Paper Type: AD

M. Prakash Institute Entrance Examination
for IIT JEE Training Batch 2018-20

April, 2018 4.00 pm to 8.00 pm Total marks: 200

Student's Name: Receipt Number:

Chemistry

Useful data:

Atomic numbers:H:1; Li:3; C:6; N:7; O:8; Na: 11; Mg:12; Al:13; S:16; Cl: 17; K:19; Ca:20; Mn: 25; Fe:26; Co: 27; Ni:28; Cu:29.

Atomic masses: H:1; Li:7; C:12; N:14; O:16; Na:23; Mg: 24; Al: 27; S:32; Cl:35.5; K:39; Ca:40; Mn: 54.9; Fe:56; Co: 58.9; Cu: 63.5; Ni: 58.7

Avogadro number : 6×10^{23} per mole.

1. A compound 'M' is formed by elements having atomic numbers 17 and 20 . Identify 'M' and write the number of atoms in one molecule of 'M' in your bubble sheet.

2. One demerit of the Mendeleev's periodic table is that "In some places, an element with a higher atomic mass was placed before an element with a lower atomic mass."
One such pair exists where both the elements belong to the fourth period of the modern periodec table. Identify the pair and write the atomic number of the element that has higher atomic mass among the two.

3. An element 'A' separately reacts with Sulphur and Nitrogen to form two compounds 'AS' and 'A_3N_2'. The molecular mass of 'AS' is 56 and that of'A_3N_2' is 100. Find the atomic number of 'A'.

4. Write the **number** of exothermic chemical reactions /processes from the following list in your bubble sheet.

(i) $KNO_{3(s)} + H_2O \rightarrow KNO_{3(aq)}$

(ii) $C_6H_{12}O_{6(aq)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(l)}$

(iii) $S + O_{2(g)} \rightarrow SO_{2(g)}$

(iv) A piece of Potassium metal introduced in a jar of Chlorine gas

(v) $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$

(vi) $C_{12}H_{22}O_{11(s)} \rightarrow 12C + 11H_2O_{(l)}$

(vii) $CH_{4(g)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(l)}$

(viii) A piece of Sodium metal dropped in a trough of water

5. An octa-atomic element 'M' reacts with Hydrogen and Oxygen in two separate reactions to form 'H_2M' and 'MO_2' respectively.'H_2M' and 'MO_2' further react with each other.The balanced chemical equation (where a,b,c,d are the respective coefficients)is as follows:

$aH_2M + bMO_2 \rightarrow cM_8 + dH_2O$

Find the value of 'a+ b+ c+ d' and write it in your bubble sheet

6. From the following, write the **number** of redox reactions in your bubble sheet.

(i) $CH_{4(g)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(l)}$

(ii) $H_2O + CO_{2(g)} \rightarrow H_2CO_{3(aq)}$

(iii) $CuO + H_2 \rightarrow Cu + H_2O$

(iv) $BaSO_4 + 4C \rightarrow BaS + 4CO$

(v) $C_2H_5OH + Na \rightarrow C_2H_5ONa + H_2 \uparrow$

(vi) $2HCl \ + \ Ca(OH)_2 \rightarrow CaCl_2 \ + \ 2H_2O$

(vii) $4Al \ + \ 3O_2 \rightarrow 2Al_2O_3$

(viii) $Zn \ + \ 2NaOH \rightarrow Na_2ZnO_2 \ + \ H_2 \uparrow$

7. Equal volumes of same concentration of HCl and NaOH are mixed together. Find the pH of the resulting mixture. Write the value in your bubble sheet.

8. From the following list of elements, identify the element that does not produce Hydrogen gas on reaction with dil. HCl:
Zn, Al, Ca, Cu, Li, Fe.
Write the atomic number of that element in your bubble sheet.

9. Fifth member of Alkyne series has total number of 'Y' atoms in one molecule. Write the value of 'Y ' in your buble sheet.

10. An element 'X' on reacting with steam produces H_2 gas along with $X_3O_{4(s)}$. Identify 'X' and write the value of $\frac{M}{4}$ where 'M' is the molecular mass of X_3O_4.

11. Write the **number** of elements from the following list that produce Hydrogen gas on reacting with $dil.HNO_3$:
Hg,Mg,Pb, Co, Mn, Cu, Ag.

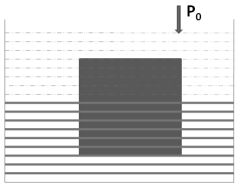
12. In electrolytic reduction of Alumina, 1 mole of Al is produced at cathode by gaining 'x' mole of electrons. 1 mole of Oxygen gas is liberated at the anode by losing 'y' moles of electrons. Write the value of 'x' +'y' in your bubble sheet (where x and y are whole numbers).

13. If the total number of single bonds in Benzene is taken as 'm' and the total number of double bonds as 'n'; write the value of ' m × n ' in your bubble sheet.

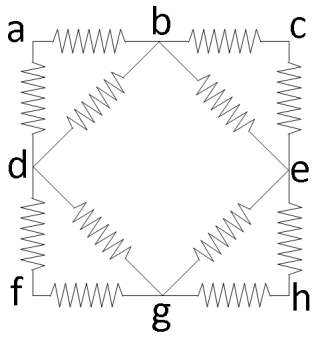
Physics

Take $g = 10 \ m/s^2$ and density of water $= 1 \ g/cc$

14. A cube of edge length 10 cm is floating in a large container having water and immiscible oil (sp. gravity 0.8) such that 65% of the block is in water as shown below. Slowly oil is siphoned off completely. Find the portion of the block in water now. Express answer as percentage of block's volume.

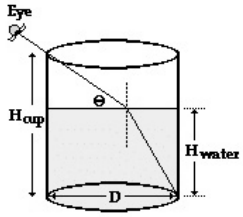


15. In the circuit given below, all the 12 resistors are of 1Ω. A 12V battery is connected across points b and e. Find the current through the battery. Express your answer in Ampere.

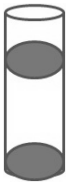


16. An iron wire of length 1 m and cross-sectional area 1 mm^2 is cut along the length into 7 equal parts. Each of these parts are connected in parallel. Find the equivalent resistance. Express your answer in $mili\Omega$.
Given: resistivity of iron is 9.8 $\mu\Omega - cm$.

17. A tall cup is partially filled with special water solution (n= $\sqrt{2}$) to a height of $7\sqrt{3}$ cm (H_{water}). The diameter (D) of the cup is 15 cm. A student looks downward just over the left rim of the cup at an angle of 45^0 with the water's surface (θ) and is barely able to see the bottom-right corner of the cup. A sketch (not drawn to scale) of the path of light is shown. Determine the height of the cup above the water surface in centimeters.



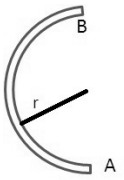
18. Two balls each carrying equal positive charge and each weighing 3.24 kg are positioned in a vertical cylinder such that they fit one above the other. Calculate the quantity of charge required such that top ball levitates 25 cm above the bottom ball. Ignore gravitational force between the two balls. Express your answer in μC.



19. An object is released from top of a tall tower of height h m. At the same instance another object is thrown from ground upwards with velocity 40 m/s. Assume air friction equal to 1/4th of the object's weight is acting on both objects during the motion. If both object collide exactly half distance from top of the tower, find $h/2$. Express your answer in m.

20. In New York City, USA, a Sky Mirror sculpture is erected at city center. It is 10 m high, one side being concave mirror facing famous Rockefeller building and other side being convex mirror facing a highway. The focal length of the concave side is of the same magnitude as the focal length of the convex side.
A taxi on highway when located 38 m from the convex side of the sculpture, image created is one-fifth the size of the taxi. Calculate the image size of the 270-m tall Rockefeller Center if it is located at of 95 meters from the sculpture.

21. A small semicircular hollow frictionless tube of radius (r) 30 cm is touching the ground at end A. Let ν m/s be minimum velocity which needs to be given to an object starting from end A so that it can reach end B. Now if the object is given velocity 2ν m/s at end A. Calculate its velocity at it reaches end B. Express your answer in m/s.



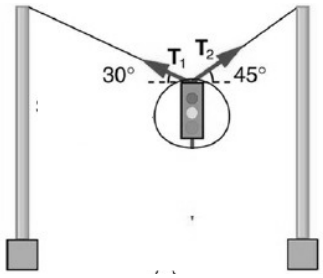
22. A converging lens of focal length 20 cm is used to create an image (I_1) of an object placed 30 cm away from it. Then a thin diverging lens of focal length 60 cm is interposed between the converging lens and image I_1 at a distance of 40 cm from the converging lens. A new image, I_2 is formed. Calculate distance between I_1 and I_2. Express your answer in cm.

23. A roller-coaster ride uses 50 KW hydraulic system designed to take cart with 3 people (total mass 200 Kg) from rest at ground to top of the ride 50 m high in 5 seconds. Calculate the speed of the cart at the highest position if the efficiency of the engine is 65%. Express your answer in km/hr.

24. An expert skater weighing 50 Kg is skating along a road at 21.6 Km/hr when he passes his friend. He picks up a bag full of skating equipments weighing 10 Kg from the friend's hand. Determine his speed immediately after grabbing the bag. Express your answer in m/s.

25. A special wax cube having a mass of 100 grams and an initial temperature of 40^0 C is placed in half liter of water at 90^0 C. What is the final temperature of the wax if the heat is transferred only between water and wax? Express your answer in ^{0}C.
Given: Wax has a melting point of 54^0 C, latent heat of fusion of 124 Cal/g and specific heat capacities of 4 cal/g/^{0} C (solid state) and 5.1 cal/g/^{0} C (liquid state).

26. A traffic light of mass $\frac{1+\sqrt{3}}{20}$ Kg is suspended between two poles using two wires as shown. Let the tensions in the wires be T_1 and T_2. Calculate $(T_1)^2 + 2(T_2)^2$ where both the tensions are expressed in Newton.



Mathematics

27. Let x be real number such that $x^4 - 3x^3 + 2x^2 - 3x + 1 = 0$ Then value of $x^3 + \frac{1}{x^3} =$

28. In $\triangle ABC$, $2(\sin A + \sqrt{1 + \cot^2 A}) = 5$. Then $3\sec^2 A \cdot Cosec^2 A =$

29. $\sqrt{3x^2 - 4x + 34} + \sqrt{3x^2 - 4x - 11} = 9$. Let the sum of the roots be S. Then $9S$ equals

30. A cyclist leaves town A for town B, and 3 hours later a motor cyclist starts from town B towards the cyclist. The speed of motor cyclist is three times the speed of cyclist and they meet each other halfway between A and B. If the motor cyclist had left B two hours after the cyclist left A, they would have met at a point 15 km closer to A. if distance between A and B is D kms, then $\frac{D}{2}$ equals.

31. If $\frac{35}{x-2} - \frac{24}{y+2} = -2$ and $\frac{35}{y+2} - \frac{24}{x-2} = 57$ and $3y \sin\theta + x = 0$ where θ is an acute angle. Then θ equals

32. x_1 and x_2 are the solutions of $(x-4)^2 + 4x - 27 = 2\sqrt{x^2 - 4x + 4}$ and $x_1 < x_2$ then $x_2 - x_1 =$

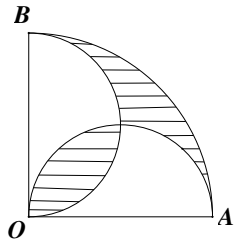
33. An equilateral triangle is constructed such that one vertex coincides with the midpoint of one side of a square and other two vertices are on diagonals of the same square. Area of this equilateral triangle is A. If positive root of the equation $k^2 - 6k - 3 = 0$ is the area of the square then $40A$ equals

34. $\overline{AF}$ is altitude of $\triangle ABC$. P and Q are the points on $\overline{AB}$ and $\overline{BC}$ respectively such that $FQ = \frac{2}{5}FC$ and $AP = \frac{2}{5}AB$. If $BC = 10$, $PQ = 8.5$ and Δ is area of $\triangle ABC$ then $\frac{2}{5}\Delta$ equals.

35. $\triangle ABC$ is right angle triangle at B. P is on $\overline{AC}$ such that m$\angle ABP = 30$. If $AB = 3$, $BC = 4$ then $(4\sqrt{3} + 3) \times BP$ equals

36. $\square ABCD$ is a parallelogram with area 100 square units. E is mid point of $\overline{AB}$. F is mid point of $\overline{BC}$. $\overline{AF}$ and $\overline{DE}$ intersect at G. Then area of $\triangle DFG$ is

37. $O-AXB$ is quadrant of a circle whose center is O and radius is 14. Semicircles on OA and OB as diameters are drawn to lie in the interior of quadrant. Semicircles intersect each other at C. Find the area of shaded region. Use $\pi = \frac{22}{7}$.



38. $\triangle ABC$ is right angle triangle right angled at B. $\overline{CD}$ is angle bisector of $\angle ACB$ with D on $\overline{AB}$. If $AB = 4,\ BC = 3$ then $16\sec^4\frac{C}{2}$ equals

39. In $\triangle ABC$, D is on $\overline{BC}$, E is on $\overline{CA}$, F is on $\overline{AB}$ such that $\frac{AF}{FB} = \frac{BD}{DC} = \frac{CE}{EA} = 2$. $D(1,-11),\ E(1,-2),\ F(-2,-1)$ and $C(x_0, y_0)$. Then $x_0 - 3y_0$ equals

40. In $\triangle ABC$, $\overline{BK}$ and $\overline{CK}$ are such that $\text{m}\angle KBC = \frac{B}{5}$ and $\text{m}\angle KCB = \frac{C}{5}$. If distance of C from line BK is $\frac{CK}{2}$ then $\text{m}\angle BAC$ equals