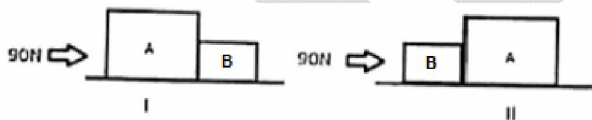


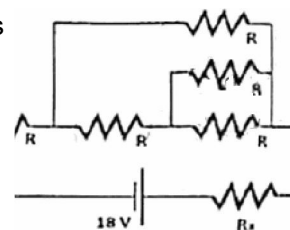
INDIAN OLYMPIAD QUALIFIER IN JUNIOR SCIENCE
(2021)
PAPER CODE: 52
DATE OF CONDUCTION: JAN 17, 2021
PART - 1
QUESTION PAPER

1. In one process for waterproofing, a fabric is exposed to $(\text{CH}_3)_2\text{SiCl}_2$ vapors. The vapors react with the hydroxyl groups on the surface of the fabric or with traces of water to form the waterproofing film $[(\text{CH}_3)_2\text{SiO}]_n$ by the reaction;
- $$n[(\text{CH}_3)_2\text{SiCl}_2] + 2n\text{OH} \rightarrow 2n\text{Cl} + n\text{H}_2\text{O} + [(\text{CH}_3)_2\text{SiO}]_n$$
- where n stands for a larger integer. The waterproofing film is deposited on the fabric layer upon layer. Each layer is 6 \AA thick [the thickness of the $(\text{CH}_3)_2\text{SiO}$ group]. How much $(\text{CH}_3)_2\text{SiCl}_2$ is needed to waterproof one side of a piece of fabric 1m by 2m, with a film 300 layers thick? The density of the film is 1.0 g/cm^3
- (A) 0.63g (B) 0.36g
(C) 63g (D) 3.6g
2. An alcohol (A) on dehydration with conc. H_2SO_4 at a high temperature yields compound (B). On ozonolysis every molecule of compound (B) yields two molecules of acetaldehyde. Which of the following is the starting alcohol (A)?
- (A) 1 butanol (B) 2 butanol
(C) propanal (D) 2 propanal
3. Given that at a certain temperature, in 1.5 l vessel, 5.0 mole of A, 7.0 mole of B and 0.1 mole of C are present. Then the value of equilibrium constant for the reaction:
- $$\text{A} + \text{B} \rightleftharpoons 2\text{C} + \text{Heat}$$
- is about
- (A) 7.22×10^{-4} (B) 2.31×10^{-4}
(C) 7.22×10^5 (D) 6.11×10^{-4}
4. Triclosan ($\text{C}_{12}\text{H}_7\text{Cl}_3\text{O}_2$) is an antibacterial and antifungal agent. It is a polychloro phenoxy phenol. It is widely used as a preservative and antimicrobial agent in personal care products such as soaps, skin creams, and deodorants etc. A label on a 200 ml hand sanitizer bottle claims that it contains Triclosan 0.2% w/v. What will be the number of molecules of Triclosan present in the bottle? (N_A is Avogadro's Number)
- (A) $1.4 \times 10^{25} N_A$ (B) $1.4 \times 10^{24} N_A$
(C) $1.4 \times 10^{23} N_A$ (D) $1.4 \times 10^{22} N_A$
5. In an experiment with 100 ml 0.1 M solution of Copper Chloride, by mistake 5 gms of a mixture containing equal weights of Tin, Silver, Lead and Calcium was added. Finally after some time the solution gets completely decolorized. This is mainly due to:
- (A) Silver reacts with Copper Chloride
(B) Calcium reacts with Copper Chloride
(C) All the metals react with Copper Chloride
(D) Only lead reacts with Copper Chloride forming white precipitate of lead chloride
6. Suppose that A and B forms compound B_2A_3 and B_2A . If 0.05 mole of B_2A_1 weighs 12 g and 0.1 mole of B_2A weighs 10g, what are the atomic weight of A and B respectively?
- (A) 70 and 25 (B) 50 and 20
(C) 40 and 30 (D) 30 and 40

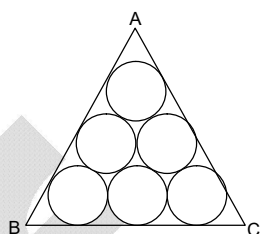
7. The tympanic membrane (ear drum) is a very delicate component of the human ear. Typically its diameter is 1 cm. The maximum force the ear can withstand is 2.5 N. In case a diver has to enter sea water of density $1.05 \times 10^3 \text{ kg/m}^3$ without any protective gear, the maximum safe depth for the diver to go into water is about
 (A) 12 m (B) 9 m
 (C) 3 m (D) 1.5 m
8. Gravitational collapse is the contraction of an astronomical object under its own gravity. This draws the matter inwards towards the centre of gravity. A neutron star is an example of the collapsed core of a giant star. A certain neutron star of radius 10 km is of mass 1.5 M. The acceleration due to gravity on the surface of the neutron star is nearly
 (A) $2.0 \times 10^{11} \text{ m/s}^2$ (B) $2.0 \times 10^{12} \text{ m/s}^2$
 (C) $2.6 \times 10^{16} \text{ m/s}^2$ (D) $2.0 \times 10^{20} \text{ m/s}^2$
9. Two illuminated point objects O_1 and O_2 are placed at a distance 24 cm, from each other along the principal axis of a thin convex lens of a focal length 9 cm such that images of both the objects are formed at the same position. Then the respective distances of the lens from O_1 and O_2 (in cm) are
 (A) 12 and 12 (B) 18 and 6
 (C) 14 and 10 (D) 16 and 8
10. A nuclear reactor is working at 30% efficiency (i.e. conversion of nuclear energy to electrical energy). In this reaction ${}_{92}^{235}\text{U}$ nucleus undergoes fission and releases 200 MeV energy per atom. If 1000 kW of electrical power is obtained in this reactor, then the number of atoms
 (A) 1.04×10^{12} (B) 6.5×10^{12}
 (C) 3.125×10^{12} (D) 3.25×10^{12}
11. Two blocks A and B are in contact with each other and are placed on a frictionless horizontal surface A force of 90N is applied horizontally on block A (situation I) and the same force is applied horizontally on block B (situation II) Mass of A is 20 kg and B is 10 kg. Then the correct statement is



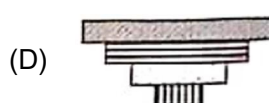
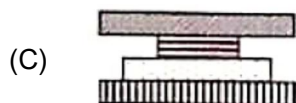
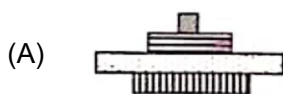
- (A) Since both the blocks are in contact, magnitude of force by block A on B will be 90 N (situation I) and magnitude of force by block B on A will also be 90 N (situation II).
 (B) Magnitude of force by block A on B is 30 N (situation I) and magnitude of force by block B on A is 60 N (situation II)
 (C) Magnitude of force by block A on B is 60 N (situation I) and magnitude of force by block B on A is 30 N (situation II)
 (D) The 90 N force will produce acceleration of different magnitudes in A and B.
12. In the adjoining circuit, $R = 5\Omega$. It is desired that the voltage across R_S should be 6 V, then the value of R_S should be
 (A) 4Ω
 (B) 12Ω
 (C) 16Ω
 (D) 20Ω



13. If $x^2 + ax + b = 0$ and $x^2 + bx + a = 0$ have one common root, then
 (A) $a + b = 0$ (B) $a + b = 1$
 (C) $a + b = -1$ (D) $a^2 + b^2 = 1$

14. Find the remainder when x^{51} is divided by $x^2 - 3x + 2$
 (A) x (B) $(2^{51} - 2)x + 2 - 2^{51}$
 (C) $(2^{51} - 1)x + 2 - 2^{51}$ (D) 0
15. If $100^{25} - 25$ is written in decimal notations, then the sum of its digits is
 (A) 444 (B) 442
 (C) 424 (D) 422
16. Six circles each of radius 3 cm, are Inscribed in an equilateral triangle ABC such that they touch each other and also touch the sides of the triangle as shown in the adjacent figure. Then height of triangle ABC is
 (A) $6(2\sqrt{3} + 3)$ (B) $3(2\sqrt{3} + 6)$
 (C) $3(2\sqrt{3} + 3)$ (D) $6(2 + \sqrt{3})$
- 
17. If $\frac{3}{x-2} < 1$, where x is real number, then
 (A) $2 < x < 5$ (B) $x < 2$ or $5 < x$
 (C) $x < -2$ or $x > 5$ (D) None of these
18. ABC is a triangle, the bisector of angle A meets BC in D. The relation between AD, AB and AC is
 (A) $AD > \sqrt{AB \cdot AC}$ (B) $AD > AB \cdot AC$
 (C) $AD = \sqrt{AB \cdot AC}$ (D) $AD < \sqrt{AB \cdot AC}$
19. If in a wheat mutant, the length of chromosome 1 B was found to be $6.7 \mu\text{m}$ instead of $5.0 \mu\text{m}$, approximately how many additional base pairs are incorporated in the mutant chromosome?
 (A) 0.5×10^4 bp (B) 5×10^4 bp
 (C) 1.7×10^4 bp (D) 5.78×10^4 bp
20. The transpiration pulls is maximum under which of the following conditions?
 (A) Closed stomata, low light intensity, humid air
 (B) Open stomata, dry air, moist soil
 (C) Open stomata, dry air, dry soil
 (D) Open stomata, high humidity in air, moist soil
21. Considering following characteristics, identify the correct inheritance pattern from the given options
- Most affected individuals are male
 - Affected sons result from female parents who are either affected or who are known to be carriers because they have affected brothers, fathers, or maternal uncles.
 - Affected daughters are born to affected fathers and either affected or carrier mothers.
 - The sons of affected mothers should be affected.
 - Approximately half the sons of carrier mothers should be affected.
- (A) Autosomal recessive inheritance (B) Autosomal dominant inheritance
 (C) Sex linked recessive inheritance (D) Sex linked dominant inheritance

22. In a marine ecosystem which rich diversity of fauna, which of the following images would be a correct representation of pyramid of biomass?



23. Curumo longo, Azadirachta indico, Basmati Rice, Indian Ginseng are all related to which of the following concepts?

- (A) Bioterrorism (B) Biomagnification
(C) Biopiracy (D) Biodegradation

24. Read following criteria carefully

- Slow evolutionary change relative to similar entities
- Gross similarity to an ancestral fossil
- Very low taxonomic richness today compared to the past
- Phylogenetic inference of specific characters as plesiomorphic
- Phylogenetic inference of genealogical divergence between other groups that diverged in the distance past.
- Known in the fossil record before being discovered alive

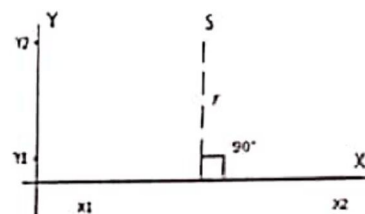
These criteria can be used to categorize a group of organisms the most probably into

- (A) Connecting links (B) Living fossils
(C) Endangered species (D) Extinct species
25. Equal lengths of magnesium ribbons are taken in four test tubes A, B, C and D in test tube A 1M acetic acid is added; in test tube B, 1M HCl is added, in test tube C, 1M HNO₃ is added and in test tube D, 1M NaOH is added. The observed results will be
(A) The fizzing occurs more vigorously in A (B) The fizzing occurs more vigorously in B
(C) the fizzing occurs more vigorously in C (D) The fizzing occurs more vigorously in D

26. Acetylen torches and burners used by glassblowers produce intense ultraviolet light. Glassblowers wear special glasses that contain which of the following elements to absorb the UV?

- (A) Neodymium (B) Praseodymium
(C) Cerium (D) Didymium

27. An infinitely long conductor when carrying current I , produces a magnetic field B around it. If such a conductor is placed along the X-axis, then the magnitude of B at a distance r is given by the relation $B = \frac{\mu_0}{4\pi} \frac{2I}{r}$, (where $\frac{\mu_0}{4\pi} = 10^{-7} \text{ NA}^{-2}$ is a constant). The following figure shows such an infinitely long conductor placed along X-axis carrying current I and B at S is $2 \times 10^{-4} \text{ T}$, directed into the plane of paper at S. Given $r = 1 \text{ cm}$. Then, the correct statements are



- (A) $I = 10 \text{ A}$
 (B) The number of electrons transported across the cross section of the conductor during time 1 s is 6.25×10^{19}
 (C) The direction of current I is from x_2 to x_1 .
 (D) The electrons will flow in the direction x_2 to x_1
28. The ratio of the charge of an ion or subatomic particle to its mass (q/m) is called specific charge. Then the correct options are
 (A) SI unit of specific charge can be written as A.s/kg
 (B) If all the isotopes of hydrogen are ionized then tritium will have least specific charge among them
 (C) specific charge of an α -particle will be greater than that of an electron.
 (D) specific charge ratio of an electron is $1.75 \times 10^{11} \text{ C/kg}$
29. If $0 \leq x \leq \pi$ and $81^{\sin^2 x} + 81^{\cos^2 x} = 30$, then $x =$
 (A) $\frac{\pi}{6}$ (B) $\frac{\pi}{3}$
 (C) $\frac{5\pi}{6}$ (D) $\frac{2\pi}{3}$
 [Useful information $\pi^c = 180^\circ$, $\sin(180 - \theta) = \sin \theta$, $\sin \theta \geq 0$ when $0 \leq \theta \leq 180^\circ$]
30. Given $(a - b)^2 + (a - c)^2 = (b - c)^2$, then which of the following statements are true?
 (A) equation is valid when $b = c$ and $a \neq c$
 (B) equation is valid when $a = b$
 (C) equation is valid when $a = c$
 (D) Given equation is not valid when a , b and c are distinct
31. Choose the correct statements from following options.
 (A) A robust adaptive immune response is initiated using weakened forms of the bacterium known as live attenuated vaccines.
 (B) Administration of a killed or chemically inactivated virus can trigger a weaker adaptive immune response, but can be strengthened with booster dose.
 (C) A conjugate or multivalent component always reduces immunogenicity of the vaccine.
 (D) Inclusion of alum, cytokins, and/or lipids, always reduces the immune response to a vaccine.
32. The minimum energy required to exist that is the energy required to perform chemical reactions even when a person is at rest is called the basal metabolic rate (BMR), which accounts for about 50 to 70 percent of the daily energy; expenditure in most sedentary individuals. It is influenced by many factors. Some statements are made about these factors. Choose the correct statements from the following options
 (A) Thyroid hormone decreases metabolic rate
 (B) Growth hormone increases metabolic rate
 (C) Fever decreases metabolic rate
 (D) Malnutrition decreases metabolic rate

ANSWER KEYS

- | | | | |
|----------------|--------------------------|--------------------------|--------------------------|
| 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. BCD | 31. AB |
| 32. BD | | | |

HINTS AND SOLUTIONS

1. A

Sol. Length of fabric = 2 m

Width of fabric = 1 m

Thickness of each layer = 6 \AA

Number of layers = 300

$$\therefore \text{Height of layer} = (300 \times 6) \text{ \AA} = 1800 \times 10^{-10} \text{ m}$$

$$\begin{aligned} \text{Volume of the layer} &= 2 \times 1 \times 1800 \times 10^{-10} \\ &= 36 \times 10^{-8} \text{ m}^3 \end{aligned}$$

Density of the layer = 1 g/cm^3

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

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

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

Molar mass of $(\text{CH}_3)_2\text{SiCl}_2 = 129 \text{ g. mol}^{-1}$

Molar mass of $(\text{CH}_3)_2\text{SiO} = 74 \text{ g}$

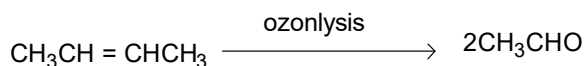
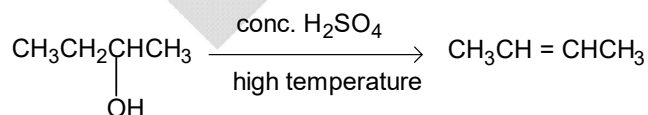
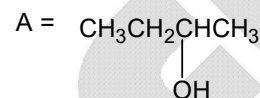
To deposit 74 g \rightarrow 129 g of $(\text{CH}_3)_2\text{SiCl}_2$ is needed

$$\begin{aligned} \therefore \text{To deposit } (36 \times 10^{-2}) \text{ g} &\rightarrow \frac{129}{74} (36 \times 10^{-2}) \\ &= 62.75 \times 10^{-2} = 0.63 \text{ g} \end{aligned}$$

\therefore **Correct option is A**

2. B

Sol.

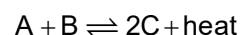


\therefore **Correct option is B**

3. No match found

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

$K_{\text{eq}} = ?$



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

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

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

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

∴ **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

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

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

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

OR

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

∴ **No match found**

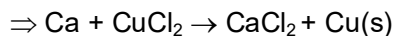
5. B

Sol. 100 ml of 0.1 M $CuCl_2$

⇒ $0.1 \times 0.1 = 0.01 \text{ mol } CuCl_2$

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

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



Complete displacement of Cu

∴ **Correct option is B**

6. No match found

Sol. B_2A_3 & B_2A are two comp.

$$0.05 \text{ mol of } B_2A_3 = 12 \text{ g}$$

$$1 \text{ mol of } B_2A_3 = \frac{12}{0.05} = \frac{12}{5} \times 100 \\ = 240 \text{ g}$$

$$2B + 3A = 240 \text{ g} \quad \text{----- (1)}$$

$$0.1 \text{ mol } B_2A = 10 \text{ g}$$

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

$$2B + A = 100 \text{ g} \quad \text{----- (2)}$$

$$A = 100 - 2B$$

$$\Rightarrow 2B + 3(100 - 2B) = 240$$

$$\Rightarrow 2B + 300 - 6B = 240$$

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

$$A = 100 - 30 = 70$$

\therefore **No match found.**

7. C

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

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

$$\Rightarrow h = 3 \text{ m}$$

8. B

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

M = Mass of sun

9. B
Sol.

Let us take two objects on other sides of lens

$$x + y = 24 \text{ cm}$$

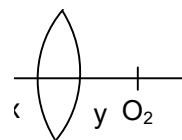
For object O_1

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

For object O_2

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

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



10. A

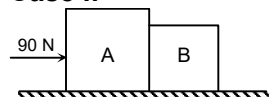
Sol. $n \times 200 \times 10^6 \times 1.6 \times 10^{-19} \times \frac{30}{100} = 1000 \times 10^3$

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

11. B

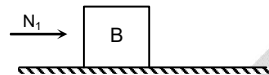
Sol. $M_A = 20 \text{ kg}, M_B = 10 \text{ kg}$

Case I:



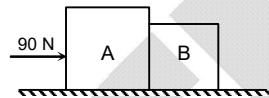
$$a = \frac{F}{m} = \frac{90}{30} = 3 \text{ m/s}^2$$

From F.B.D of block B



$$N_1 = M_B \times a = 10 \times 3 = 30 \text{ N}$$

Case II:



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

From F.B.D of block A



$$N_2 = M_A \times a = 20 \times 3 = 60 \text{ N}$$

12. A
Sol.

Given $R = 5 \Omega$

$i R_s = 6v$

...(i)

Using loop law

$$i\left(\frac{8R}{5} + R_s\right) = 18$$

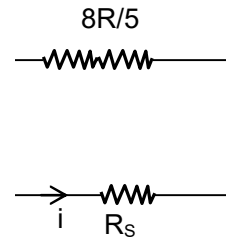
$$i \times \frac{8R}{5} + iR_s = 18$$

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

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

Using (i) $i R_s = 6 \Rightarrow 1.5 \times R_s = 6$

$\Rightarrow R_s = 4 \Omega$



13. C
Sol.

$$x^2 + ax + b = 0 \quad \dots(i)$$

$$x^2 + bx + a = 0 \quad \dots(ii)$$

Let's say common root = K

$$\Rightarrow K^2 + aK + b = 0 \quad \dots(iii)$$

$$\Rightarrow K^2 + bK + a = 0 \quad \dots(iv)$$

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 \times 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 $x = 1$

$$1 = a + b \quad \dots(i)$$

and at $x = 2$

$$2^{51} = 2a + b \quad \dots(ii)$$

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.

$$100^{25} - 25$$

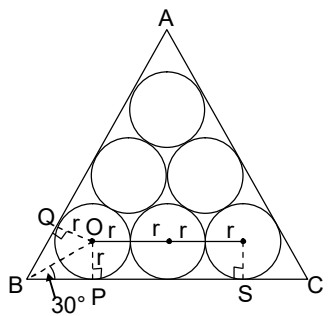
$$\begin{array}{r} 9999 \dots 975 \\ \hline \text{48 times} \end{array}$$

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

$$= 9 \times 48 + 12$$

$$= 432 + 12 = 444$$

16. C
Sol.



$\therefore \Delta ABC$ is equilateral
 $\therefore \angle ABC = 60^\circ$

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

In $\Delta OBP \rightarrow$

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

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

$$\therefore BC = BP + PS + SC$$

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

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

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

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

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

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

17. B

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

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

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

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

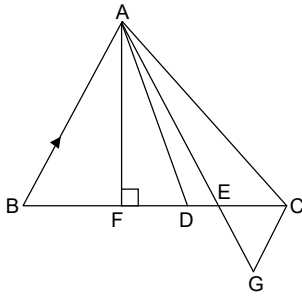
$$\Rightarrow \frac{x-5}{x-2} > 0$$

$$\Rightarrow -\infty \quad \begin{array}{c} + \quad - \quad + \\ \hline 2 \quad 5 \end{array} \quad \rightarrow \infty$$

$$\therefore x < 2 \text{ and } x > 5$$

18. D

Sol.



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

As AD is angle bisector

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

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

On putting inequality in equation (i)

$$AC > AB$$

And hence $\angle B > \angle C$

$$\angle A + \angle B + \angle C = 180^\circ \Rightarrow \angle A + 2\angle C < 180^\circ \text{ (by using inequality)}$$

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

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 $\triangle AGC$, AE is median $\Rightarrow AB + AC > 2AE > 2AD$

$$\frac{AB + AC}{2} > AD \dots(ii)$$

$Ar(ABC) = Ar(ABD) + Ar(ADC) \dots(iii)$

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

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

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

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
 $= 6.7 - 5.0$
 $= 1.7 \mu\text{m}$

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

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

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

$$x = 0.5 \times 10^4 \text{ bp}$$

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

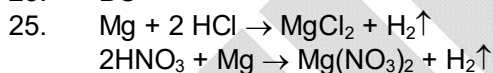
Sol. Biopiracy is the commercial exploitation or monopolization of biological or genetic material, as medicinal plant extracts, usually without compensating the indigenous peoples or countries from which the material is obtained.

Ex: Turmeric (*curcuma longa*) need for healing wounds.

24. B

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

25. BC



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

26. ABC

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

27. ABC

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

$$\Rightarrow i = 10 \text{ A}$$

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 $\frac{\text{it}}{\text{m}} = \frac{\text{A-S}}{\text{kg}}$

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

Specific charge ratio of an electron = $\frac{1.6 \times 10^{-19}}{9.1 \times 10^{-31}} = 1.75 \times 10^{11} \text{ C/kg}$

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 $\cos x = \pm \frac{1}{2}$

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

or $\frac{\pi}{3} \text{ or } \frac{2\pi}{3}$

30. BCD

Sol. $a + b^2 - 2ab + a^2 + c^2 - 2ac = b^2 + c^2 - 2bc$

$\cancel{a^2} - \cancel{2ab} - \cancel{2ac} = -\cancel{2bc}$

$a(a - c) = b(a - c)$

$(a - c)(a - b) = 0$

(i) $(a - c) = 0, (a - b) \neq 0$

$a = c, a \neq b$

(ii) $a - b = 0, a - c \neq 0$

$a = c, a \neq b$

(iii) $a - b = 0, a - c = 0$

$a = b = c$

31. AB

Sol. The correct statements are A and B.

32. BD

Sol. Both statements B and D are correct.