SECTION A

Q. No.	(a)	(b)	(c)	(d)	Q. No.	(a)	(b)	(c)	(d)
1	☐	☐	☐	☒	16	☒	☐	☐	☐
2	☐	☐	☐	☒	17	☐	☐	☐	☒
3	☐	☒	☐	☐	18	☐	☒	☐	☐
4	☒	☐	☐	☐	19	☒	☐	☐	☐
5	☐	☐	☒	☐	20	☐	☐	☐	☒
6	☐	☐	☒	☐	21	☐	☐	☐	☒
7	☐	☒	☐	☐	22	☐	☐	☒	☐
8	☐	☒	☐	☐	23	☒	☐	☐	☐
9	☒	☐	☐	☐	24	☐	☒	☐	☐
10	☐	☐	☐	☒	25	☒	☐	☐	☐
11	☐	☐	☒	☐	26	☐	☐	☐	☒
12	☐	☐	☐	☒	27	☐	☐	☒	☐
13	☐	☒	☐	☐	28	☐	☐	☒	☐
14	☐	☒	☐	☐	29	☐	☐	☐	☒
15	☐	☐	☐	☒	30	☒	☐	☐	☐

(For questions 31-42 all valid alternative solutions have been considered)

31. A.

I) $2ZnS + 3O_2 \longrightarrow 2ZnO + 2SO_2$

II) $ZnCO3 \longrightarrow ZnO + CO_2$

III) $\mathbf{ZnO + C \longrightarrow Zn + CO}$

$\mathbf{ZnO + CO \longrightarrow Zn + CO_2}$

OR

$\mathbf{2ZnO + C \longrightarrow 2Zn + CO_2}$

31. B.

I. iv. It is a reaction between iron oxide and aluminium where aluminium acts as reducing agent and iron acts as oxidizing agent and reaction is exothermic.

II. $Fe_2O_{3(s)} + 2Al_{(s)} \longrightarrow Al_2O_{3(s)} + 2Fe_{(l)}$

31. C.

P1 / T1 = P2 / T2 at constant volume

P2 = $(250 \times 10^3 \times 1800)/300 = 1.5 \times 10^6$ Pa

Hence the cylinder will blow up.

32. A.

I) Consider P + Q as a system. As the speed is constant, applied force must be equal and opposite of total frictional force (or balances total frictional force).

$$\therefore F = (\mu_P m_P + \mu_Q m_Q)g = 64 \text{ N}$$

II) Block Q experiences two forces from the table

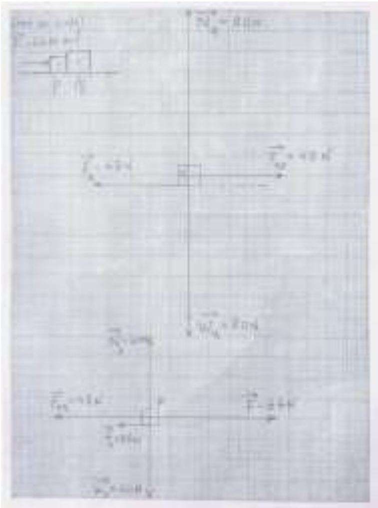
A) Horizontal frictional force $\mu_Q . m_Q . g = 48$ N

B) Vertical (normal) reaction force (numerically) equal to weight $W_Q = 80$ N

This gives magnitude of the reaction force as $R = \sqrt{48^2 + 80^2} = 16\sqrt{34} = 93.29$ N

Direction of $\vec{R}$ makes angle of $tan^{-1}(5/3)$ with the horizontal, inclined towards P.

III)



32. B.

I) P = 300J/6 = 50 W

II) K = ½ mv^2 = ½ x 25 x $(31/6)^2$ = 334 J

III) The student provides 300J of energy to the cycle in one full pedal. However the kinetic energy of the cycle remains constant as it moves with uniform velocity. So 300 J of energy is lost in dissipation in one full pedal.

Fraction = 300/334 = 0.9 or 90%

33.

1000 eV β particle will give 15 low energy photons.

So 10 keV i.e. 10,000 eV β particle will give 150 photons.

At 10% efficiency photomultiplier will generate 15 electrons.

Now these 15 into m i.e. 15m electrons will generate a charge of 15fq.

C=120 pF and voltage is 2 mV so Q on capacitor is CV = 120 x 10^{-12} x 2 x 10^{-3} = 240x10^{-15} Q

Which is same as f x 15 x 1.6 x 10^{-19}Q → f=10^{5}.

34.

I. (ii) ~425

II. Violet-blue, violet or blue.

III. Chlorophyll

IV. Plant leaves appear green in color because pigments in leaves **absorb** violet-blue and red light and **transmit** green light.

V. Yes

VI. $6CO_2 + 12\ H_2O$ + Light energy ------> $C_6H_{12}O_6 + 6\ O_2 + 6\ H_2O$
OR , $6CO_2 + 6H_2O$ + Light energy ------> $C_6H_{12}O_6 + 6O_2$. Release of oxygen is a measure of rate of photosynthesis in this experiment. Thus oxygen sensing bacteria was used in this experiment.

VII. Spectrophotometer / colorimeter

35.

I) $3NaOH + H_3PO_4 \longrightarrow Na_3PO_4 + 3H_2O$

II) 23mL of 0.9M of H_3PO_4 gives 0.0207 moles. Which implies 0.0621 moles of NaOH is consumed. 1 mole of NaOH is 40 grams and therefore 0.0621 moles of NaOH gives 2.48 grams.

III) 10% solution ⇒ 10 g of HCl are found in 100 g of the solution

The mass 100 g is converted to volume of the solution using the density: $\rho = m/V \rightarrow V = m/\rho$

(V = 100/1.047 = 95,5 mL) ⇒ 10 g of HCl are found in 95.5 mL of the solution. Therefore 104.7 g of HCl are found in 1000 mL of the solution.

1 mol = 36.5 g
x mol = 104.7 g
Therefore x = 2.87 and hence it is a 2.87 M solution

IV) Mass of HCl is 40X1.140 = 45.60 grams
Therefore mass of reactants = 1.2 + 45.60 = 46.80 g
But mass of reactants = mass of products
46.80g = mass of solution + mass of CO_2
46.80g = 46.7g + mass of CO_2
Therefore mass of CO_2 = 0.1g
Volume of CO_2 is 0.1/1.98 = 0.051 L

36. A.

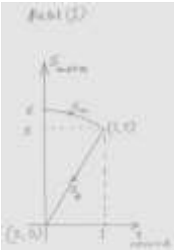
I) from dimensional analysis, x = 1, y = - 2 & z = 1, $r_s = 2Gm/c^2$

II) r_e = 0.9 cm.

Gravitational force between earth and the moon is unaffected.

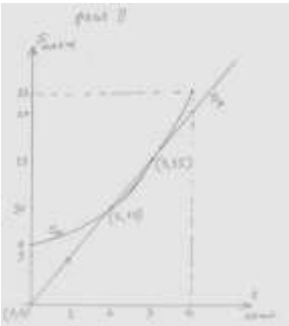
36. B.

I) At the instant they cross, $s_m = 6 - s_p \therefore t^2=6-5t \therefore t=1$



II) In this case, $s_p = s_m + 6 \;\therefore 5t = t^2 + 6$

$$\therefore t = 2\ s\ (Prashant\ overtakes)\ and\ 3\ s\ (Milind\ overtakes)$$



37.

I) $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

II) 70% of 1 ton is 700 kg of Carbon.
Mol. Wt of sugar is 180 gm/mol of which 72 gm/mol is Carbon.
Hence carbon is 72/180*100 = 40% of sugar.
Hence 700 kg carbon corresponds to 700/0.4 = 1750.0 kg of sugar/biomass.

III) $500MW$ over 8000 hrs is $500 \times 8000 \times 3600MJ$ of electricity.

At 30% power plant efficiency, this needs: $500 \times 8000 \times \frac{3600}{0.3} MJ$ of heat. i.e. $500 \times 8000 \times \frac{3600}{0.3} \times \frac{1}{21}$ kg of coal i.e. 2.3 MT (mega tons) of coal.

IV) We need to sequester 2.3 MT of coal. 1 ton of coal needs 1.75 tons of biomass to sequester. Hence we need to grow 1.75×2.3MT= 4 MT of biomass of biomass.
Since 1 hectare produces 50 tons of biomass per year, 4 megatons of biomass will need 4/50=0.08 million hectares of land i.e. 80,000 hectares of land.

V) 80,000 hectares of land will receive $80000 \times 10000 \times 800 = 640 \times 10^9$ watts of solar radiation i.e. in a year, $640 \times 10^9 \times 2000 \times 3600 = 4.6 \times 10^{18} J$ of solar energy.
This is turned into $500 \times 10^6 \times 8000 \times 3600 = 1.44 \times 10^{16} J$ of electricity.

Solar to electric conversion efficiency is therefore: $\frac{1.44 \times 10^{16}}{4.6 \times 10^{18}} \times 100 = 0.3$

38. $2KClO_3 \rightarrow 2KCl + 3O_2$

$$2 \times 122.5 = 2 \times 74.5 + 96$$

$$i.e.\, 1\ gm\ KClO_3 = \frac{96}{2 \times 122.5} = 0.39\ gm\ O_2$$

$$2KHCO_3 \rightarrow K_2CO_3 + H_2O + CO_2$$

$$2 \times 100 = 138 + 18 + 44$$

$$i.e.\, 1\ gm\ KHCO_3 = \frac{18}{2 \times 100} = 0.09\ gm\ H_2O, \frac{44}{2 \times 100} = 0.22 gm\ CO_2$$

$$K_2CO_3 \rightarrow K_2O + CO_2$$

$$138 = 94 + 44$$

$$i.e.\, 1\ gm\ K_2CO_3 = \frac{44}{138} = 0.32\ gm\ CO_2$$

Let w, c, o be the weight of water, carbondioxide and oxygen evolved.

Since all oxygen comes from chlorate, hence the weight of $KClO_3$ in the sample is $\frac{o}{0.39} = \frac{40}{0.39} = 102\ gm.$

Since all water comes from bicarbonate, hence the weight of $KHCO_3$ in the sample is $\frac{w}{0.09} = \frac{18}{0.09} = 200\ gm.$

The remainder is potassium carbonate i.e. the weight of K_2CO_3 is $1000 - 200 - 102 = 698\ gm$

Hence the composition of the original mixture is: 10.2% chlorate, 20% bicarbonate and 69.8% carbonate.

39.

As both the projectiles have the same horizontal range, their angles of projection must be complementary. $\therefore sin\theta_2 = cos\theta_1$

Time of flight, $T = \frac{2usin\theta}{g}$ $\therefore\ T_1 = \frac{2usin\theta}{g}$ and, $T_2 = \frac{2ucos\theta}{g}$

Horizontal range, $R = (ucos\theta)T = \frac{u^2 \sin 2\theta}{g} = \frac{g}{2} \times \frac{2usin\theta}{g} \times \frac{2ucos\theta}{g} = \frac{g}{2} \times T_1 \times T_2$

$$(T_1 - T_2)^2 = T_1^2 + T_2^2 - 2T_1T_2$$
$$\therefore (T_1 - T_2)^2 = \frac{4u^2}{g^2} - \frac{4R}{g}$$
$$\therefore u^2 = g\left[\frac{g}{4}(T_1 - T_2)^2 + R\right] = 2500$$

$$\therefore u = 50 \text{ m/s}$$

Alternate solution:

$t_1 = \frac{2u.sin\theta}{g}$ $t_2 = t_1 - 6 = \frac{2u.cos\theta}{g}$

$160 = \frac{2u^2.cos\theta.sin\theta}{g} = \frac{2}{g} \times \frac{gt_1}{2} \times \frac{g(t_1-6)}{2}$

Forming and solving quadratic equation in t_1, we get $t_1 = \sqrt{41} + 3$ & $t_2 = \sqrt{41} - 3$

Using $sin\theta$ and $cos\theta$ from the expressions of t_1 & t_2 in ($sin^2\theta + cos^2\theta = 1$), we get $u^2 = 2500$

$\therefore u = 50$ m/s

40.

I)

P1 <u>nuclei</u>

P2 <u>mitochondria</u>

P3 Membrane Fraction

P4 <u>ribosome particles</u>

40. II.

P1. Hematoxylin

P2. Redox dyes

P3. Lipophilic stains

40. III.

In animal cells: Mitochondria In plant cells: Mitochondria and chloroplast

40. IV.

Smooth Endoplasmic Reticulum

41.

I. (i) P

II. (i) P

III. (iii) R

IV. (iii) O_2 , H_2O and temperature

V. (ii) Increase in germination frequency

42.

I. (ii) Water

II. (ii) active transport of salts from ascending tubule to interstitial fluid.

III. (iii) It will excrete large amount of dilute urine.

IV. (i) Aquatic

V. (i) semipermeable, isotonic, passive