2011

NOTE:-

1. *Attempt all questions. There is no negative marking. No additional sheets are provided*
2. *Answer all the questions of the **same subject at one place**.*
3. *Students may take around 80 minutes for Mathematics, 50 minutes for Physics and 50 minutes for Chemistry.*
4. *Use of calculators, slide rule, graph paper and logarithmic, trigonometric and statistical tables is not permitted.*

PART-A : **MATHEMATICS**

Note:- All answers to questions in **Section-A, Section-B** and **Section-C** must be supported by mathematical arguments. In each of these sections order of the questions must be maintained.

SECTION-A

This section has Five Questions. Each question is provided with 5 alternative answers. One or more than one of them are correct answers. Indicate the correct answer by A, B, C, D, E.   (4x3=12 MARKS)

1. If 2011 is written as the sum of 11 consecutive primes in their ascending order, then the 6th prime is
   A) 167   B) 187   C) 181   D) 211   E) 183

2. In a triangle ABC, D is the mid point of BC and AD > BC/2. Then A is
   A) $<90^0$ B) $<120^0$ C) $<135^0$ D) $<60^0$ E) $<45^0$

3. Let l be a fixed line. ABCD be a square having a fixed side length, moving such that its vertex D is at a fixed point on the line l and such that the square is on one side of the line l. Let A', C' be the feet of the perpendiculars of A and C on l respectively. Then Δ AA'D and Δ DC'C are congruent if angle BDA' =
   A) 30^0 B) 45^0 C) 90^0 D) 60^0 E) none of these

4. If x<y and x+y = k then
   A) x < k/2 only when k>0   B) y> k/2 only when k> 0   C) x < k/2
   D) y > k/2   E) x < k/2 when k>0 and x> k/2 when k < 0

SECTION-B

This section has Five Questions. In each question a blank is left. Fill in the blank.   (4x3=12 MARKS)

5. In the sequence obtained by omitting the perfect squares from the sequence of natural numbers, 2011th term is _____

6. In a plane, given any three non collinear points, the number of parallelograms that can be formed such that the three given points become three consecutive vertices is _____

7. A certain integer has only two distinct prime factors. The number of its divisors is 6, and the sum of the divisors is 28. The integer is_____

8. The value of $2^{\log_6 18}.3^{\log_6 3}$ in decimal form is _____

SECTION-C

State True or False in each of the following statements.   (4x3=12 MARKS)

9. $2011^{64} + 64$ is a composite number.

10. There exist four distinct points A, B, C, D in a plane such that $\overleftrightarrow{AD} \perp \overleftrightarrow{BC}$ and $\overleftrightarrow{BD} \perp \overleftrightarrow{CA}$.

11. There exist a pair of non negative real numbers a, b such that $(a - b)(a(a+b) - 2b^2)$ is negative.

12. If n is a natural number, 2n+1 and 3n+1 are squares then 5n+3 is not a prime.

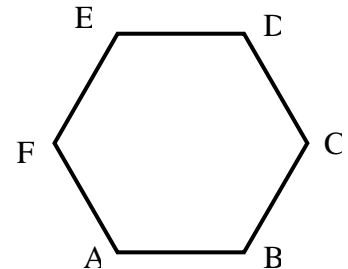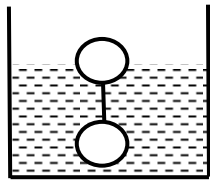### SECTION-D   (4x6=24 MARKS)

13. If [x] represents the greatest integer less than or equal to x then solve the equation $x^{2011} – [x]^{2011} = (x – [x])^{2011}$ in positive real numbers.

14. Find all possible ordered triads (a, b, c) such that $(n+3)^2 = a(n+2)^2 + b(n+1)^2 + cn^2$ for every positive integer n.

15. State and Prove Alternate Segment Theorem on circles.

16. Write any two functions f: **R** → **R** such that f(x) = f(x/2) for every real number x.
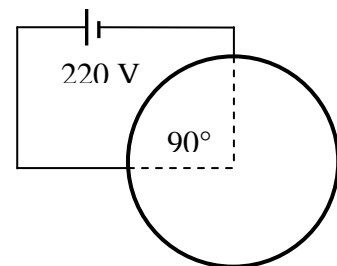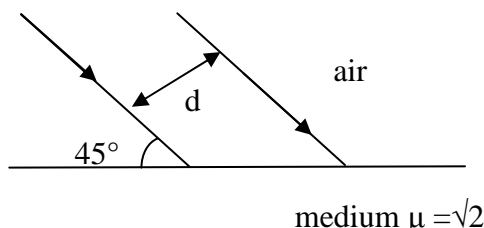
PART-B : PHYSICS
(10x6=60 Marks)

17. Two bodies of equal volume connected by a string are floating with one of them completely submerged and the other with half of its volume outside the liquid as in the figure (Below, Left). Find the densities of the materials of the bodies if the densities are in the ratio 1:3. If the volume of the floating body is doubled, find the fraction of the floating body that now lies submerged in the liquid.(Density of liquid = 800 kgm^{-3})

18. An insect crawls along the sides of a regular hexagon (Above, Right) with a uniform speed v in the anticlockwise sense. find the magnitude of its average velocity in moving from (i) A to C and (ii) A to D and (iii) A to E

19. Two parallel rays of light separated by 'd' (Below, Left) are incident at the boundary of air and a medium of refractive index √2 at 45°. Find the angle of deviation of each ray and the distance between these rays in the medium

20. A wire of resistance R is bent in the form of a circle and is connected to a 220 V source as shown (Above, Right). If the energy provided by the source in 42 s is same as the energy required to raise the temperature of 11 kg of water through 44 C°, find the value of R.

21. Resistances of 2 Ω and 3Ω are connected in series between terminals A and B, and a potential difference of 20 V is applied between the terminals. An unknown resistance is connected in parallel to the 3 Ω resistance and the current in this unknown resistance is 5/12 times the current that was flowing from A to B before it was connected. Find the unknown resistance.

22. A long conductor carries a current northward. A moving positively charged particle is located vertically below the conductor. Find the force acting on it if its velocity is directed (i) downward (ii) westward

23. Rate at which energy is incident on 1 m^2 area facing the sun is 1400 W. The average area of the roof top of a moderate home is 150 m^2. Since the angle of incidence of the energy from sun on the roof top varies during the day, the average rate for a 12 hour duration is half of the maximum rate of incidence at the noon time. Find the energy received in 12 hour duration by the roof of the building. Assuming yield of 200 MeV per reaction in the fission of uranium nucleus, find the number of reactions that produce the same amount of energy as provided by the sun to the roof in the 12 hour duration.

Questions 24 to 26 are based on the following physical situation.

A stream of particles each of mass 1 g moving horizontally with a velocity of 5 m/s strike a vertical wall. The particles stick to the wall after hitting the wall. Number of particles per m^3 of the stream is 10000.

24. Find the number of particles striking a square area of side 50 cm of the wall in one second.

25. Find the number of particles of the stream that cross a vertical section of area 0.4 m^2 in two seconds

26. The change in momentum of the particles that strike an area 2 m^2 of the wall in four seconds.

PART-C : **CHEMISTRY**

(15x4=60 Marks)

27. Ferrous sulphate is treated with potassium permanganate in the presence of suphuric acid. Potassium sulphate, manganese sulphate, ferric sulphate are the products of the reaction. The number of moles of sulphuric acid required for 1 mole of $KMnO_4$ _____.

28. Amongst the following the total number of compounds whose aqueous solution turns red litmus paper blue is ____.
KCN , K_2SO_4 , $NaCl$, $Zn(NO_3)_2$, $FeCl_3$, K_2CO_3 , NH_4NO_3 , $LiCN$

29. The value of n in the molecular formula $Be_nAl_2Si_6O_{18}$ is ____

30. Total number of diprotic acids among the following is ____
H_3PO_4 , H_2SO_4 , H_3PO_3 , H_2CO_3 , $H_2S_2O_7$, H_3BO_3 , H_3PO_2 , H_2CrO_4 , H_2SO_3

31. Among the following the number of elements showing only one non-zero oxidation state ____
O , Cl , F , N , P , Sn , Tl , Na , Ti

32. Iron (II) sulphide is heated in air to form compound A, and an oxide of sulphur. The oxide of sulphur is dissolved in water to give an acid. The basicity of this acid is ____.

33. A current of 10 A flows for 2 hours through an electrolytic cell containing a molten salt of metal X and results in the deposition of 0.25 moles of metal X at cathode. The oxidation state X in the electrolysed salt is _____ .

34. Ar and He are both gases at room temperature. The average velocity of He atom is x times of average molecular velocity Ar atoms at this temperature. The numerical value of x is ____.
(atomic wt of Ar = 36, He = 4)

35. Among BF_3 , NF_3 , pH_3 , IF_3 , IF_5 and SF_4 the number of species having the same number of loan pair of electrons on central atom is _____

36. On heating 1.763g of hydrated $BaCl_2$ to dryness 1.505g of anhydrous salt remained. Number of moles of H_2O present in the mole of hydrated $BaCl_2$ is _____ (mol.wt. of anhydrous $BaCl_2$ is 208)

37. Dry air contains at one atmosphere pressure contains 78% nitrogen 21% oxygen and 1% other gases. The partial pressure of other gases is $ax10^{-2}$ atm where a is ____.

38. The bond energy of an O-H bond is 109 k.cal $mole^{-1}$. When $5x10^{-3}$ mole of water is formed, the energy released in k.cal is _____.

39. On decomposition of NH_4HS the following equation is established $NH_4HS(s) \rightleftharpoons NH_3(g)+H_2S(g)$

    If the total pressure is p atmospheres then the equilibrium constant K_p will be equal to $\dfrac{p^2}{x}$ atm^2 where x is ____

40. 10 ml of pure ethyl alcohol of density 0.785g ml was diluted with water to a final value of 100 ml. The density of resulting solution was 0.9866 g/ml. Percentage by weight of ethyl alcohol is ____.

41. Match the following

Column - I	Column - II
A) 0.55 mole	p) 4.48 lit of SO_2 at NTP
B) 0.10 mole	q) 100 ml of H_2O
C) 0.20 mole	r) 22g of CO_2
D) 0.50 mole	s) 2.24 lit. NH_3
	t) 0.1 g atom of Iron