Chemistry

Useful information:
Atomic Masses: H : 1, He : 4, C : 12, O : 16, Na : 23, P : 31, Cl : 35.5

1. The given tables contain atomic masses of the elements that follow Dohereiner's law of triads. Using this data, find out the values of 'x' and 'y'; enter $(y - x)$ as your answer:
   .   Table-1 :

Ca	Sr	Ba
x	88	137

   Table-2:

S	Se	Te
32	79	y

2. When slowly heated, a sample of 6.022×10^{23} molecules of potassium chlorate ($KClO_3$) decomposes to produce a gas and a salt. What will be the mass in grams of the gas liberated?

3. Study the following series of chemical reactions carefully:
   $CH_3COOH + Na_2CO_3 \rightarrow$ Gas (X) + Byproducts
   Gas (X) + $CaOCl_2 \rightarrow$ Gas (Y) + Byproducts
   Gas (Y) + $Ca(OH)_2 \rightarrow$ Compond (Z) + $CaOCl_2$
   Identify compound (Z) and write its molar mass.

4. How many of the following chemicals will give only 2 H$^+$ ions if fully dissociated ?
   $H_3PO_4, H_3PO_3, H_3BO_3, H_2CO_3, Ca(OH)_2, H_2SO_3, HCl, HNO_3, NaOH, Fe(OH)_2$

5. What is the total number of nucleons present in one alpha particle ?

6. An element is having electronic coniguration = (2,8,7). If 'x' = group number of the element in the modern periodic table and 'y' = period number of the element in the modern periodic table, then calculate the product of 'x' and 'y'.

7. 1755 grams of NaCl is dissolved in water to produce 15 litres of its aqueous solution. Calculate the molarity of this solution.

8. Methane on complete combustion with pure oxygen gas produces carbon dioxide and water. If 5 mole of methane is to be consumed in this reaction, then calculate the number of mole of oxygen gas needed for the complete combustion.

9. n-Butyl Alcohol ($HO-CH_2-CH_2-CH_2-CH_3$) is heated at 170^oC in the presence of concentrated sulphuric acid to produce a chemical 'X' and water. What is the molecular mass of the chemical 'X' in this reaction?

10. What is the total number of basic radicals among the following:
    $Fe^{3+}, SO_4^{2-}, NH_4^+, MnO_4^-, Mg^{2+}, S^{2-}, ClO_3^-, NO_3^-$

Physics

Use following data:
Density of water $= 1 \text{gm/cc}$
Gravitaional acceleration (g) $= 10 \text{ m/s}^2$
Melting point of ice $= 0°\text{C}$
Boiling point of water $= 100°\text{C}$

11. A certain substance has a melting point of $-50°\text{C}$ and a boiling point of $160°\text{C}$. A thermometer is designed with this liquid and its melting and boiling points are designated at $30°\text{L}$ and $100°\text{L}$. The boiling points of water on this scale ($°\text{L}$) is

12. Two blocks of masses 0.2 kg and 0.5 kg are placed 22 m apart on a rough flat horizontal surface. The resistive force (frictional in nature) acting on each block is equal to half of its weight in magnitude. At time $t = 0$ sec, blocks are pushed towards each other with equal forces of 3 N on each of the block. Find time (in sec) at which blocks collide with each other.

13. A person goes from point P to point Q covering 1/3 of the distance with speed 10 km/h, the next 1/3 of the distance at 20 km/h and the last 1/3 of the distance at $\dfrac{50}{3}$ m/s. The average speed of the person (in m/s) is

14. A solid plastic cube of side 4 cm has density of 1500 kg/m³. It is hanging from a massless thread attached to a spring balance. Now the spring balance is held from top in such a way that the cube attached below is completely immersed in a liquid of density 1.2 g/cc. While in the liquid, the reading of the spring balance (in gram) is M. Find $5M$ and mark that number as your answer

15. A long horizontal mirror is next to a very tall vertical screen (see figure).
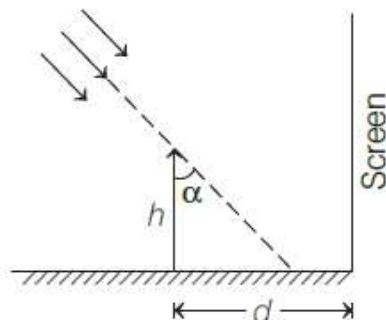
Parallel light rays are falling on the mirror at an angle $\alpha = 45°$ from the vertical. If a vertical object of height $h = 24$ cm is kept on the mirror at a distance $d = 1$ m. The length (in cm) of the shadow of the object on the screen would be

16. A current of 25 A flows through a 25Ω resistor represented by the circuit diagram. The current (in A) in 80Ω resistor is
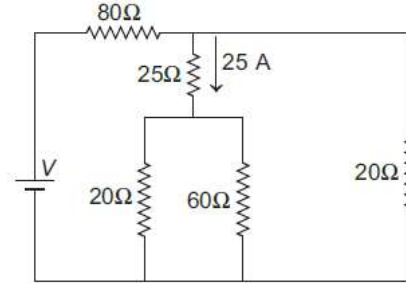
17. 150 gm of ice at 0°C is mixed with 100 gm of water at temperature 80°C. The latent heat of ice is 80 cal/gm and the specific heat of water is 1 cal/gm°C. Assuming no heat loss to the environment, the amount of ice (in gm) which does not melt is

18. A juggler tosses a ball up in the air with initial speed u. At the instant, it reaches its maximum height H, he tosses up a second ball with the same initial speed. The two balls will collide at a height $n \times H$, where n is a fraction. Calculate $72n$ and mark that as answer

19. Two charges $+Q$ and $-4Q$ are located at fixed points A and B, $16 cm apart$ on a horizontal line as shown below. A free charge $+3Q$ is placed at point C on line AB such that it remains at rest. Find the distance of point C from point B.

20. Two point masses are kept some distance apart. First mass is smaller and the other is bigger . The gravitational force between them is 47.25 N. Now, the set up is changed. The first mass is replaced by a point mass that is four times the smaller mass. The second mass is replaced by a point mass that is eight times the bigger mass. Also the distance between them is now six times the earlier distance. Find the force (in Newton) between the new set up of masses.

Maths

21. What is the largest distance between a circle of diameter 15 that is centered at $(2, 2)$ and circle of diameter 5 that is centered at $(22, -19)$?

22. Circles with centers at A and B, both with radius 10 units are not intersecting and the minimum distance between them is 7 units. Lines l, m are direct tangents and n is a transverse tangent. n intersects l and m at C and D. Find CD. (When both the circles are on the same side of the line then the line is called **direct tangent** and when two circles are on opposite sides of the line then the line is called **transverse tangent**)

23. Consider a sequence of integers $19, 11, -8, -19, \cdots$ where each term is equal to the term preceding it minus the term before that, except first two terms. What is the sum of first 2022 terms?

24. Quadrilateral $ABCD$ is square with side length $4\sqrt{5}$. E is midpoint of side BC. F is on side AB such that $\overline{DE}$ is angle bisector of $\angle CDF$. Find FE.

25. Let $S = 1 + \dfrac{1}{4} + \dfrac{1}{5} + \dfrac{1}{6} + \dfrac{1}{7} + \dfrac{1}{4 \cdot 5} + \dfrac{1}{4 \cdot 6} + \dfrac{1}{4 \cdot 7} + \dfrac{1}{5 \cdot 6} + \dfrac{1}{5 \cdot 7} + \dfrac{1}{6 \cdot 7} + \dfrac{1}{4 \cdot 5 \cdot 6} + \dfrac{1}{4 \cdot 5 \cdot 7} + \dfrac{1}{4 \cdot 6 \cdot 7} + \dfrac{1}{5 \cdot 6 \cdot 7} + \dfrac{1}{4 \cdot 5 \cdot 6 \cdot 7}$. Find S.

26. Quadrilateral $ABCD$ is inscribed in a circle with diameter 12. If m$\angle BDA = 40^o$ and $AD = 6$. If m$\angle BAD = (2X)^o$ report X.

27. Find the sum of digits of constant term in the expansion of $(3x + 5)^3 \times (2 + \frac{3}{x})^2$.

28. It is given that $x^3 - 23x^2 + 167x - 385 = 0$ has one integer root α such that $8 \le \alpha \le 12$. Find the positive difference of remaining two roots.

29. $ABCD$ is a parallelogram. M and N are on $\overline{AB}$ and $\overline{AD}$ respectively such that $AB = 4AM$ and $AD = 3AN$. Let K be the point of intersection of $\overline{MN}$ and $\overline{AC}$. Find $\frac{AC}{AK}$.

30. A model maker has clay models of sheeps, goats and cows (some of each). One buyer offers to pay Rs. 100 per each sheep, Rs 200 per each goat and Rs 400 per each cow for total of Rs 4700. Another buyer offers to pay Rs. 135 per each sheep, Rs 265 per each goat and Rs 309 per each cow for total of Rs 5155. How many clay models of sheeps does the model maker have?

Answer Key:
Chemistry:

1	2	3	4	5	6	7	8	9	10
87	48	18	3	4	51	2	10	56	3

Physics:

11	12	13	14	15	16	17	18	19	20
80	2	5	96	48	75	50	54	32	42

Maths:

21	22	23	24	25	26	27	28	29	30
39	27	0	5	2	55	14	2	7	13