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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

Solutions for sample questions

Class : 11 (PCM)

Mathematics

1. **(D)** We have $2^{n+10} = 2.2^2 + 3.2^3 + 4.2^4 + \ldots + n.2^n$

$\Rightarrow 2(2^{n+10}) = 2.2^2 + 3.2^3 + \ldots + (n-1).2n \mid n.2^{n+1}$

Subtracting, we get -2^{n+10}

$= 2.2^2 + 2^3 + 2^4 + \ldots + 2n - n.2^{n+1}$

$= 8 + \frac{8(2^{n-2}-1)}{2-1} - n.2^{n+1}$

$= 8 + 2^{n+1} - 8 - n.2^{n+1} = 2^{n+1} - (n)2^{n+1}$

$\Rightarrow 2^{10} = 2n - 2 \Rightarrow n = 513.$

2. **(D)** Point of intersection of given lines is (6, 7)

Required distance

$= \sqrt{(6-2)^2 + (7-3)^2} = \sqrt{32} = 4\sqrt{2}.$

3. **(A)** $a + b = 9$, $ab = 20$, $a > b$

$\Rightarrow a = 5, b = 4.$

$\therefore$ Equation of the line is $\frac{x}{5} + \frac{y}{4} = 1$

$\Rightarrow 4x + 5y = 20.$

4. **(B)** $\alpha + \beta = -\frac{b}{a}, \quad \alpha\beta = \frac{c}{a}$

Required equation is $x^2 - (\alpha + \beta + \alpha\beta)x + (\alpha + \beta)\alpha\beta = 0$

$\Rightarrow x^2 - \left(-\frac{b}{a} + \frac{c}{a}\right)x + \left(\frac{-b}{a}\right)\left(\frac{c}{a}\right) = 0$

$\Rightarrow a^2x^2 + a(b-c)x - bc = 0.$

5. **(D)** $\frac{1}{t_1} + \frac{1}{t_2} + \ldots + \frac{1}{t_{2003}}$

$= 4\left[\frac{1}{3.4} + \frac{1}{4.5} + \ldots + \frac{1}{2005 \times 2006}\right]$

$= 4\left[\frac{1}{3} - \frac{1}{4} + \frac{1}{4} - \frac{1}{5} + \ldots + \frac{1}{2005} - \frac{1}{2006}\right]$

$= 4\left[\frac{1}{3} - \frac{1}{2006}\right] = \frac{4 \times 2003}{3 \times 2006} = \frac{4006}{3009}.$

Physics

6. **(D)** $\alpha = \frac{\omega_1 - \omega_2}{t}$

$= \left[\frac{1200 \times 2\pi}{60} - \frac{600 \times 2\pi}{60}\right]$ rad s^{-1}/10 s

$= 2\pi$ rad s^{-2}

7. **(B)** Below the sea level the pressure is increasing with depth in mine due to presence of atmosphere air there. The acceleration due to gravity below the surface of the earth decreases with the distance from the surface of the earth, as

$g' = g\left(1 - \frac{d}{R}\right)$

8. **(C)** Applying work-energy theorem,

work done by all the forces = change in kinetic energy.

$$W_{mg} + W_{air} = \frac{1}{2}mv^2$$

$$W_{air} = \frac{1}{2}mv^2 - W_{mg}$$

$$= \frac{1}{2}mv^2 - mgh$$

$$= \frac{1}{2} \times 5 \times (10)^2 - (5) \times (10) \times (20)$$

$$= -750 \text{ J}$$

9. **(D)** Dipole moment = (charge) × (distance)

Electric flux = (electric field) × (area)

10. **(A)** $Y = \frac{FL}{\pi r^2 \Delta L}$ or $\Delta L = \frac{L}{r^2}$

Here L/r^2 is maximum when L = 40 cm and r = 0.20 mm as compared to other cases.

Chemistry

11. **(C)** Magnalium contains Al = 95% and Mg = 5%.

12. **(A)** O.N. of Cr in $K_2Cr_2O_7$ is

$2 \times (+1) + 2x - (2 \times 7) = 0$ or $x = +6$

Similarly, O.N. of Cr in $K_2Cr_2O_4$ is

$2 \times (+1) + 2x - (2 \times 4) = 0$ or $x = +6$.

13. **(D)** Both hydrogen and alkali metals are liberated at the cathode when their halides are electrolysed. Thus hydrogen resembles alkali metals.

14. **(B)** Benzene-1, 2, 3, 4, 5, 6-hexol

15. **(C)** A liquid which is immiscible to water and has a vapour pressure of 10 – 15 mm of Hg at 373 K can be conveniently purified by steam distillation.