry adiabatic rate

12. The average radius of a spherical cloud droplet and raindrop are 10 micron and 1 mm, respeclively. How many cloud droplets are required to make 1 rain drop?
(A) One hundred
(B) One thousand
(C) One million
(D) One billion

13. Large scale horizontal winds around a low-pressure centre in the southern hemisphere fiow in
(A) Clockwise direction
(B) Counter clockwise direction
(C) A straight line directed toward the centre
(D) The form of Kelvin waves

14. Greenhouse gases:
(A) absorb and irap infrared radiation emitted from the Earth
(13) reflect ultraviolet radiation from the sun
(C) cool the planet
(D) produce clouds

15. Which of the following gases is not a greenhouse gas?
(A) Carbon Dioxide
(B) Water vapour
(C) Oxygen
(D) Methane

16. Surface ocean currents are set in motion by
(A) the Coriolis effect
(B) gravity
(C) tidal force

(D) prevailing surface winds

17. During El Nino the sea surface temperature in the eastern equatorial Pacific
(A) decreases
(B) increases
(C) does not change
(D) remains at 24°C

18. The average ocean albedo at low wind conditions is:
(A) 6%
(B) 16%
(C) 36%
(D) 60%

19. The decrease in visible light in the ocean as a function of depth is
(A) exponential
(B) linear
(C) sinusoidal
(D) parabolic

20. Life first appeared on the Earth during the:
(A) Cenozoic Era
(B) Mesozoic Era
(C) Paleozoic Era
(D) None of the above

END OF PART A

PART B

THERE ARE **EIGHT** QUESTIONS IN THIS PART. **ANSWER ANY SIX**.
ALL QUESTIONS **CARRY** EQUAL WEIGHT.
(6 x 10 = *60* marks)

(STATE YOUR ASSUMPTIONS CLEARLY)

1. **Make an estimate of the mass and thermal capacity of the oceans assuming that the mean depth of oceans is 3.8 km. Also, estimate the mass and thermal capacity of ice over Greenland and Antarctica given that if all the ice melis, the sea level will rise by** 70 meters. **[Radius of earth= 6370 km,** density **of** water **= 1000 kg m^{-3}**, Specific heat capacities of water and ice are 4180,** 2108 **J kg^{-1} K^{-1}, respectively. Assume that the fractional increase in ocean area is negligible.]**

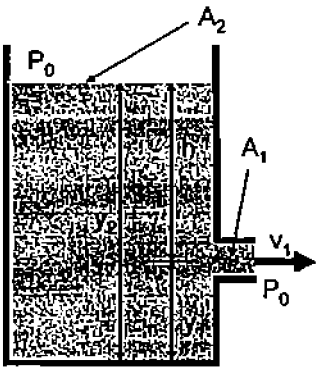
2. The world needs 15 Terawatts (Tera = 10^{12}) *of* energy today. Let us assume all of this is coming from coal. Burning one kilogram of coal releases 30×10^6 J of energy and average efficiency of a coal plant is 30%. How much coal will be burned in a year?

3. The density p of the ocean as a function of depth z is given by
$$\rho(z) = \rho_o + \alpha z$$
where a is a positive constant. Find the potential energy of the upper 100 metres of ihe water column. Assume that the potential energy is zero at a reference level at $z = 100$ meters.

4. **Show with the help of a** simple example that the phase speed and group **velocity of waves need not be the same.**

5. Calculate the height of a geostationary satellite from the surface of the earth. [Newton's gravitational constant = 6.61 x 10^{-11} m^3 kg^{-1} s^{-2}; Mass of the earth = *5.93* x 10^{24} kg; Radius of the earth = 6370 km.]

6. An open tank containing a liquid of density ρ has a hole in its side at a distance y_1 from the tank's bottom (see figure). The hole is open to the atmosphere, and its diarneter is much smaller than the diameter of the tank.
   a) Determine the speed of the liquid, v_1, as it leaves the hole when the liquid's level is a distance h above the hole.
   b) What position of the hole would cause the water to land at the farthest distance from the tank?



7. Consider a horizontally uniform atmosphere in hydrostatic balance. The atmosphere is isothermal, with temperature of 263 K. Surface pressure is 1000 hPa. Find the altitude, pressure and density of the level that divides the atmosphere into two equal parts by mass (i.e. one-half of the atmosphere is above this level). Assume acceleration due to gravity = 9.8 m s^{-2}, density at surface to be 1 kg m^{-3}. Make suitable assumptions if necessary and state the same.

8. When cloud droplets form, latent heat is released to the atmosphere. If the entire latent heat is utilized in increasing the temperature of the atmospheric column between 500 and 200 hPa, find the increase in temperature of the column in 1 hour. Assume that the rate of condensation is 5×10^{-4} kg m^{-2} s^{-1}. [Latent heat of condensation of water vapor is 2.26×10^{6} J kg^{-1}; Specific heat capacity of air at constant pressure is 1006 J kg^{-1} K^{-1}.]

END OF PART B