INDIAN NATIONAL JUNIOR SCIENCE OLYMPIAD – 2019
Held on – February 02, 2019

ANSWER KEYS

1.	**C**	2.	**C**	3.	**A**	4.	**A**
5.	**D**	6.	**D**	7.	**B**	8.	**A**
9.	**C**	10.	**B**	11.	**B**	12.	**B**
13.	**B**	14.	**D**	15.	**D**	16.	**D**
17.	**A**	18.	**D**	19.	**C**	20.	**C**
21.	**B**	22.	**D**	23.	**C**	24.	**B**
25.	**D**	26.	**D**	27.	**B**	28.	**C**
29.	**D**	30.	**A**				

HINTS & SOLUTIONS

1. C

1. The substance and three activities I-III respectively must be:

Glucose	I→ After meals	II→ Resting	III→ Exercise

2. C
2. The correct statement is, when in low salt conditions, body fluids of shore crab is hypertonic compared to surrounding medium.

3. A
3. As chicken will develop eyes according to red light hence, when goggles are removed other light will get focus before the retina, therefore concave lens will be required to correct the vision of chicken. This is called Myopia.

4. A
4. The best quality clearance is shown by swimmer I.

5. D
5. Reaction (i), (ii) and (iii) represents autotrophic nutrition.

6. D
6. Animals I-IV most likely would be: (D) Cat, Human, Mouse and Elephant

7. B
7. The changes that must have occurred in his eyes during this period are circular muscles relax, radial muscle contracts and pupil dilates.

8. A
8. Reabsorption of water does not occur in an artificial kidney.

9. C

9. $\boxed{\text{Solution I} \rightarrow \text{Detergent} \rightarrow \text{lysis}}$

$\boxed{\text{Solution II} \rightarrow \text{Distilled water} \rightarrow \text{lysis}}$

$\boxed{\text{Solution III} \rightarrow 5\%\ \text{NaCl} \rightarrow \text{shrinkage}}$

10. B

10. The correct conclusion is [B] i.e., problem in pituitary is indicated if there is increase in the T_4 level.

11. B

11. Mass of an atom is due to neutrons and protons since mass of electron is almost $\frac{1}{1833}$ times of mass of neutron and proton, we can neglect mass of electron.

$_{18}Ar^{40}$ No. of protons = 18

No. of neutrons = 40 – 18 = 22

Mass of proton $\simeq$ Mass of neutron = m

M = 18m + 22m = 40 m

$M' = 18m + 22\left(\frac{m}{2}\right) = 29\ m$

So% Change = $\left[\frac{(40-29)m}{40m}\right] \times 100 \simeq 27\%$

12. B

12. Salt = 0.5 g

$40\%\ Na \Rightarrow 0.5 \times \frac{40}{100} = 0.2\,g$

380×10^{-6} gms of I

$Na^+\ Cl^-$ $\frac{0.2}{23}$ moles of Na^+(total)

$Na^+\ I^-$ = 0.0087 moles = 8700×10^{-6} moles

$I^- = \frac{380 \times 10^{-6}}{127} \simeq 3 \times 10^{-6}$ moles of I^-

Since it is neutral

Moles of I^- = moles of Na^+ in NaI

$3 \times 10^{-6} = 3 \times 10^{-6}$

Moles of Na^+ left = $(8700 - 3) \times 10^{-6}$

Which will be equal to moles of Cl^-

No. of ions of Cl^- = $8697 \times 10^{-6} \times 6.023 \times 10^{23}$

= $52382 \times 10^{17} \simeq 5.2382 \times 10^{21}$

13. B

13. $C_4H_{10} + C_3H_8$

$C_4H_{10} + \frac{13}{2}O_2 \longrightarrow 4CO_2 + 5H_2O$

t = 0 V Lt

t = t 0 4V

$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$

t = 0 (5 – V) Lt

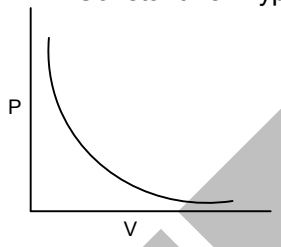
t = t 0 3(5 – V)

Volume of CO_2 = 4V + 3(5 - V) = 17
= 4V + 15 – 3V = 17
$\Rightarrow$ V = 2 Lt
Ratio of C_4H_{10} to C_3H_8 = V : 5 –V = 2 : 3

14. D
14. Let no. of neutralisable H^+ be = n
So no. of gm equivalents of acid = (no. of moles) $\times$ (n)
$= \frac{0.42}{146} \times n = 0.00287n$ gm eq
Now for neutralization
no. of gm equivalents of NaOH = no. of gm equivalent of acid
$\frac{0.17 \times 33.8}{1000} \times 1 = 0.00287n$
$\therefore n \simeq 2$

Amount of acid to neutalise one mole of alkali will be = $\left(\frac{1}{2}\text{mole}\right) \times 146 = 73\,\text{gms}$

15. D
15. As PV = nRT n, R, T $\rightarrow$ Constant
So PV = Constant i.e. Hyperbola.



16. D
16. Mg > Al > Zn > Cu > Ag
Copper rod is used to stir solution of $Al(NO_3)_3$ so no reaction as one above in series will displace metal lower in series.

17. A
17. P = NaCl
Q = Cl_2
R = $Ca(OH)_2$
$NaCl + H_2O \xrightarrow{\text{Electrolysis}} H_2 \text{ and } Cl_2$
$Cl_2 + Ca(OH)_2 \longrightarrow CaOCl_2 + H_2O$

18. D
18. $5Fe^{2+} + MnO_4^- + 8H^+ \longrightarrow Mn^{2+} + 4H_2O$

19. C
19. $NH_4NO_3 \longrightarrow N_2O + 2H_2O$ is a comproportionation reaction.

20. C
20. It is an alkali metal of group-1 of the periodic table.
$\therefore$ Configuration is $(n-1)s^2p^6, ns^1$

21. B
21. Let us assume motion starts with u and acceleration a

So, $v_1 = \dfrac{2u + a\Delta t_1}{2}$ …(1)

$v_2 = \dfrac{(u + a\Delta t_1) + [u + a(\Delta t_1 + \Delta t_2)]}{2}$ …(2)

$v_3 = \dfrac{u + a(\Delta t_1 + \Delta t_2) + u + a[(\Delta t_1) + (\Delta t_2) + (\Delta t)_3]}{2}$ …(3)

Hence,

$v_2 - v_1 = \dfrac{a(\Delta t_1 + \Delta t_2)}{2}$

$v_3 - v_2 = \dfrac{a(\Delta t_2 + \Delta t_3)}{2}$

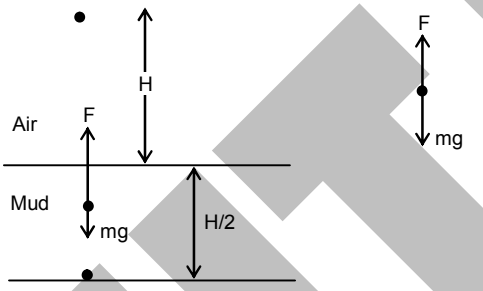
$\therefore \quad \dfrac{v_2 - v_1}{\Delta t_1 + \Delta t_2} = \dfrac{v_3 - v_2}{\Delta t_3 + \Delta t_2}$

22. D

22. In case of Q the swimmer will reach the other end in t_{min} but the swimmer will not be able to reach directly opposite O, due to drift it will move towards right (somewhere east of x).
Hence, D option is correct

23. C

23.



F – mg = ma …(1)

Velocity of stone just before striking the mud will be $\sqrt{2gH}$

Applying $v^2 - u^2 = 2as$

$0 - 2gH = -2a\dfrac{H}{2}$

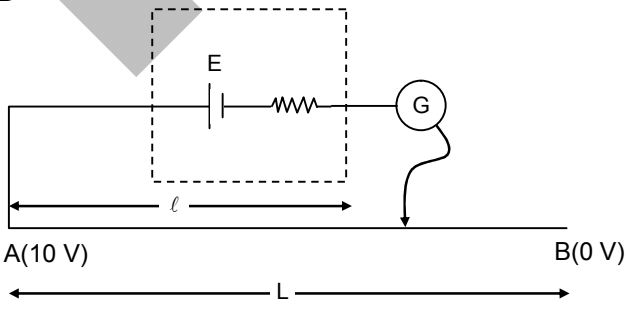
a = 2g

Hence, F = mg + ma

F = 3 mg.

24. B

24.

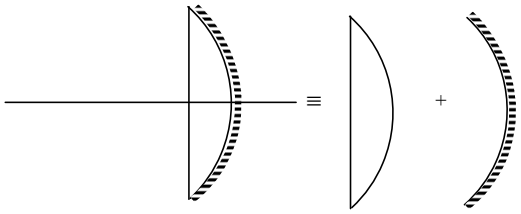


This is a standard potentiometer when deflection is zero.

$$E = \left(\frac{10}{L}\right)\ell$$

Hence, (B) option is correct.

25. D

25. 

$$P_L = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$P_L = \left(\frac{4}{3} - 1\right)\left[\frac{1}{\infty} - \frac{1}{(-2f)}\right]$$

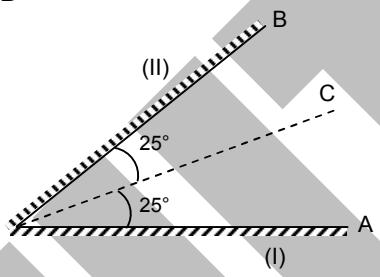
$$P_L = \frac{1}{6f}$$

$P_{ef} = 2P_L + P_m$

$$P_q = 2\frac{1}{6f} + \frac{1}{f} = \frac{1+3}{3f} = \frac{4}{3f}$$

$\Rightarrow$ equivalent focal length is $-\frac{3f}{4}$

26. D

26. 

Angle of image w.r.t mirrors

Mirror I	Mirror II
25°	25°
75°	75°
125°	125°
175°	175°

Last two will be considered.
Hence 8.

27. B

27. Heat supplied by the heater in 1 sec is 420 J

$Q = ms\,\Delta T$

$420 = m\,4200 \times 5$

$m = \frac{1}{50}kg$

as $m^\circ = \theta^\circ\rho$

$\theta° = \frac{1}{50\times10^3}m^3 = \frac{1}{50\times10^3}\times10^3 L$

$\theta^o = \frac{1}{50}L$

But actual $\theta°$ will be half of this as efficiency is $\frac{1}{2}$

$\therefore \quad \theta^o_{actual} = \frac{1}{100}$ L per sec

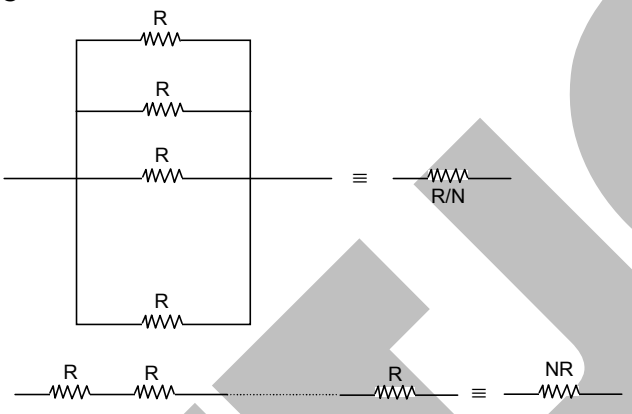
$\theta^o_{actual} = \left(\frac{1}{100}\times60\right)$ L min^{-1}

$= \frac{3}{5}$ L min^{-1}

$\theta°$ = 0.6 L min^{-1}

28. C

28.

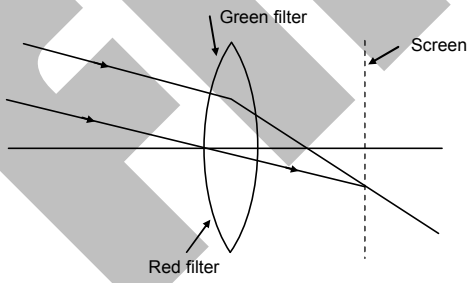


Power = $\frac{v^2}{R} \propto \frac{1}{R}$

$\therefore$ Ratio = $\frac{\text{Power}_{\text{Parallel}}}{\text{Power}_{\text{series}}} = \frac{NR}{\frac{R}{N}} \propto N^2$

29. D

29.



Green filter will allow green color while red filter will allow red color
Hence, image will contain both the colors. Hence, it will become yellow.

30. A

30. It is Rutherford's scattering experiment.

31. Hypothesis I $\rightarrow$ Plants grown in sun will show more shoot growth than root growth as compared to plants grown in shade $\rightarrow$ incorrect

A $\rightarrow$ C [only (leaf weight + stem weight)/root weight helps to test hypothesis I]

B → (i) Value of the ratio obtained for plants in the sun: 1.71
(ii) Value of the ratio obtained for plants in shade condition: 2.23

C → (ii) The value obtained in (B) do not support Hypothesis 1: **X**

Hypothesis 2 → correct

D → (a) leaf weight/ leaf area help to test hypothesis 2

E → D

32. (A) 100 mL of solution of glucose contains 100 mg of solute

$\therefore$ Moles of solute(glucose) = $\frac{100\times10^{-3}}{180}=\frac{1}{18}\times10^{-2}$

$\therefore$ Molarity of glucose = $\frac{10^{-2}}{18}\times\frac{1000}{100}=\frac{1}{180}$ = 5.5×10^{-3} = 0.005 M

(B), make graph.
(C) 0.96 mg %
(D) 180 mg/dl (deci liter)

33. (A) (i) Z
(ii) Y
(iii) X

(B) The average biomass of producer = 0.0060 gm
Using population size on day 1 = 200
= 0.0060 gm $\times$ 200 = 1.2
The average biomass of herbivores = 0.0025 g
Using population size on day 1 = 40
= 0.0025 $\times$ 40 = .1
The transfer of energy in the form of biomass from producer to consumer is

$1.2\times\frac{x}{100}=0.1$

x = 8.33%

(C) The day which has most likely disturbing the balance of ecosystem is day 17.
Activity responsible is a (removal of component X)

34. (A) $2KMnO_4+5H_2C_2O_4+3H_2SO_4\longrightarrow K_2SO_4+2MnSO_4+10CO_2+8H_2O$

(B) (i) $KMnO_4$ (i) $H_2C_2O_4$

(C) 2 moles of $KMnO_4$ reacts with 5 moles of $H_2C_2O_4$

Moles of $KMnO_4$ = $\frac{V\times M}{1000}=\frac{17.8\times0.1}{1000}=1.78\times10^{-3}$

$\therefore$ Moles of $H_2C_2O_4$ = $\frac{5}{2}\times1.78\times10^{-3}=4.45\times10^{-3}$ moles

(D) Mass of sample ($CaCO_3$ + Na_2SO_4) = 0.626 g

$CaCO_3+H_2C_2O_4\longrightarrow CaC_2O_4+CO_2+H_2O$

$CaC_2O_4+H_2SO_4\longrightarrow CaSO_4+H_2C_2O_4$

$\therefore$ Moles of $H_2C_2O_4\equiv$ Moles of $CaC_2O_4\equiv$ Moles of $CaCO_3$

$\therefore$ Moles of $CaCO_3=4.45\times10^{-3}$

Mass of $CaCO_3=4.45\times10^{-3}\times100=0.445$ g

$\therefore$ Mass of $CaCO_3$ = 0.445 g

(E) Mass of Na_2SO_4 = 0.626 – 0.445 = 0.181 g

% of Na_2SO_4 = $\frac{0.181}{0.626}\times100=28.91\%$

35. (A) $H^+ + OH^- \longrightarrow H_2O(\ell)$

$\Delta H = ns\Delta T = 90 \times 4.186 \times (30.5 - 29) = 565.11 J$

(B) $H^+ + OH^- \longrightarrow H_2O$

1 g 17 g

1 mole 1 mole 1 mole

For 90 g H_2O heat absorbed = 565.11 J

For 1 mole H_2O heat evolved = $\frac{565.11}{5} = 113.02 J$

36. (A) d = 2.28 g/L, T = 300 K, P = 1 atm

PM = dRT

or, $M = \frac{dRT}{P} = \frac{2.28 \times 0.0821 \times 300}{1} = 56.15$

Molar mass = 56.15

Mass of carbon = 85.7 g, Moles of carbon = $\frac{85.7}{12} = 7.14$

(B) Mass of H_2 in 100 g = 14.3 g

Moles of H atoms = $\frac{14.3}{1} = 14.3 mole$

(C) No. of C atoms = $\frac{85.7}{12} = 7.14$

No. of H atoms = $\frac{14.3}{1} = 14.3$

$\therefore$ C : H = 7.14 : 14.3 = 1 : 2

$\therefore$ Empirical formula = CH_2

(D) PV = nRT

or, $P = \frac{n}{V}RT = CRT$

$C = \frac{P}{RT} = \frac{1}{0.0821 \times 273} = 0.0446$

(E) $\frac{\text{Molar mass}}{\text{Empirical mass}} = \frac{56.15}{14} = 4$

C_4H_8

37. $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$ & $\frac{h_I}{h_0} = -\frac{v}{u}$

$\Rightarrow \quad \frac{1}{v} + \frac{1}{-18} = \frac{1}{-12}$

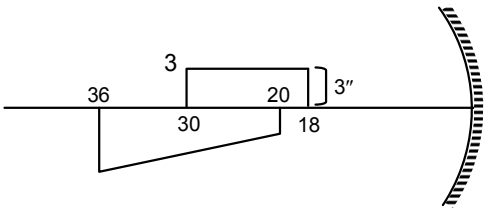
$\Rightarrow \quad v = -36''$

$\therefore \quad h_I = (+3'')\left[-\left(\frac{-36}{-15}\right)\right] = -6''$

$\frac{1}{v} + \frac{1}{-30} = \frac{1}{-12}$

$\Rightarrow \quad v = -20''$

$\Rightarrow \quad h_I = (+3'')\left[-\left(\frac{-20}{-30}\right)\right] = -2''$



38. $f = \dfrac{(2n+1)v}{4(L+e)}$

But according to question. It is fundamental frequency.

e = 0.3 d

= 0.3 × 5

e = 1.5 cm

Hence, $f = \dfrac{v}{4(L+e)}$

$$\frac{1}{f} = \frac{4(L+e)}{v}$$

$$\frac{1}{f} = \frac{4L}{v} + \frac{4e}{v}$$

Variable on X axis is (L + e)

Variable on Y axis is $\dfrac{1}{f}$

We will find slope and that slope will be $\dfrac{4}{v}$ and v can be calculated.