FIITJEE

INDIAN NATIONAL JUNIOR SCIENCE OLYMPIAD (INJSO) – 2023
Held on – January 28, 2023

ANSWER KEYS

Section – I

1.	B	2.	B	3.	B	4.	A
5.	B	6.	C	7.	B	8.	A
9.	A	10.	C	11.	A	12.	A
13.	B	14.	D	15.	A		

Section - II

16.	CD	17.	CD	18.	AB	19.	D
20.	C	21.	D	22.	B	23.	C
24.	D						

HINTS & SOLUTIONS

1. B

Sol. Erythrocytes are enucleated cells which are best to taken.

2. B

Sol. In wild Chimpanzees, demonstration of the ability to use of fire to process food has not yet been observed.

3. B

Sol. Based on the growth patterns shown after 24 hrs.
P – are photoautotroph
Q – are chemoheterotrophs
R – Chemoautotrophs

4. A

Sol. In recessive epistasis interaction the result obtained in F_2 progeny will be 9 : 3 : 4
(Blue : Chocolate : Golden)

5. B

Sol. Based on the results, in plant II the potassium concentration is more which leads to the opening of stomata due to exposure to light.

6. C

Sol. X = $Pb(NO_3)_2$, Y = NH_4NO_3

$2Pb(NO_3)_2 \xrightarrow{Heat} 2PbO + 4NO_2 + O_2$

O_2 helps in burning candle

PbO is yellow when hot

$NH_4NO_3 \xrightarrow{Heat} N_2O + 2H_2O$

$N_2O \rightarrow$ Make us laugh

7. B

Sol. The hydrolysis of polymer produces glucose and after anaerobic decomposition it produces ethanol & carbon dioxide.

8. A

Sol. (i) Dissolution of glucose in water is endothermic as cooling is observed in the surrounding.

$\therefore$ It is wrong statement.

(ii) $CaO + H_2O \longrightarrow Ca(OH)_2 + Heat$

$\therefore$ It is exothermic.

$\therefore$ It is wrong statement.

(iii) $H_2O(s) \xrightarrow{Heat} H_2O(\ell)$

It is an endothermic process.

$\therefore$ This statement is correct.

(iv) $H_2SO_4 + H_2O \longrightarrow H_2SO_4.xH_2O + Heat$

$\therefore$ This statement is wrong.

(v) $H_2O(\ell) \xrightarrow{Heat} H_2O(g)$

This is endothermic process.

$\therefore$ This statement is wrong.

9. A

Sol. $2K + 2H_2O \longrightarrow 2KOH + H_2$

Mass of K = 39 g

Moles of K = $\frac{39}{39}$ = 1

Moles of H_2O = 7.8 g

Moles of H_2O = $\frac{7.8}{18} = 0.43$

$\therefore$ Limiting reactant is H_2O

2 moles of H_2O produces one mole H_2

$\therefore$ 0.43 moles of H_2O will produce $\frac{0.43}{2} = 0.215$ mole H_2

10. C

Sol. Mass of NaOH = 48 g

Mole of NaOH = $\frac{48}{40} = 1.2$ [Mol. mass of NaOH = 40]

Mass of H_2O = 52 g

Moles of H_2O = $\frac{52}{18} = 2.8$ [Molar mass of H_2O = 18 g mol^{-1}]

Mass of $(NH_4)_2SO_4$ = 132 g

Moles of $(NH_4)_2SO_4$ = $\frac{132}{132} = 1$

(Molar mass of $(NH_4)_2SO_4$ = 132 g mol^{-1})

$\therefore$ Moles of oxygen atoms = 1.2 + 2.8 + 1 $\times$ 4 = 8

11. **A**

Sol. It take 12 hour for moon to cover 180° in sky.

So, it must take 15°/hr.

Moon takes 2 min on horizontal

So, $\theta = \frac{15^0}{60} \times 2$ = 0.5°.

12. **A**

Sol. Final velocity = 7.5 m/s [Conservation of momentum]

Energy lost = $K.E_i - K.E_f$ = Gain in heat energy

$\Rightarrow \frac{1}{2} \times 10^{-2}[10^2 + 5^2] - \frac{1}{2} \times 2 \times 10^{-2} \times (7.5)^2 = mC\,(\Delta T)$

$\Rightarrow$ 125 – 112.5 = 200 × 2 × 10^{-2} × 451 × ΔT

$\Rightarrow \Delta T = 0.007$ K

13. **B**

Sol. Time for same speed:

$$u + at = \frac{u}{2} + 2at$$

$$\Rightarrow t = \frac{u}{2a}$$

Distance travelled in this time:

$$S_1 = u \times \frac{u}{2a} + \frac{1}{2}a\left(\frac{u}{2a}\right)^2 = \frac{u^2}{29}\left(1 + \frac{1}{4}\right) = \frac{5u^2}{8a}$$

$$S_2 = \frac{u}{2} \times \frac{u}{2a} + \frac{1}{2} \times 2a \times \left(\frac{u}{2a}\right)^2 = \frac{u^2}{4a}(1+1) = \frac{u^2}{2a}$$

$S_1 > S_2$. So, answer is B.

14. **D**

Sol. Power is additive

If image is now at longer distance, power is reduced.

Hence, must be concave lens but with larger focal distance, so as to form real image.

15. **A**

Sol. Heat generated by diet = mc ΔT

= (82 × 3.5 × 10^3 × 2) J

Mass of water drank = $\frac{\text{Heat given}}{\text{Heat of evaporation}}$

$$= \frac{82 \times 3.5 \times 10^3 \times 2}{2.3 \times 10^6}$$

$$= \frac{1}{4}\text{kg}$$

= 1 bottle

16. CD

Sol. In this M could be the number as well as energy pyramid for food chain 1 & 2 both.

17. CD

Sol. The option C & D describe the condition for each annotated point on the graph.

18. AB

Sol. In the dormant cambium cell, the vacuoles are smaller in size, very less amount of RER & very few golgi bodies are present. The cell wall is thick & dormant cambium contains less hot water extractable pectin.

19. D

Sol. 'α' is antimony which atomic mass is 120.9 and number of neutrons.
120.9 $\approx$ 121 - 51 = 70 and γ is silver. The atomic mass of it's isotope is 106.9 and number of neutrons = 106.9 $\approx$ 107 – 47 = 60.

20. C

Sol. $2I^- + Cl_2 \longrightarrow I_2 + 2Cl^-$

$2I^- + Br_2 \longrightarrow I_2 + 2Br^-$

Cl_2 is a stronger oxidizing agent than Br_2. So the reaction with Cl_2 is becomes faster than that with Br_2. Since both Cl_2 and Br_2 are reduced to Cl^- and Br^-. The higher reactivity of Cl_2 is due to

(i) It can gain electrons easily, which is possible if it's effective nuclear charge is higher.
$Z^* = Z - \sigma$
Since σ is less, the effective nuclear charge Z^* is high.
$\therefore$ It can easily gain electron and reduced to Cl^- ion as compared to Br_2.

21. D

Sol. $C_nH_{2n} = 28$
$12n + 2n = 28$
$14n = 28$
$n = 2$

$$C_2H_4 + 3O_2 \longrightarrow 2CO_2(g) + 2H_2O$$

150 mL 450 mL 300 mL 300 mL
CO_2 formed H_2O formed

Volume or air = V

Volume of $O_2 = \frac{20}{100} \times V = 450$

$V = 450 \times 5 = 2250$ mL

Vol. of O_2 unreacted = 2250 – 450 = 1800 mL

(B) Molecules of CO_2 PV = nRT

$1 \times 300 = n_{CO_2} \times 0.0821 \times 373$

$n_{CO_2} = 9.796$

$N_{CO_2} = 9.796 \times 6.023 \times 10^{23} = 5.9 \times 10^{24}$ molecules

$N_{H_2O} = 5.9 \times 10^{24}$

22. **B**

Sol. Echoes will be heard in multiples of $\left(\frac{20}{350}\right)$ Sec and $\left(\frac{30}{350}\right)$ Sec

= n[86] and n[57] milliseconds

23. **C**

Sol. Force is in X – Y plane.

So, magnetic field should be in Z-axis, to generate magnetic force in X – Y plane.

An electric field in X – Y plane is also possible or the component of electric force in Z-axis should be balancing out the component of magnetic force in Z-axis.

24. **D**

Sol. Assuming no slippage and pure rolling of both tyres at all time, and her weight is mostly on rear tyre.

Brakes provided angular deceleration while friction is required to decrease speed of centre of tyre accordingly, which is mostly given by rear tyre.

So, answer is D.

25. (a) A & C

Sol. (i) Lactic acid and other bacteria are already present in the milk as we know coagulation of milk takes place.

(ii) In C, the flavour is rancid smell so desired fermentation doesn't occur.

(iii) Yes, the spoon of curd contains lactic acid bacteria into the milk.

(b) A & C

Sol.(i) In experiment A - On heating the juice/tamarind extract it will destroy the bacteria & only acid will be present & since the outcome is no curdling, it shows acid has no role in curdling of milk.

(ii) In experiment C – Since the curdling in unboiled milk is faster & slow in boiled milk it also shows that the acid has no role in curdling.

(c) A & C

Sol.(i) Milk protein acts like a buffer and hence takes a long time to curdle, as bacterial acids produced, accumulate slowly.

(ii) Weak acids are released from the small piece of tamarind, and take a long time to denature the milk protein that leads to the curdling of milk.

26. a)

Serial No.	Effect on species 1	Effect on species 2	Type of interaction	Situation I	Situation II	Situation III
1	+	-	Predation	✓	✓	×
2	+	-	Herbivory	✓	×	×
3	0	-	Amensalism	✓	×	×
4	+	0	Commensalisms	×	×	✓
5	-	-	Competition	×	×	×
6	+	-	Parasitism	×	×	×
7	+	+	Mutualism	✓	×	×

(b) Antagonistic interactions are 1, 2 & 6 in which one species benefits & the other is harmed.

(c)

Situation	Type of antagonistic interaction	Species 1(+)	Species 2 ( )
I	Predation	Erget birds	Insects
	Herbivory	African buffaloes	Grasses
Situation	**Type of antagonistic interaction**	**Species 1(+)**	**Species 2 ( )**
II	Predation	Timberwolves	Herbivores animals
		Grizzly bear	Herbivores animals
Situation	**Type of antagonistic interaction**	**Species 1(+)**	**Species 2 ( )**
III	None		

27. (a) $\rightarrow$ C

(b)

A	Wrist bones (Carpels)	
B	Hip bone	✓
C	Skull	
D	Rib cage	
E	Vertebral column	✓

(c) $g = \frac{GM\in}{(R\in+H)^2}$

The acceleration due to gravity on earth surface is 0.885 g or 8.68 m/s^2 are the units of acceleration.

28. (a)

(i) $\rightarrow$ F

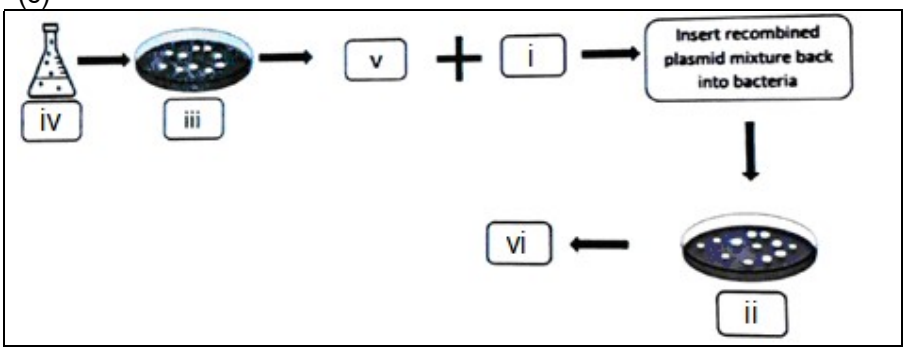
(ii) $\rightarrow$ T

(iii) $\rightarrow$ F

(iv) $\rightarrow$ F

(b) $\rightarrow$ A

(c)



29. (a) $2Al(s) + 6HCl(aq) \longrightarrow 2AlCl_3(aq) + 3H_2(g)$

(b)

Burette reading in mL	Sumeet's experiment	Swapnil's experiment
Final burette reading	17.1	13.5
Initial burette reading	Zero	2.6
Vol. of acid added	17.1	10.9

(c) $[HCl]_{sumeet}$= 3.5 mol/dm^3

Mass of Al = 0.57 g

Moles of Al = $\frac{0.57}{27}$ = 0.021 mole

2 moles Al reacts with 6 moles HCl

$\therefore$ 0.021 mole Al will react with $\frac{6}{2} \times 0.021 = 0.063$ mole of HCl

Vol. of HCl used by Swapnil = 10.9 mL

$\therefore$ Concentration of HCl = $\text{Mole} \times \frac{1000}{\text{Vol. of HCl}}$

$= 0.063 \times \frac{1000}{10.9}$ = 5.77 M

= 5.77 mol/dm^3

(d) Swapnil $\rightarrow$ Burette started leaking.

11% volume consumed before stopping the burette

(i) $HCl + NaHCO_3 \longrightarrow NaCl + CO_2 + H_2O$

(ii) Volume of HCl leaked = $\frac{11}{100} \times 10.9 = 1.199$ mL

Moles of HCl in 1.199 mL

$= \frac{\text{Molarity} \times 1.199}{1000} = \frac{5.77 \times 1.199}{1000} = 6.91 \times 10^{-3}$ mole

Moles of HCl = 6.91 $\times$ 10^{-3}

$\therefore$ Moles of $NaHCO_3$ = 6.91$\times$ 10^{-3}

Mass of $NaHCO_3$ = 6.91 $\times$ 10^{-3} $\times$ 84 = (580.44 $\times$ 10^{-3})g = 0.58 g

(iii) Percentage of purity of Al sample

From Sumeet's experiment

Vol. of HCl consumed = 17.1 mL

Concentration of HCl = 3.5 mol/dm^3

$\therefore$ Moles of HCl = $\frac{\text{Molarity} \times \text{Vol. of HCl}}{1000} = \frac{3.5 \times 17.1}{1000} = 0.05985$

6 moles of HCl consumes 2 moles of Al

0.05985 mole HCl consume $\left(\frac{2}{6} \times 0.05985\right) = 0.01995$ moles of Al

$\therefore$ Mass of Al = 0.01995 $\times$ 27 = 0.53865 g

% purity = $\frac{0.53865}{0.57} \times 100 = 94.5\%$

(e) Mass of zinc = 0.57 g

(i) $Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$

(ii) Mass of Zn = 0.57 g

Moles of Zn = $\frac{0.57}{65.38} = 8.71 \times 10^{-3}$

$\therefore$ Moles of HCl required = 2 $\times$ 8.71 $\times$ 10^{-3} = 17.42 $\times$ 10^{-3} mol

For sumeet, concentration of HCl = 3.5 mol/dm^3

$\therefore$ Vol. of HCl needed for sumeet for titration = $\frac{17.42 \times 10^{-3} \times 1000}{2.5} = 4.977$ mL

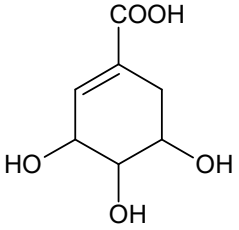
Vol. of HCl required by Sumeet = 4.977 mL

Since, 4.977 mL of stock solution contains desired amount of HCl to react with zinc to make the reading of burette 10 to 15 mL dilute the solution twice to thrice

30. Shikimic acid

M.P = 186°C, B.P = 401°C

(a)



Molecular formula = $C_7H_{10}O_5$

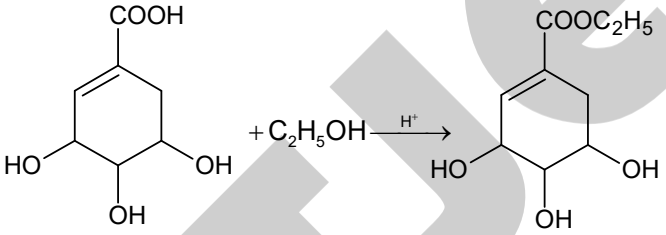
$\therefore$ Molar mass = 174

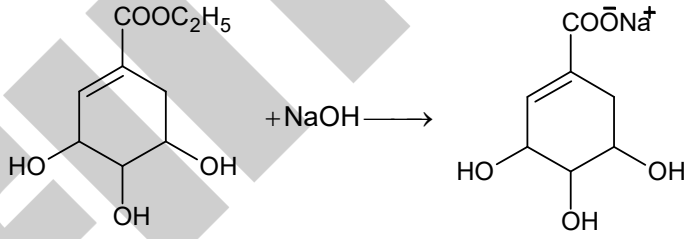
% of carbon = $\frac{7\times12}{174}\times100 = 48.27\%$

% of hydrogen = $\frac{10}{174}\times100 = 5.74\%$

% of oxygen = $\frac{16\times5}{174}\times100 = 45.97\%$

(b)





(B)

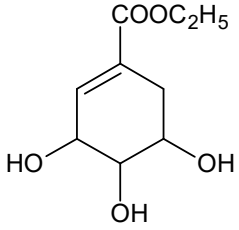
Moles of Shikimic acid = $\frac{10}{174} = 0.0574$

1 mole of acid gives one mole of A

Molar mass of A($C_8H_{14}O_5$) = 190

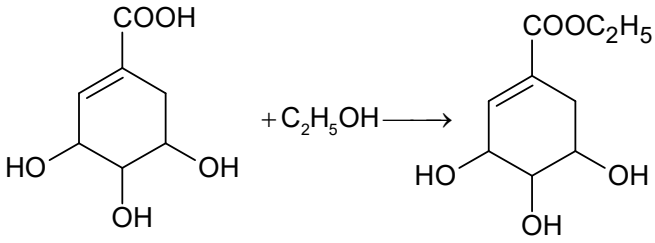
Moles of A = $\frac{8.5}{190} = 0.044$

(i) Structure of A is



(ii) No. of C – H bonds = 11

(iii) pH will increase as acid(containing more H^+ ions) is converted to ester(no acidic H atom).

(iv) 

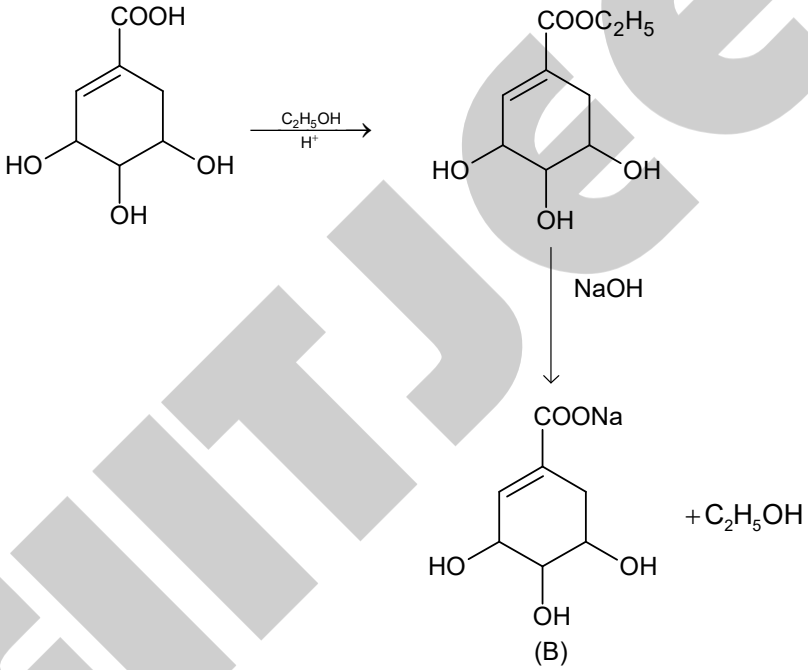
One mole of acid gives one mole of ester

Moles of acid = $\frac{10}{174}$ = 0.0574

Moles or product = $\frac{8.5}{190}$ = 0.044

$\therefore$ Product yield = $\frac{0.044}{0.0574} \times 100 = 76.65\%$

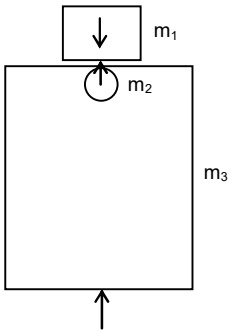
(v) Acid is more soluble in aqueous solution as it ionizes in water.

(vi) 

(B)

(vii) Since shyama is boiling the star anise in water and the b.p of star arise is 401°C. The lose of acid from biryani will be less

31. Centrifugation for separation of gold followed by filtration to separate $CaCO_3$ followed by distillation to separate water & sugar.

32. 

m_1 = 0.5 kg

m_2 = 100 gm

m_3 = 4 kg

Initially, N $(m_1 + m_2 + m_3)g$

$\Rightarrow$ $t_{collision}$ = (0.19 – 0.05) = 0.14

$\Rightarrow \sqrt{\frac{2H}{g}} = 0.14$

$\Rightarrow$ H = 9.8 cm

After collision reading $\Rightarrow (m_1 + m_2 + m_3)\, g$

$\Rightarrow$ 46 N

During collision reading $\Rightarrow (m_1 + m_3)\, g.$

$\Rightarrow$ 45 N

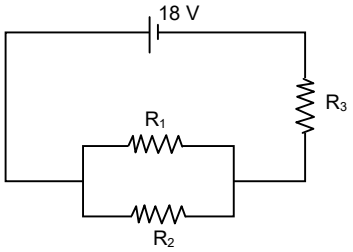
Option R is correct.

$\Rightarrow$ Difference in reading = $m_2 g$ $\Rightarrow$ 1 N.

So, force during impact $\Rightarrow$ 45 + 15

$\Rightarrow$ 60 N

33.

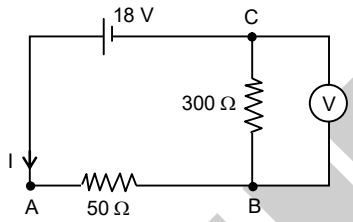


$R_1 = 100$

$R_2 = 100$

$R_3 = 300$

$\Downarrow$



<u>Voltmeter</u>

Resistance = R_V

$V_{BC} = 14.4$

$V_{AB} = 18 - 14.4$

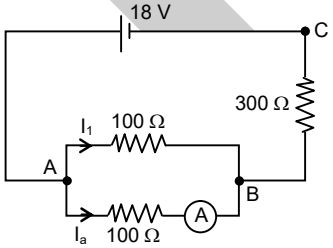
$\Rightarrow$ 3.6

So, $I = \frac{3.6}{50}$ = 72 mA.

$\Rightarrow R_{BC} = 200 = \frac{V_{BC}}{I}$

$\Rightarrow$ So, $R_V = 600\ \Omega$.

Now,



<u>Ammeter</u>

Resistance = R_a

I_a = 20 mA

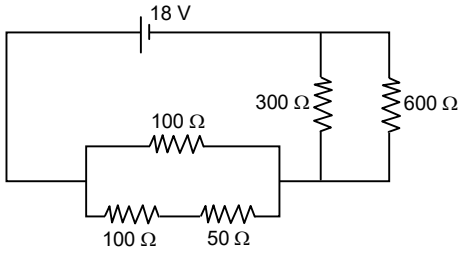
$V_{AB} = (20 \times 10^{-3})\,(100 + R_A)$

$I_1 = \frac{V_{AB}}{100}$

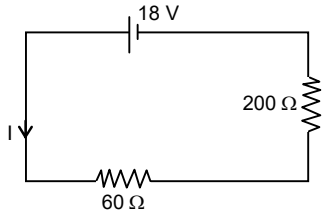
$\Rightarrow V_{AB} + V_{BC} = 18$

$\Rightarrow (20 \times 10^{-3})\,(Ra + 100) + (I_A + I_a)\,(300) = 18$

$\Rightarrow 4R_a = 200$ $\Rightarrow$ $R_a = 50$



$$I = \frac{18}{260}$$



$$\Delta V_{200} + I(200) = 13.85$$

$$\Rightarrow \quad I_{R_2} = I\left[\frac{100}{250}\right] = 27.69 \text{ mA}$$

34. Mass of Block = 625 gm = M
Side length = 5 cm
Mass of container = 5 kg = M_1
Density of liquid = 1.5 g/cm^3

(a)

$$F_B = (1.2)\frac{(5\times5\times2)(10)}{1000} \Rightarrow 0.6$$

$\Rightarrow$ $T + F_B = Mg \Rightarrow T = Mg - F_B$

$\Rightarrow 6.25 - 0.6$

$\Rightarrow 5.65$

$\Rightarrow$ $N = M_1g + F_B \Rightarrow 50 + 0.6 \Rightarrow 50.6$

$(\text{Reading})_P = 565$ gm

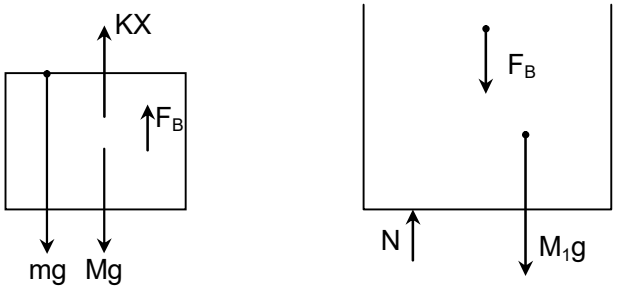
$(\text{Reading})_Q = 5.06$ kg

$\Rightarrow$ $\boxed{K X_0 = 5.65}$

$\Rightarrow$ $X = X_0 + 0.03$

$\Rightarrow$ $KX = 5.65 + 1.5 \Rightarrow 7.15$

(b)



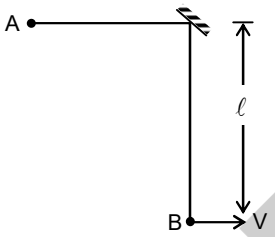
- $F_B = (1.2)\frac{(5\times5\times5)}{1000}\times10 \Rightarrow 1.5$
- $N = M_1g + F_B \Rightarrow 50 + 1.5 = 51.5$
  $(Reading)_Q = 5.15$ kg
- $KX + F_B = mg + Mg$

$\Rightarrow$ 7.15 + 1.5 = mg + 6.25

$\Rightarrow$ 2.4 = mg

$\Rightarrow$ m = 240 gm

35.

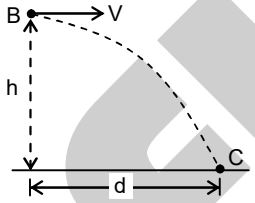


$A \longrightarrow B$

$\Rightarrow \Delta U + \Delta K = 0$

$\Rightarrow -Mg\ell + \frac{1}{2}MV^2 = 0$

$\Rightarrow V = \sqrt{2g\ell}$



$B \longrightarrow C$

$\Rightarrow t = \sqrt{\frac{2h}{g}}$

$\Rightarrow d = V(t) = \sqrt{2g\ell}\ \sqrt{\frac{2h}{g}}$

$\Rightarrow d \Rightarrow \sqrt{4\ell h}$

$\Rightarrow \ell + h = \text{constant} = C$

So, $d = \sqrt{4(h)(C-h)} \Rightarrow \sqrt{4(Ch-h^2)}$

$\Rightarrow \frac{d}{dh}(d) = 0 \quad \Rightarrow \quad h = \frac{C}{2}$

So, $\ell = \frac{C}{2}$; $\frac{\ell}{h} = 1$

(c) Not affected. (d is independent of 'g')