INDIAN OLYMPIAD QUALIFIER IN JUNIOR SCIENCE (2021)
PAPER CODE: 52
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PART – 1
ANSWER KEYS AND SOLUTIONS

1.	**A**	2.	**B**	3.	**No match found**	4.	**No match found**
5.	**B**	6.	**No match found**			7.	**C**
8.	**B**	9.	**B**	10.	**A**	11.	**B**
12.	**A**	13.	**C**	14.	**C**	15.	**A**
16.	**C**	17.	**B**	18.	**D**	19.	**A**
20.	**B**	21.	**C**	22.	**D**	23.	**C**
24.	**B**	25.	**BC**	26.	**ABC**	27.	**ABC**
28.	**ABD**	29.	**ABCD**	30.	**BC**	31.	**AB**
32.	**BD**						

SOLUTIONS

1. A

Sol. Length of fabric = 2 m

Width of fabric = 1 m

Thickness of each layer = $6\,\mathring{A}$

Number of layers = 300

$\therefore$ Height of layer = $(300\times 6)\,\mathring{A} = 1800\times 10^{-10}$ m

Volume of the layer $= 2 \times 1 \times 1800 \times 10^{-10}$

$= 36 \times 10^{-8}\ m^3$

Density of the layer = 1 g/cm^3

$\therefore$ Mass of the coated layer = density $\times$ volume

$= (1 g/cm^3)\,[36 \times 10^{-8} \times (100\ cm)^3]$

$= 36 \times 10^{-2}$ g

Molar mass of $(CH_3)_2SiCl_2$ = 129 g. mol^{-1}

Molar mass of $(CH_3)_2SiO$ = 74 g

To deposit 74 g $\rightarrow$ 129 g of $(CH_3)_2SiCl_2$ is needed

$\therefore$ To deposit (36×10^{-2}) g $\rightarrow \frac{129}{74}\left(36\times 10^{-2}\right)$

$= 62.75 \times 10^{-2} = 0.63$ g

$\therefore$ **Correct option is A**

2. B

Sol.

A = $CH_3CH_2\underset{\underset{OH}{|}}{C}HCH_3$

B = $CH_3CH = CHCH_3$

$$CH_3CH_2\underset{\underset{OH}{|}}{C}HCH_3 \xrightarrow[\text{high temperature}]{\text{conc. } H_2SO_4} CH_3CH = CHCH_3$$

$$CH_3CH = CHCH_3 \xrightarrow{\text{ozonlysis}} 2CH_3CHO$$

$\therefore$ **Correct option is B**

3. No match found

Sol. 1.5 ℓ vessel having 5 mol of A, 7 mol of B and 0.1 mol of C.

K_{eq} = ?

$A + B \rightleftharpoons 2C + \text{heat}$

$$K_{eq} = \frac{[C]^2}{[A][B]} = \frac{\left(\frac{0.1}{1.5}\right)^2}{\left(\frac{5}{1.5}\right)\left(\frac{7}{1.5}\right)}$$

$$= \frac{(0.1)^2}{5 \times 7} = \frac{1}{35 \times 100}$$

$$= \frac{10^{-2}}{35}$$

$$= 2.85 \times 10^{-4}$$

∴ **No match found**

4. No match found

Sol. Triclosan $C_{12}H_7Cl_3O_2$

200 ml sanitizer is 0.2% w/v

⇒ 100 ml contains 0.2 g

So, 200 ml contains 0.4 g

$$0.4\,g = \frac{0.4}{289.5} = \frac{4}{2895}\,mol$$

$$\Rightarrow \frac{4}{2895} \times 6.022 \times 10^{23}$$

$= 8.3 \times 10^{20}$ molecules

OR

$= 1.3 \times 10^{-3}\ N_A$ molecules

∴ **No match found**

5. B

Sol. 100 ml of 0.1 M $CuCl_2$

⇒ $0.1 \times 0.1 = 0.01$ mol $CuCl_2$

1.25 g Ca = $\frac{1.25}{40} = \frac{125}{4} \times 10^{-3}$

$= 31.25 \times 10^{-3}$ mol

$\Rightarrow Ca + CuCl_2 \rightarrow CaCl_2 + Cu(s)$

Complete displacement of Cu

∴ **Correct option is B**

6. No match found

Sol. B_2A_3 & B_2A are two comp.

0.05 mol of B_2A_3 = 12 g

1 mol of B_2A_3 = $\frac{12}{0.05} = \frac{12}{5} \times 100$

= 240 g

2B + 3A = 240 g ---------- (1)

0.1 mol B_2A = 10 g

1 mol $B_2A = \frac{10}{0.1} = 100\,g$

2B + A = 100 g ---------- (2)

A = 100 – 2B

$\Rightarrow$ 2B + 3(100 – 2B) = 240

$\Rightarrow$ 2B + 300– 6B = 240

$\Rightarrow$ 60 = 4B $\Rightarrow$ B = $\frac{60}{4}$ = 15

A = 100 – 30 = 70

$\therefore$ **No match found.**

7. C

Sol. $pgh \times \pi\left(\frac{d}{2}\right)^2 = F$

$\Rightarrow h = \frac{2.5}{1.05 \times 10^3 \times 10 \times 3.14 \times \left(\frac{10^{-2}}{2}\right)^2}$

$\Rightarrow$ h = 3 m

8. B

Sol. $g = \frac{G \times 1.5 \times M}{r^2} = \frac{6.67 \times 10^{-11} \times 1.5 \times 2 \times 10^{30}}{\left(10 \times 10^3\right)^2} = 2 \times 10^{12}\ m/s^2$

M = Mass of sun

9. B

Sol.

Let us take two objects on other sides of lens

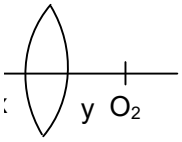
x + y = 24 cm

For object O_1

$u_1 = -x$, $v_1 = +v$, $f = 9$ cm; using $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

For object O_2

$u_2 = -y$, $v_2 = -V$, $f = 9$ cm; using $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$



We get, x and y as 18 cm and 6 cm

10. A

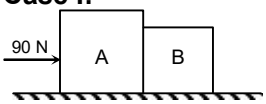
Sol. $n \times 200 \times 10^6 \times 1.6 \times 10^{-19} \times \frac{30}{100} = 1000 \times 10^3$

$n = 1.04 \times 10^{17}$

11. B

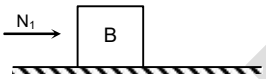
Sol. $M_A = 20$ kg, $M_B = 10$ kg

Case I:



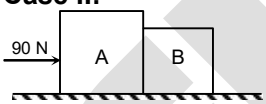
$a = \frac{F}{m} = \frac{90}{30} = 3\ m/s^2$

From F.B.D of block B



$N_1 = M_B \times a = 10 \times 3 = 30$ N

Case II:



$a = \frac{F}{m} = \frac{90}{30} = 3\ m/s^2$

From F.B.D of block A

$N_2 = M_A \times a = 20 \times 3 = 60$ N

12. A

Sol.

Given R = 5 Ω

$i R_S = 6v$ …(i)

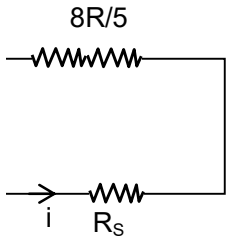
Using loop law

$i\left(8R/5 + R_S\right) = 18$

$i \times \frac{8R}{5} + iR_S = 18$

$\Rightarrow i \times \frac{8 \times 5}{5} + 6 = 18$

$\Rightarrow i = \frac{12}{8} = 1.5A$



Using (i) I $R_S = 6 \Rightarrow 1.5 \times R_S = 6$

$\Rightarrow R_S = 4\ \Omega$

13. C

Sol. $x^2 + ax + b = 0$ …(i)

$x^2 + bx + a = 0$ …(ii)

Let's say common root = K

$\Rightarrow K^2 + aK + b = 0$ …(iii)

$\Rightarrow K^2 + bK + a = 0$ …(iv)

Now (iii) – (iv)

$\Rightarrow aK - bK = a - b$

$\Rightarrow K(a - b) = a - b$

$\Rightarrow K = 1$

$\therefore$ by equation (iii) $1 + a + b = 0$

$\Rightarrow a + b = -1$

14. C

Sol. dividend = divisor × quotient + remainder

$x^{51} = (x^2 - 3x + 2) \times q(x) + ax + b$

$\Rightarrow x^{51} = (x - 1)(x - 2) \times q(x) + ax + b$

At x = 1

$1 = a + b$ …(i)

and at x = 2

$2^{51} = 2a + b$ …(ii)

Now (ii) – (i)

$\Rightarrow 2^{51} - 1 = a$

$\therefore$ by equation (i)

$1 = 2^{51} - 1 + b \Rightarrow b = 2 - 2^{51}$

$\therefore$ Remainder = ax + b

$= (2^{51} - 1)x + (2 - 2^{51})$

15. A

Sol. $100^{25} - 25$

$\underbrace{9999.....9}_{48\text{ times}}\ 75$

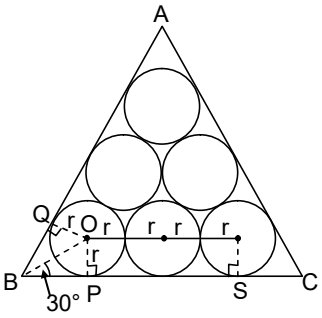
$\Rightarrow (9 + 9 + \ldots\ldots \text{ 48 times}) + 7 + 5$

$= 9 \times 48 + 12$

$= 432 + 12 = 444$

16. C

Sol.



$\because$ Δ ABC is equilateral

$\therefore$ $\angle ABC = 60°$

$\Delta OQB \cong \Delta OPB \Rightarrow \angle OBQ = \angle OBP = 30°$

In $\Delta OBP \rightarrow$

$$\tan 30° = \frac{OP}{BP} = \frac{3}{BP} \Rightarrow \frac{1}{\sqrt{3}} = \frac{3}{BP} \Rightarrow BP = 3\sqrt{3} \text{ cm}$$

Similarly, SC = $3\sqrt{3}$ cm

$\therefore$ BC = BP + PS + SC

$$= 3\sqrt{3} + 4r + 3\sqrt{3}$$

$$\Rightarrow 6\sqrt{3} + 4 \times 3 \Rightarrow 6\sqrt{3} + 12 = 6\left(\sqrt{3} + 2\right)$$

As we know height of equilateral triangle is $= \frac{\sqrt{3}}{2}a$

$$= \frac{\sqrt{3}}{2} \times 6\left(\sqrt{3} + 2\right)$$

$$= 3\sqrt{3}\left(2 + \sqrt{3}\right)$$

$$= 3\left(2\sqrt{3} + 3\right)$$

17. B

Sol. $\frac{3}{x-2} < 1$

$$\frac{3}{x-2} - 1 < 0$$

$$\frac{3-(x-2)}{x-2} < 0$$

$$\frac{5-x}{x-2} < 0$$

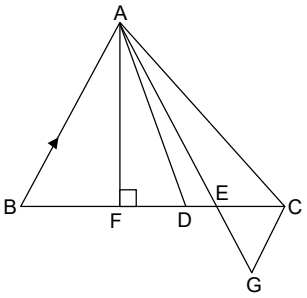
$$\Rightarrow \frac{x-5}{x-2} > 0$$

$$\Rightarrow -\infty \quad \underset{2}{+} \quad \underset{5}{-} \quad + \quad \infty$$

$\therefore$ x < 2 and x > 5

18. D

Sol.



Construction : AE is median, AF is altitude, CG is parallel to AB

As AD is angle bisector

$\frac{AB}{AC} = \frac{BD}{DC}$ …(i) (angle bisector theorem)

As D lies to left of E, so BD < DC

On putting inequality in equation (i)

AC > AB

And hence $\angle B > \angle C$

$\angle A + \angle B + \angle C = 180° \Rightarrow \angle A + 2\angle C < 180°$ (by using inequality)

$\frac{1}{2}\angle A <$ 90 – $\angle C$

From figure 90 – $\angle C = \angle FAC$

$\frac{1}{2}\angle A = \angle DAC$

$\angle DAC < \angle FAC$

So F must lie left of D

In ΔAGC, AE is median $\Rightarrow$ AB + AC > 2AE > 2AD

$\frac{AB + AC}{2} > AD$ …(ii)

Ar(ABC) = Ar(ABD) + Ar(ADC) …(iii)

$Ar(ABC) = \frac{1}{2}(AB)(AC)\sin A = AB \cdot AC \sin\frac{A}{2}\cos\frac{A}{2}$

$Ar(\Delta ABD) = \frac{1}{2}(AB)(AD)\sin\left(\frac{A}{2}\right)$

$Ar(\Delta ACD) = \frac{1}{2}(AC)(AD)\sin\left(\frac{A}{2}\right)$

On putting in (iii)

$AB \cdot AC \sin\frac{A}{2}\cos\frac{A}{2} = \frac{1}{2}AD\sin\left(\frac{A}{2}\right)(AB + AC)$

$AB \cdot AC\cos\left(\frac{A}{2}\right) = AD\left(\frac{AB + AC}{2}\right)$

As already proved $\frac{AB + AC}{2} > AD$

On putting

$AB \cdot AC\cos\left(\frac{A}{2}\right) > AD^2$

As we know $0 < \cos\frac{A}{2} < 1$

After implementing the inequality

$AB \cdot AC > AD^2$

$AD < \sqrt{AB \cdot AC}$

19. A

Sol. Lengths of chromosome 1B $\rightarrow$ 6.7 μm

Normal length of chromosome $\rightarrow$ 5.0 μm

= 6.7 – 5.0

= 1.7 μm

For 1.7 μm length the number of additional base pairs required:

$1.7 \times 10^{-6} = x \times 0.34 \times 10^{-9}$

$$x = \frac{1.7 \times 10^{-6}}{3.4 \times 10^{-10}}$$

$x = 0.5 \times 10^4$ bp

20. B

Sol. The transpiration pull is maximum when stomata are open, dry air and soil is moist.

21. C

Sol. All the Characteristics are of sex-linked recessive inheritance.

22. D

Sol. In a marine ecosystem with rich diversity of fauna, the pyramid of biomass is inverted.

23. C

Sol. Biopiracy is the commercial exploitation or monopolization of biological or genetic material, as medicinal plant extracts, usually without compensating the indigenous peoples or countries from which the material is obtained.
Ex: Turmeric (curcuma longa) need for healing wounds.

24. B

Sol. All the criteria are used to categorize living fossils.

25. BC

25. $Mg + 2\,HCl \rightarrow MgCl_2 + H_2\uparrow$

$2HNO_3 + Mg \rightarrow Mg(NO_3)_2 + H_2\uparrow$

$\therefore$ **Correct options are (B) and (C)**

26. ABC

26. **Correct options are (A),(B) and (C).**

27. ABC

Sol. $\frac{\mu_0 \times 2i}{4\pi \times r} = 2 \times 10^{-4}$

$\Rightarrow i = 10$ A

Also, $q = ne$

$\Rightarrow n = \frac{q}{e} = \frac{it}{e} = \frac{10 \times 1}{1.6 \times 10^{-19}} = 6.25 \times 10^{19}$

Using Maxwell right hand thumb rule, current flows from x_2 to x_1

28. ABD

Sol. Specific charge = $\frac{q}{m}$

S.I. unit is $\frac{it}{m} = \frac{A-S}{kg}$

Tritium is heavier in all isotopes, hence will have specific charge.

Specific charge ratio of an electron = $\frac{1.6\times10^{-19}}{9.1\times10^{-31}} = 1.75\times10^{11}$ C/kg

Hence, ABD options are correct.

29. ABCD

Sol. $81^{\sin^2 x} + 81^{\cos^2 x} = 30$

$\Rightarrow 81^{1-\cos^2 x} + 81^{\cos^2 x} = 30$

Let $81^{\cos^2 x} = y$ then equation reduces to

$\frac{81}{y} + y = 30 \Rightarrow y^2 - 30y + 81 = 0$

$\Rightarrow y = 27$ or $y = 3$

$\Rightarrow 81^{\cos^2 x} = 3^3$ or $81^{\cos^2 x} = 3^1$

$\Rightarrow 4\cos^2 x = 3$ or $4\cos^2 x = 1$

$\cos^2 x = \frac{3}{4}$ or $\cos^2 x = \frac{1}{4}$

$\cos x = \pm\frac{\sqrt{3}}{2}$ or $\cos x = \pm\frac{1}{2}$

$\Rightarrow x = \frac{\pi}{6}$ or $\frac{5\pi}{6}$ or $\frac{\pi}{3}$ or $\frac{2\pi}{3}$

30. BC

Sol. $(a-b)^2 + (a-c)^2 = (b-c)^2$

$\Rightarrow (a-b)^2 + (a-c)^2 = [(a-c)-(a-b)]^2$

$\Rightarrow (a-b)^2 + (a-c)^2 = (a-c)^2 + (a-b)^2 - 2(a-c)(a-b)$

$\Rightarrow -2(a-c)(a-b) = 0$

$\Rightarrow a = c$ or $a = b$

31. AB

Sol. The correct statements are A and B.

32. BD

Sol. Both statements B and D are correct.