IOQJS 2021 (Part I) held on 17.01.21 Final Answer Key

	Code 51	Code 52	Code 53	Code 54
Question	Response	Response	Response	Response
PART A1				
1	b	a	c	c
2	c	a or b	c	d
3	b	b	b	c
4	a	--	c	b
5	b	b	a	b
6	a	--	d	a
7	a	c	a	c
8	b	b	c	c
9	a or b	b	b	c
10	b	a	d	a
11	--	b	c	b
12	--	a	b	d
13	a	c	b	b
14	c	c	c	a or b
15	d	a	a	a
16	b	c	b	b
17	c	b	b	--
18	b	d	a	--
19	c	a	a	b
20	c	b	b	b
21	c	c	a or b	b
22	b	d	b	c
23	a	c	--	a
24	d	b	--	a
PART A2				
25	a, b, c	b, c	a, b, c, d	a, b
26	a, b, c or a, b, d	a, b	b, c, d	b, d
27	a, b	a, b, c	a, b	b, c, d
28	b, c	a, b, c or a, b, d	b, d	a, b, c, d
29	a, b	a, b, c, d	a, b, c	b, c
30	b, d	b, c, d	a, b, c or a, b, d	a, b
31	a, b, c, d	a, b	a, b	a, b, c or a, b, d
32	b, c, d	b, d	b, c	a, b, c

SOLUTIONS FOR CODE 51:

PHYSICS (Q1 to Q6 and Q25, Q26)

Q1: F = G $\frac{m\,M}{r^2}$

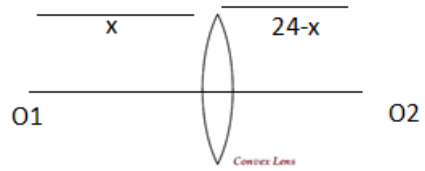
$g = \frac{F}{m}$ = G $\frac{M}{r^2}$ = 6.67 X 10^{-11}X 1.5 X 2 X 10^{30} / $(10^4)^2$ = 2.0 X 10^{12} m/s^2

Q2: External pressure will increase with depth:

F = PA = hρg A

Hence, h = F/ρ g A = 2.5 / (9.8 X 1.05 X10^3 X 3.14 X (0.5 X 10^{-2})^2) = 3.09 m ~ 3m

Q3:



Distances in cm

For O1, u = -x and f = +9, Hence, 1/v = 1/9 - 1/x …… ….(1)

For O2, u = +(24 – x) and f = - 9, Hence, 1/v = 1/(24 – x) - 1/9 …… ….(2)

From 1 and $2x^2$ - 24x + 108 =0,

x = 18 cm and 6 cm

Q4: Energy released per fission = 200 Mev

Efficiency of utilization = 30% = $\frac{30}{100}$ X 200 = 60 MeV = 60 X 10^6 X 1.6 X 10^{-19} = 9.6 X 10^{-12} J/fission

O/P electrical power to be obtained = 1000kW = 10^6 J/sec

Hence number of fissions per second = 10^6 / 9.6 X 10^{-12} = 1.04 X 10^{17} per sec

Q5: $a_{system} = \frac{F_{system}}{m_{system}}$ = 90N / 30 kg = 3 m/s^2

Situation I : $F_A = m_B$ a = 30 N (force on B due to A)

Situation II : $F_B = m_a$ a = 60 N (force on A due to B)

Q6: The equivalent circuit of all R is 8 Ω.

Hence, V across R_x = 6 V = (R_x / R_x + 8) 18 V, solving Rx = 4Ω

Q25: Using the given relation for B the value of I = 10 A

Q = n e = I t. Hence n = 10 X 1 / 1.6 X 10^{-19} gives n = 6.25 X 10^{19}

As B is into the paper at S, I will flow from X2 to X1 (hence a, b, c are correct)

Q26: q / m = I t / m = A s/ kg

Isotopes are: H_1^1 , H_1^2 , H_1^3. The charge is same but tritium has the highest mass and hence will have the least q / m

α particle is a doubly ionized helium atom. Hence $(q / m)_{\alpha} < (q / m)_{e}$

q/ m of electron comes out to be 1.75 X 10^{11} C/kg (hence a, b, d are correct)

CHEMISTRY (Q7 to Q12 and Q27, Q28)

Q7:

Mass of film = (volume of film) (density of film) = (area of film) (thickness of film) (density of film)

= (100cm X 200 cm) (300 X 6 À X 10^{-8} cm/À) (1.0g/cm^3) = 0.36 g

Amount of $(CH_3)_2SiCl_2$ = {0.36 g $[(CH_3)_2SiO]_n$} {1mol $[(CH_3)_2SiO]_n$ / 74*n* g $[(CH_3)_2SiO]_n$ } X

$$\left\{\frac{n \text{ mol } (CH_3)_2SiCl_2}{1 \text{ mol } [(CH_3)_2SiO]_n}\right\}\left[\frac{129 \text{ g } (CH_3)_2SiCl_2}{1 \text{ mol}(CH_3)_2SiCl_2}\right]$$

= 0.63 g $(CH_3)_2SiCl_2$

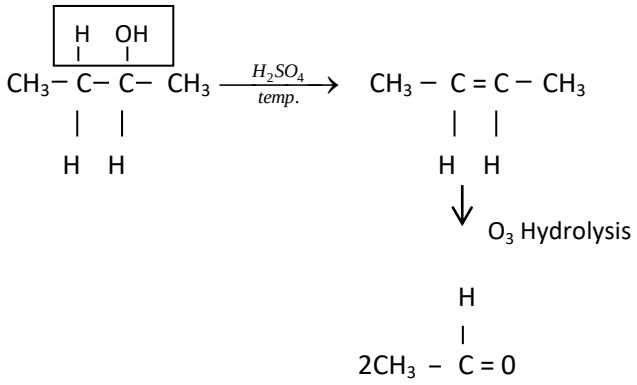
Note that the unknown integer *n* is canceled in the above *fabric-level* calculation along woth the unit (except for grams).

Q8:

[A]=5.0/1.5=3.33 mole/L [B] =7.0/1.5=4.66 mole/L [C] =0.1 mole/1.5L =0.06 mole/L

$$Ka = \frac{[C]^2}{[A]\,[B]} = \frac{(0.06)^2}{3.33 \times (4.66)} = 2.31 \times 10^{-4}$$

Q9: 2- butanol



Q10: This is because calcium has highest position amongst all the metals mentioned in the question.

Q11: -----Question deleted

Q12: ---- Question deleted

Q27:

(a) Neodymium (b) Praseodymium (because they are elements)

Q28

HCl and HNO_3 are strong acids which react with Mg metal (ribbon) vigorously thus liberating H_2 gas; whereas NaOH does not react with Mg metal (ribbon).

BIOLOGY (Q13 to Q18 and Q29, Q30)

Q13: 1 µm = 10000 Å. Since 1.7 µm is added, this is equal to 17000 Å. For every 34Å (helical turn), 10 bp are involved. Thus for 17000 Å, $\frac{17000\ x\ 10}{34} = 5000$ bp will be added.

Q14: From the given characteristics, it is evident that the mutation is in the gene located on 'X' chromosome and other characteristics clearly indicate that the mutant gene is expressed only when it is in homozygous condition and is masked when the other mating partner is either homozygous dominant.

Q15: The trophic levels from bottom to top are: phytoplanktons, zooplanktons, small fishes, and large fishes. The biomass of phytoplanktons will be in ascending order from phytoplanktons to large fishes. Thus the pyramid will be inverted.

Q16: Transpiration pull: since stomata are open and atmosphere is dry, continuous water will be lost. Since soil is moist, water will be absorbed. Because of this the upward movement of water will be more.

Q17: Biopiracy: these plants are indigenous to Indian subcontinent and were unlawfully commercially exploited without giving due compensation to the native country.

Q18: All the characteristics are typical to living fossils; especially the last one.

Q29: All the statements are actually factors that regulate immunogenicity of the vaccines. Option 'c' is incorrect; because, it is well documented that conjugate or multivalent component increases the capacity of an immunogen to induce heightened immune response. Option 'd' is incorrect; because, alum, cytokines, and/or lipids act as adjuvants to enhance immune response to vaccines.

Q30: It is well documented that thyroid hormone and fever both increase the BMR. Hence options 'a' and 'c' are incorrect.

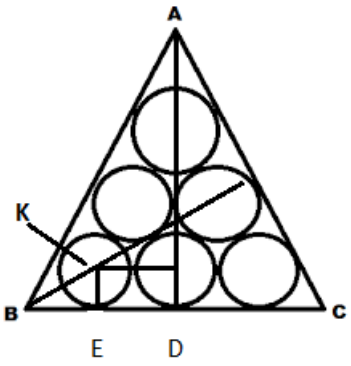
MATHEMATICS (Q19 to Q24 and Q31, Q32)

Q19: Let the common root be α. Then, α^2+ a α + b = 0 and α^2+ b α + a = 0

$$\frac{\alpha^2}{a^2-b^2} = \frac{\alpha}{b-a} = \frac{1}{b-a}$$

Or α^2 = $a + b$; α = 1 or $a + b$ = - 1

Q20:



Height of triangle = AD = BD tan 60

But AD = (BE + ED) $\sqrt{3}$ = (KE cot 30 + 6) $\sqrt{3}$ = 3(2$\sqrt{3}$ +3)

Q21: Remainder when x^{51} is divided by x^2 -3 x +2 that is (x-2)(x-1)

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

x^{51} = (x-2) (x-1) q(x) + ax +b …… (1)

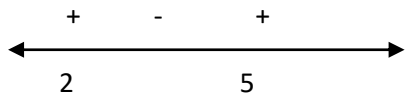
Put x =2 in (1) 2^{51} = 2a + b ….. (a)

Put x = 1 in (1) 1 = a + b ….. (b)

Using (a) and (b) $2^{51} - 1 = a$ and put it in (b) gives b = 1- a

Hence Remainder (ax + b) = (2^{51}-1) x +2 - 2^{51}

Q22: $\frac{3}{x-2}$ -1 < 0 or $\frac{x-5}{x-2}$ > 0



or x <2 0r x > 5

Q23: 100^{25} = 10^{50} = 100……0 (50 zeros)

10^{50} – 25 = 10……..0 – 25 = 999…..9975 (48 nines) = sum of its digits = 48 X 9 +12 = 444

Q24: Draw the circumcircle of Δ ABC and let the bisector AD of angle A, meet the circumcircle again at E.

Δ ABD ~ Δ AEC

Hence, $\frac{AD}{AC} = \frac{AB}{AE}$ or AB X AC = AD X AE > AD^2

Hence AD < $\sqrt{AB\ X\ AC}$

Q31:

Let $81^{\sin^2 x} = y$ $\quad \therefore 81^{\cos^2 x} = 81^{(1-\sin^2 x)} = \frac{81}{81^{\sin^2 x}} = \frac{81}{y}$

Thus $y + \frac{81}{y} = 30 \Rightarrow y = 3\ or\ 27$ means

$81^{\sin^2 x} = 3 \Rightarrow Sin^2 x = \frac{1}{4} or\ x = \frac{\pi}{6}\ or\ \frac{5\pi}{6}$ Also if

$81^{\sin^2 x} = 27 \Rightarrow Sin^2 x = \frac{3}{4} or\ x = \frac{\pi}{3}\ or\ \frac{2\pi}{3}$

Q32:

$(a - b)^2 + (a - c)^2 = (b - c)^2$
$a^2 + b^2 - 2ab + a^2 + c^2 - 2ac = b2 + c^2 - 2bc$
$2a^2 - 2ab - 2ac + 2bc = 0$
$a^2 - ab - ac + bc = 0$
$a(a - b) - c(a - b) = 0$
$(a - c)(a - b) = 0$
$a = c$ or $a = b$ or $a = b = c$

Clearly the equation will be invalid if a, b, c are all distinct