FIITJEE FARIDABAD

MOCK PRACTICE PAPER FOR
JEE -Advance- 2020

MOCK PRACTICE PAPER-21

Time: 3 hours *Maximum marks: 249*

INSTRUCTIONS

Caution: Question Paper CODE as given above MUST be correctly marked in the answer OMR sheet before attempting the paper. Wrong CODE or no CODE will give wrong results.

A. General Instructions
1. Attempt ALL the questions. Answers have to be marked on the OMR sheets.
2. This question paper contains Three Parts.
3. **Part-1** is Mathematics, **Part-2** is Chemistry and **Part-3** is Physics.
4. Rough spaces are provided for rough work inside the question paper. No additional sheets will be provided for rough work.
5. Blank Papers, clip boards, log tables, slide rule, calculator, cellular phones, pagers and electronic devices, in any form, are not allowed.

B. Filling of OMR Sheet
1. Ensure matching of OMR sheet with the Question paper before you start marking your answers on OMR sheet.
2. On the OMR sheet, darken the appropriate bubble with HB pencil for each character of your Enrolment No. and write in ink your Name, Test Centre and other details at the designated places.
3. OMR sheet contains alphabets, numerals & special characters for marking answers.

C. Marking Scheme For All Sections.

(i) **Section-A (01 – 5)** contains **5** multiple choice questions which have **only one** correct answer. Each question carries **+3 marks** for correct answer and **-1** for incorrect answer.

(ii) **Section-A (06 – 10)** contains **5** multiple choice questions which have **one or more than one** correct answers. Each question carries **+4 marks** for correct answer and **-2** for incorrect answer.

(iii) **Section-C (01 – 05)** contains **5** questions. The answer to each question is a single –digit integer, ranging from **0 to 9** (both inclusive). Each question you will be awarded +**4** marks for correct answer and **No** negative marking in this section.

(iii) **Section-A (11 – 17)** contains **7** comprehension type questions which have **one or more than one** correct answers. Each question carries **+4 marks** for correct answer and **No** negative marking in this section

Name of the Candidate :____

Batch :____________________ **Date of Examination :**__________________________

Enrolment Number :____

MATHEMATICS

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE option can be correct.

1. The general solution of the differential equation $\left(1+y^2\right)+\left(x-e^{\tan^{-1}y}\right)\frac{dy}{dx}=0$ is $2xe^{f(y)}=e^{2f(y)}+c$ (f(0) =0) then the area of the region bonded by the curves $x=f(y), y=\pm\sqrt{3}$ & y axis is

A) $\frac{\pi}{\sqrt{3}}-\log 2$ **B)** $\frac{2\pi}{\sqrt{3}}-\log 4$ **C)** $\frac{\pi}{\sqrt{3}}+\log 2$ **D)** $\frac{2\pi}{\sqrt{3}}$

2. If $|z-4+3i|\le 1$ and α and β be the least and greatest value of $|z|$ & K be the least value of $\frac{x^4+x^2+4}{x}$ on the interval $(0,\infty)$, then K=

A) α **B)** β **C)** $\alpha+\beta$ **D)** $\beta-\alpha$

3. Let $g(x)$ & $f(x)$ be twice differentiable functions in R and $f(2)=8, g(2)=0, f(4)=10$ & $g(4)=8$ then,

A) $g^1(x)>4f^1(x)\forall x\in(2,4)$

B) $g(x)>f(x)\forall x\in(2,4)$

C) $3g^1(x)=4f^1(x)$ *for at least one* $x\in(2,4)$

D) $g^1(x)=4f^1(x)$ *for at least one* $x\in(2,4)$

4. If $f''(x)>0,\forall x\in R$ and $f^1(3)=0$ and $g(x)=f\left(\tan^2 x-2\tan x+4\right), 0<x<\frac{\pi}{2}$ then $g(x)$ is increasing in

A) $\left(0,\frac{\pi}{3}\right)$ **B)** $\left(0,\frac{\pi}{6}\right)$ **C)** $\left(0,\frac{\pi}{4}\right)$ **D)** $\left(\frac{\pi}{4},\frac{\pi}{2}\right)$

5. Equation of the circle of minimum radius which touches both the parabolas $y = x^2 + 2x + 4$ and $x = y^2 + 2y + 4$ *is*

A) $4x^2 + 4y^2 - 11x - 11y - 31 = 0$ **B)** $4x^2 + 4y^2 - 11x - 11y - 13 = 0$

C) $4x^2 + 4y^2 - 11x - 11y - 11 = 0$ **D)** $4x^2 + 4y^2 - 11x - 11y - 6 = 0$

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

6. A function is defined as $f(x) = [\tan x] + \sqrt{\tan x - [\tan x]}, 0 < x < \frac{\pi}{2}$, where [.] denotes the greatest integer function then

A) $f(x)$ is continuous in $\left(0, \frac{\pi}{2}\right)$ **B)** $f(x)$ is non continuous at $x = 0$

C) $f(x)$ is continuous at $x = 0, \frac{\pi}{4}$ **D)** $f(x)$ has infinite points of discontinuity

7. The probabilities that a student passes in mathematics, physics and chemistry are m,p,c respectively of these subjects, a student has a 75% chance of passing in atleast one, a 50% chance of passing in atleast two, and a 40% chance of passing in exactly two subjects which of the following relations are true

A) $p + m + c = \frac{19}{20}$ **B)** $p + m + c = \frac{27}{20}$

C) $pmc = \frac{1}{10}$ **D)** $pmc = \frac{1}{4}$

8. Area of the region bounded by the curves $y = e^x$ & the lines $x = 0$ & $y = e$ is

A) $e - 1$ **B)** $\int_1^e \log_e(e + 1 - y)dy$

C) $e - \int_0^1 e^x dx$ **D)** $\int_1^e \log_e y dy$

9. Equations of a common tangent to the two hyperbolas $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$ and $\frac{y^2}{a^2}-\frac{x^2}{b^2}=1$ is

A) $y=x+\sqrt{a^2-b^2}$
B) $y=x-\sqrt{a^2-b^2}$
C) $y=-x+\sqrt{a^2-b^2}$
D) $y=-x-\sqrt{a^2-b^2}$

10. $f(x)$ is a differentiable function such that $f(x)=x^2+\int_0^x e^{-t} f(x-t)\,dt$ then

A) $f(x)=\frac{x^3}{3}+x$ B) $f(x)=\frac{x^3}{3}+x^2$ C) $f^1(x)=x^2+2x$ D) $\int_{-2}^{2}\left[f(x)-x^2\right]dx=0$

SECTION - III
(INTEGER ANSWER TYPE)

This section contains 5 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).

1. Find the number of points where the function $f(x)=2|x|+|x+2|-\left||x+2|-2|x|\right|$ is not differentiable

2. Consider two lines $L_1=\frac{x-7}{3}=\frac{y-7}{2}=\frac{z-3}{1}$ and $L_2=\frac{x-1}{2}=\frac{y+1}{4}=\frac{z+1}{3}$ if a line L whose direction ratios are (2,2,1) intersect the lines L_1 and L_2 at A and B, then find the distance $\frac{AB}{2}$

3. In a certain test there are n questions In this test 2^k student gave wrong answer to atleast $(n-k)$ questions. Where $k=0,1,2,3......n$ If the total number of wrong answer is 4095, then the value of $\frac{n}{4}=---$

4. If n is an even positive integer and $k=\frac{3n}{2}$ then value of $\sum_{r=1}^{k}(-3)^{r-1}\,{}^{3n}C_{2r-1}=----$

5. $If\ \lim_{x\to 0}\frac{1-\cos^n(1-\cos x)}{\tan^m x}=1,$ then $\frac{n}{m}=$

SECTION – IV
(Paragraph Type)

This section contains 3 paragraphs each describing theory, experiment, data etc. 7 questions related to three paragraphs. Each question pertaining to a particular **paragraph** should have one or more correct answer among the four choices A, B, C and D.

Paragraph for Questions 11 & 12

For points $P=(x_1,y_1)$ and $Q=(x_2,y_2)$ of the coordinate plane, as new distance $d(P,Q)$ is defined by $d(P,Q)=|x_1-x_2|+|y_1-y_2|$

Let $O=(0,0), A\equiv(1,2), B\equiv(2,3)$ and $C\equiv(4,3)$ are four fixed points on xy plane

11. Let $R(x,y)$ such that R is equidistant from the points O & A with respect to new distance and if $0\le x<1, 0\le y<2$ then R lie on a line segment whose equation is

A) $x+y=3$ **B)** $x+2y=3$ **C)** $2x+y=3$ **D)** $2x+2y=3$

12. Let $S(x,y)$, such that S is equidistant from points O & B with respect to new distance and if $x\ge 2$ and $0\le y<3$, then locus of S is

A) a line segment of finite length **B)** a line of infinite length

C) a ray of finite length **D)** a ray of infinite length

Paragraph for Questions 13 & 14

Let α,β be two real numbers satisfying the following relations

$\alpha^2+\beta^2=5, 3(\alpha^5+\beta^5)=11(\alpha^3+\beta^3)$

13. Possible value of $\alpha\beta$ is

A) 2 **B)** $-\frac{10}{3}$ **C)** -2 **D)** $\frac{10}{3}$

14. Possible values of $(\alpha+\beta)$ is

A) ± 2 **B)** ± 3 **C)** ± 1 **D)** $\pm\sqrt{3}$

Paragraph for Questions 15 & 17

If A and B are square matrices then

15. If AB+BA=0 then which of the following option is equivalent to $A^3 - B^3$

A) $(A-B)(A^2+AB+B^2)$ **B)** $(A-B)(A^2-AB-B^2)$

C) $(A+B)(A^2-AB-B^2)$ **D)** $(A+B)(A^2-AB+B^2)$

16. If A,B are non-singular matrices such that $B \neq I, A^6 = I, AB^2 = BA.$ then the least value of k for $B^k = I$ is

A) 7 **B)** 15 **C)** 63 **D)** 127

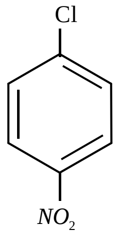
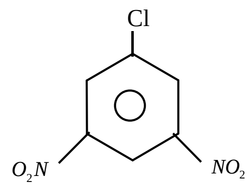
17. $|A-B| \neq 0, A^4 = B^4, C^3A = C^3B, B^3A = A^3B$ then $|A^3+B^3+C^3| =$

A) 0 **B)** 1 **C)** $3|A|^3$ **D)** 6

CHEMISTRY

SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE option can be correct.

1. **Statement-1:**  is more reactive than  towards nucleophilic aromatic substitution.

Statement-2: Meisenheimer complex or σ complex formed in $ArSN^{AE}$ mechanism is stabilized by $-NO_2$ group attached to ortho or para position w.r.t leaving group.

A) statement-1 is true,statement-2 is true and statement-2 is correct explanation for statement-1.

B) statement-1 is true,statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

C) statement-1 is true,statement-2 is false.

D) statement-1 is false,statement-2 is true.

2. Some standard potentials are given at 25^0C

$E^0_{A^+/A} = -1.50V$; $E^0_{B^{2+}/B} = -0.50V$

$E^0_{C/C^-} = +0.20V$; $E^0_{D^{-3}/D^{-2}} = -0.70V$

Which of the following is best oxidizing agent under standard condition?(Assuming that element exist in only given oxidation states)

A) A^+ **B)** B^{2+} **C)** c^- **D)** D^{2-}

3. Which of the following is formed by condensation polymerization.

A) Nylon-66 **B)**Terylene **C)**Bakelite **D)**All of these

4. Which of the following is an example of $2p_{\pi} - 3d_{\pi}$ back bonding.

A) OCl_2 **B)** CCl_2

C) both (A) and (B) **D)**None of these

5. Which compound is capable of showing aldol condensation as well as haloform reaction.

A) $CH_3CH_2CH_2CHO$ **B)** $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CHO$

C) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CHO$ **D)** $Ph-\overset{\displaystyle O}{\overset{||}{C}}-Me$

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

6. Which of the following conditions may lead to a non-spontaneous change?

A) ΔH *and* ΔS **both +ve** **B)** $\Delta H = -ve; \Delta S = +ve$

C) $\Delta H = +ve; \Delta S = -ve$ **D)** $\Delta H = -ve; \Delta S = -ve$

7. Which of the following reaction is an example of comproportionation reaction.

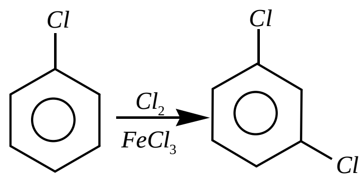
A) $5I^- + IO^-{}_3 \xrightarrow{6H^+} 3I_2 + 3H_2O$

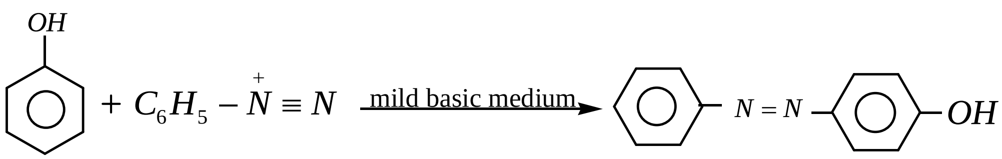
B) $SO_2 + 2H_2S \longrightarrow 3S + 2H_2O$

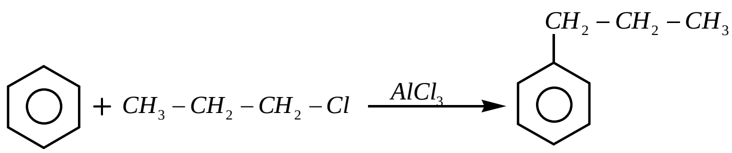
C) $Cl_2 + OH^- \longrightarrow Cl^- + OCl^- + H_2O$

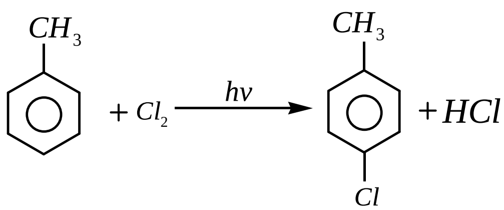
D) $Cl^- + OCl^- + 2H^+ \longrightarrow Cl_2 + H_2O$

8. Which of the following reaction(s) is/are not representing the correct major product?

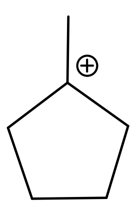
A) 

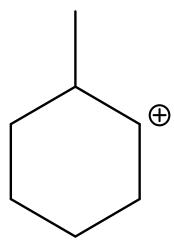
B) 

C) 

D) 

9. Which of the following carbocation undergoes rearrangement

A) 

B) 

C) $CH_3-\overset{\oplus}{C}H-CH_2-OH$

D) $CH_3-\overset{\oplus}{C}H-CH_2-CH_3$

10. Which of the following complexes are tetrahedral in shape.

A) $[FeCl_4]^-$ **B)** $[BrF_4]^-$ **C)** $[Cu(CN)_4]^{3-}$ **D)** $[AuCl_4]^-$

SECTION - III
(INTEGER ANSWER TYPE)

This section contains 5 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).

1. Number of oxygen atoms involved in oxidation state -1 in CrO_5

2. 5 moles of an ideal monatomic gas undergoes adiabatic free expansion from 10 L, (e^4) atm to (e) atm. The change in entropy(in Cal/K) of the system is $x \times 10$. Then the value of x

3. On conversion into Grignard followed by treatment with ethanol. How many monochloro alkane would yield 2-methyl butane.

4. How many enantiomers pairs exist for $\left[M\left(AB\right)_3\right]$complex.

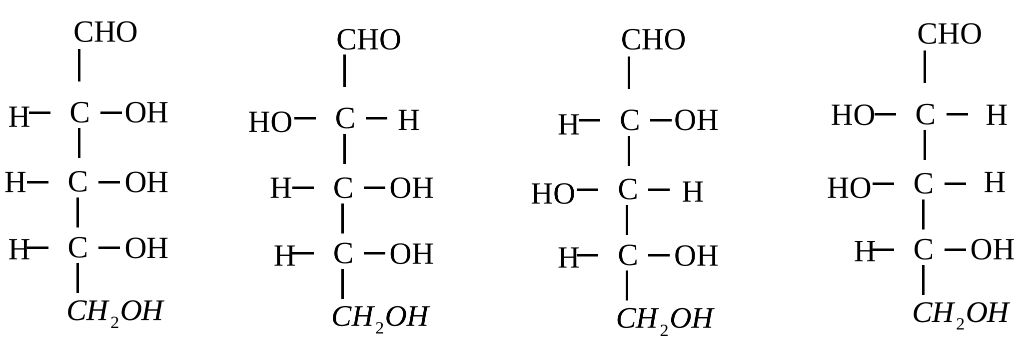
5. A hydrogen electrode when a buffer solution A^- and HA in the ration of a : b and b : a has oxidation electrode potential E_1 and E_2 volts respectively at 25^0C. If HA is weak acid, pH of buffer solution is 6.0(partial pressure of H_2 is 1.0 atm). The pKa of acid Ha is….

SECTION – IV
(Paragraph Type)

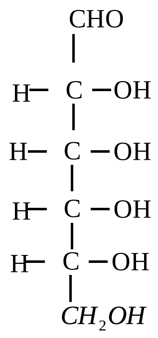
This section contains 3 paragraphs each describing theory, experiment, data etc. 7 questions related to three paragraphs. Each question pertaining to a particular **paragraph** should have one or more correct answer among the four choices A, B, C and D.

Paragraph for Questions 11 & 13

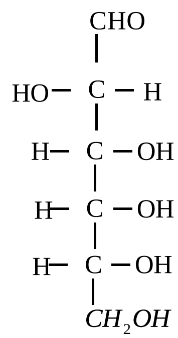
Observe these compound and give answer of following questions.



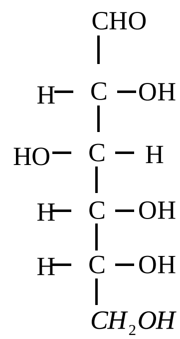
D-ribose **D-arabinose** **D-xylose** **D-lyxose**



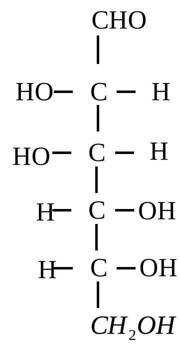
D(+)allose



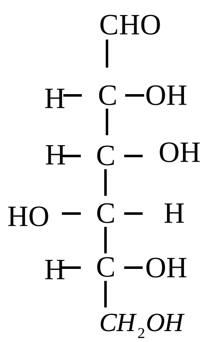
D(+)altrose



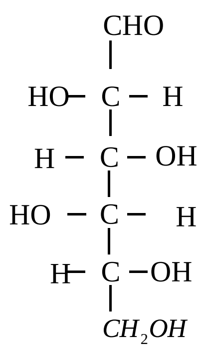
D(+)glucose



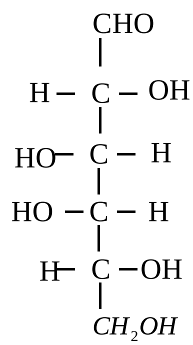
D(+)mannose



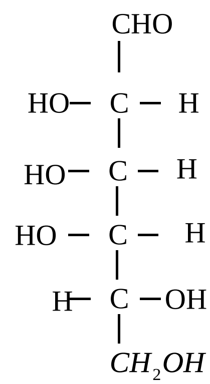
D(-)gulose



D(-)iodose



D(+)galactose



D(+)talose

11. In the given Aldose which can form same osazone

I) D-ribose II) D-arabinose III) D-iodose IV) D-galactose

A) I&III **B)** I,III,IV **C)**I,II **D)**III,IV

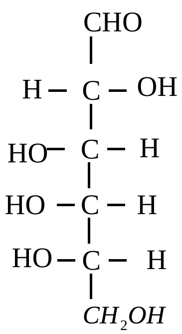
12. A carbohydrate undergoes the following conversion.

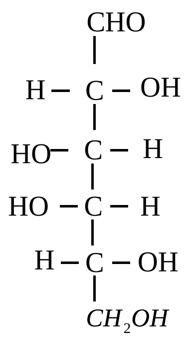
$$\text{D-arabinose} \xrightarrow[HCl]{NaCN} \text{'A'} \xrightarrow{H_2 / Pd - BaSO_4} \text{'B'} \xrightarrow{H_3O^{\oplus}} \text{'C'}$$

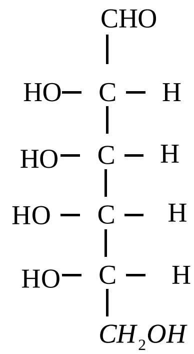
'C' can be

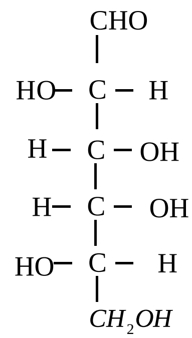
A) D-Glucose **B)** D-mannose **C)** Both (A) & (B) **D)** None of these

13. Which of the following is correct presentation of L-galactose.

A) 

B) 

C) 

D) 

Paragraph for Questions 14 & 15

In solids, the constituent particles are closed packed, leaving the minimum vacant space. The constituent particles are identical hard spheres and they build the three dimensional structure. In ionic solids normally the bigger anions occupy the void spaces, depending on their relative size.

14. The radius ratio of P^{2+} and Q^- ions $\left(\frac{r_{P^{2+}}}{r_{Q^-}}\right)$ is 0.8. The unit cell of this ionic solid in expanded view appears as:

A) Simple cubic for Q^- ions and P^{2+} ions occupy all the cubic voids

B) Face centered cubic for Q^- ions and P^{2+} ions occupy all the tetrahedral voids.

C) Face centered cubic for P^{2+} ions and Q^- ions occupy all the tetrahedral voids.

D) Face centered cubic for Q^- ions and P^{2+} ions occupy 50% of octahedral voids.

15. An ionic solid PQ crystallizes in rock salt structure with density 4.0 gm/cm^3. If the radius of cation and anion is 83 and 167 pm respectively, then the molar mass of solid is $[N_A = 6\times10^{23}]$

A) **75gm/cm^3** **B)** **50gm/cm^3** **C)** **25gm/cm^3** **D)** **150gm/cm^3**

Paragraph for Questions 16 & 17

The space model which is obtained by joining the points representing various bonded atoms gives the shape of the molecule. The geometry of the molecule is definite relative arrangement of the bonded atoms in a molecule. The shape and geometry of a molecule is explained by valence shell electron pair repulsion theory given by Gillespie and Nyholm.

16. Select the correct code for the following repulsion orders, according to VSEPR theory:

i) lone pair-lone pair > lone pair-bond pair

ii) lone pair-bond pair > bond pair-bond pair

iii) lone pair-lone pair > bond pair-bond pair

iv) lone pair-bond pair > lone pair-lone pair

A) I, ii & iii B) ii & iv C) I, ii & iv D) All

17. Which molecule has both shape and geometry identical?

i) $SnCl_2$ ii) NH_3 iii) PCl_5 iv) SF_6

A) i, iii & iv **B)** ii, iii & iv **C)** iii & iv **D)** All

PHYSICS

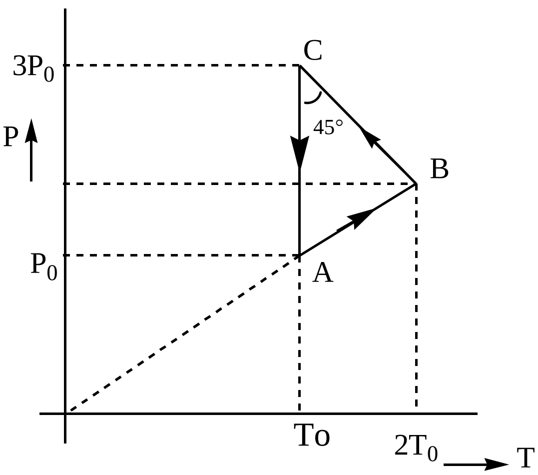
SECTION – I
(SINGLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE option can be correct.

1. A steel wire with cross-section 3cm^2 has elastic limit $2.4\times10^8 Pa$ the maximum upward acceleration that can be given to a 1200kg elevator supported by this cable if the stress is not to exceed $\frac{1}{3^{rd}}$ of the elastic limit is $\left(g=10m/s^2\right)$

A) $9m/s^2$ **B)** $10m/s^2$ **C)** $11m/s^2$ **D)** $12m/s^2$

2. An ideal mono-atomic gas is undergoing a cyclic process as shown in the fig. then choose the correct statement



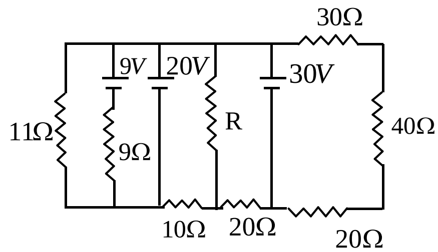
A) work done by gas in process CA is negative

B) Heat is rejected by the system in process BC

C) work done by gas in the cyclic process is positive

D) Internal energy of the gas decreases in the process AB

3. In the given figure. The value of R so that power generated in R will be maximum is



A) $\frac{45}{4}\Omega$ **B)** 20Ω **C)** 10Ω **D)** $\frac{20}{3}\Omega$

4. The percentage error in calculation of specific resistance $\rho = \pi r^2 \frac{R}{\ell}$, where r is radius of wire $r = 0.26 \pm 0.02 cm,$ is length of wire $\ell = 156.0 \pm 0.1 cm,$ R is resistance of wire $R = 64 \pm 2\,\text{ohm},$ will be

A) 18.57 **B)** 10.02 **C)** 5.38 **D)** 6.42

5. A force $F = (3\hat{i} + 4\hat{j})$ Newton acts on a particle moving along a line $4y + kx = 3$. The work done by the force is zero if the value of k is

A) 1 B) 2 C) 3 D) 4

SECTION – II
(MULTIPLE CORRECT ANSWER TYPE)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

6. The electric potential at a point P at a distance 'r' from a point charge is given by

$V = \frac{k}{r}$

Where k is a constant

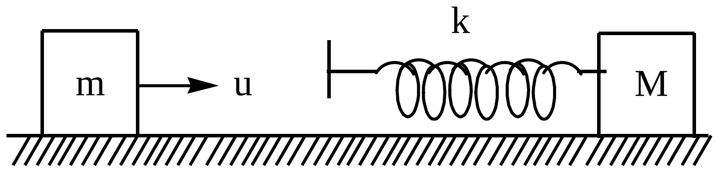
A) k is dimensionless

B) the dimensions of k are $[ML^{-3}T^{-3}A^{-1}]$

C) Magnitude of electric field at $P = \left|\frac{k}{r^2}\right|$

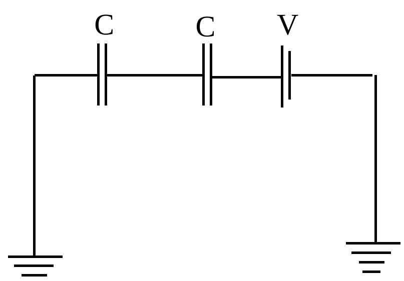
D) Magnitude of electric field at $P = kr^2$

7. A block of mass M with a massless spring of force constant k is resting on a horizontal frictionless surface. A block of mass m projected horizontally with a speed u collides and sticks to the spring at the point of maximum compression of the spring. If υ is the velocity of the system after mass m sticks to the spring and n is the fraction of the initial kinetic energy of mass m that is stored in the spring, then



A) $\frac{\upsilon}{u}=\frac{M}{(M+m)}$ B) $\frac{\upsilon}{u}=\frac{m}{(M+m)}$ C) $n=\frac{M}{(M+m)}$ D) $n=\frac{m}{(M+m)}$

8. Two capacitors, each of capacitance C, are connected to a battery of voltage V as shown in fig. one plate of a capacitor and the negative terminal of battery are earthed as shown. If the combined capacitance of the arrangement is C' and the energy stored in the capacitors is U, then



A) $C'=2C$ B) $C'=\frac{C}{2}$ C) $U=\frac{1}{4}CV^2$ D) $U=\frac{1}{2}CV^2$

9. Two springs A and B have force constants k_1 *and* k_2 respectively. The ratio of the work done on a to that done on B in increasing their lengths by the same amount is α and the ratio of the work by the same to that done on B when they are stretched with the same force is β. Then

A) $\alpha=\frac{k_1}{k_2}$ B) $\alpha=\frac{k_2}{k_1}$ C) $\beta=\frac{k_1}{k_2}$ D) $\beta=\frac{k_2}{k_1}$

10. A beam of light having frequency D is incident on an initially neutral metal of work function $\phi\left(hv > \phi\right)$. Then

A) All emitted electrons have kinetic energy equal to $\left(hv - \phi\right)$

B) All free electrons in metal, that absorb photons of energy hυ completely may not be ejected out of metal

C) After being emitted out of the metal, the kinetic energy of photo-electrons decreases continuously as long as they are at a finite distance from metal.

D) The emitted photo electrons move with constant speed after being ejected out of metal

SECTION - III
(INTEGER ANSWER TYPE)

This section contains 5 questions. The answer is a single digit integer ranging from 0 to 9 (both inclusive).

1. Two solid spheres of radii r and 2r, made of the same material, are kept in contact. The mutual gravitational force of attraction between them is proportional to r^x where x =

2. The wavelength of light of a particular wavelength received from a galaxy is measured on earth and is found to be 5% more that its wavelength. It follows that the galaxy is going away from the earth with a speed $1.5 \times 10^x\, ms^{-1}$ where x is

3. An inductor of self inductance 100 H and a resistor of resistance $50\,\Omega$ are connected to a 2 V battery. The time required for the current to fall to half its steady value is $2\ln x$ sec where x is ___

4. A solid sphere of mass M and Radius R is released from the top of an inclined plane of inclination θ. The minimum coefficient of friction between the plane and the sphere so that it rolls down the plane without sliding is given by $\mu = \frac{2}{x}\tan\theta$ where x =

5. An alternating current (in ampere) varies with time t as $I = 3\sin\omega t + 4\cos\omega t$ the rms value of the current is $\frac{x}{\sqrt{2}}$ where x is

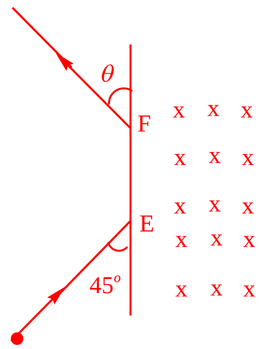
SECTION – IV

(Paragraph Type**)**

This section contains 3 paragraphs each describing theory, experiment, data etc. 7 questions related to three paragraphs. Each question pertaining to a particular **paragraph** should have one or more correct answer among the four choices A, B, C and D.

Paragraph for Questions 11 & 12

A particle of mass $1.6\times10^{-27}kg$ and charge $1.6\times10^{-19}C$ enters a region of uniform magnetic field of 1 T at E along the direction shown in fig. the speed of the particle is $10^{7}\ ms^{-1}$. The magnetic field is directed along the inward normal to the plane of the paper. The particle leaves the region of the field at F



11. The radius of the circular path of the particle in the magnetic field is

A) $0.1\,m$ B) $0.2\,m$ C) $0.3\,m$ D) $0.4\,m$

12**.** The distance EF is

A) $\sqrt{2}\ m$ B) $\frac{\sqrt{2}}{5}m$ C) $\frac{\sqrt{2}}{10}m$ D) $\frac{1}{\sqrt{2}}m$

Paragraph for Questions 13 & 14

If two deuterium nuclei get close enough together, the attraction of strong nuclear force will fuse them to make as isotope of helium the process will release a vast amount of energy. The range of nuclear force is $10^{-15}m$. This is the principle behind the nuclear fusion. The deuterium nuclei moves so fast hence it is not possible to contain them by physical walls. Therefore they are confined magnetically then there are two statement given below

13. Statement-I: - two nuclei should have minimum speed to have head on collision to fuse is

$8.3\times10^{6} m/s$

Statement-II: - the magnetic field required to make a deuterium nuclei moving with above speed

$\left(8.3\times10^{6} m/s\right)$ to be confined in a circle of diameter 2.5m is 1.39 mT

Choose the option from below

A) Statement I is correct **B)** statement I is wrong

C) Statement II is wrong **D)** statement II is correct

14. The process of formation of helium nuclei from nuclear fusion of deuterium nuclei, a huge amount of energy is released that is given $\Delta E_1 + \Delta E_2 = 21.6 MeV$ for this choose the correct reaction

A) ${}_1H^2 +_1 H^1 \rightarrow_1 H^2 +_o n^1 + \Delta E_1$ **and** ${}_1H^2 +_1 H^2 \rightarrow_1 H^2 +_1 H^3 +_1 H^1 + \Delta E_2$

B) ${}_1H^2 +_1 H^2 \rightarrow_1 H^3 +_1 H^1 + \Delta E_1$

C) ${}_1H^2 +_1 H^1 \rightarrow_1 H^2 + e^+ + \Delta E_2$

D) ${}_1H^3 +_1 H^2 \rightarrow_1 He^4 +_o H^1 + \Delta E_2$

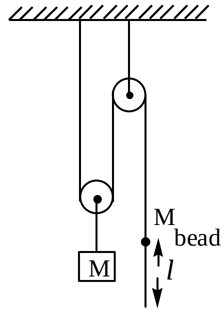
Given

$\left[m\left({}_1H^2\right) \Rightarrow 2.014102 amu, m\left({}_1H^3\right) = 3.016049 amu\ m\left({}_2He^4\right) \Rightarrow 4.002603 amu\right.$

$\left. m\left({}_0n^1\right) = 1.008665 amu, m\left({}_1H^1\right) = 1.007825 amu\right]$

Paragraph for Questions 15 & 17

In the fig friction force between bead and string is $\frac{Mg}{4}$ the system is releases from rest with bead of mass M at distance l from free end of string assume the string and pulley as mass less



15. Choose the correct alternative

A) The acceleration of block is $\frac{g}{2}$ downward

B) The tension in the string is $\frac{Mg}{4}$

C) The acceleration of block is $\frac{g}{4}$ upward

D) Tension in the string is $\frac{3Mg}{4}$

16. Acceleration of bead with respect to ground and acceleration of the point of a string connected to bead is

A) $\frac{3g}{4}$ downward, g upward **B)** $\frac{3g}{4}$ downward, g downward

C) g upward, $\frac{g}{2}$ downward **D)** $\frac{3g}{4}$ downward, $\frac{g}{2}$ downward

17. Statement-I: - the time taken by the bead to loose the contact with the string is $\sqrt{\frac{8l}{g}}$

Statement-II: - The time taken be the bead to loose contact with string is $\sqrt{\frac{8l}{7g}}$

Statement-III: - The relative acceleration of the bead with respect to string is $\frac{g}{4}$ upwards

Statement-IV:- The relative acceleration of the bead with respect to string is $\frac{7g}{4}$

Then choose incorrect option

A) I & II, IV **B)** II & III **C)** I **D)** statement III

ANSWER KEY

MATHEMATICS		CHEMISTRY		PHYSICS	
1	B	1	A	1	B
2	B	2	D	2	B
3	D	3	D	3	D
4	D	4	A	4	A
5	B	5	D	5	C
6	AC	6	ACD	6	C
7	BC	7	ABD	7	BC
8	BCD	8	ACD	8	BC
9	ABCD	9	BC	9	AD
10	BCD	10	AC	10	BC
1	4	1	4	1	4
2	9	2	3	2	7
3	3	3	6	3	2
4	0	4	2	4	7
5	2	5	6	5	5
11	D	11	C	11	A
12	D	12	C	12	C
13	A	13	D	13	AD
14	B	14	C	14	B
15	C	15	A	15	AB
16	C	16	A	16	A
17	A	17	C	17	CD

MATHEMATICS

1. $\frac{dx}{dy}+\frac{x}{1+y^2}=\frac{e^{\tan^{-1}y}}{1+y^2}$

I.F $=e^{\int\frac{dy}{1+y^2}}$

$=e^{\tan^{-1}y}$

$\therefore$ General sol's is $xe^{\tan^{-1}y}=\int\frac{\left(e^{\tan^{-1}y}\right)^2}{1+y^2}dy$

$\Rightarrow xe^{\tan^{-1}y}=\frac{e^{2\tan^{-1}y}}{2}+c \quad \Rightarrow 2xe^{\tan^{-1}y}=e^{2\tan^{-1}y}+c \therefore f(y)=\tan^{-1}y$

$\therefore$ Area $=\int_{-\sqrt{3}}^{\sqrt{3}}\left|\tan^{-1}y\right|dy=2\int_0^{\sqrt{3}}\tan^{-1}y\,dy=2\left[\left(y\tan^{-1}y\right)_0^{\sqrt{3}}-\int_0^{\sqrt{3}}\frac{y}{1+y^2}dy\right]$

$=2\frac{\pi}{\sqrt{3}}-\left[\log\left(1+y^2\right)\right]_0^{\sqrt{3}}=\frac{2\pi}{\sqrt{3}}-\log 4$

2. Given that $|z-4+3i|\le 1$

$\Rightarrow |z-(4-3i)|\le 1 \qquad \Rightarrow 1\ge |z-(4-3i)| \ge \begin{cases}|z|-|4-3i|\\ |4-3i|-|z|\end{cases}$

$\therefore |z|\le 6 \,\&\, |z|\ge 4\left[\therefore |4-3i|=5\right] \quad \Rightarrow 4\le |z|\le 6$

Y will be the least when $x^3=x=\frac{1}{x}\Rightarrow x=1$ as $y=x^3+x+\frac{4}{x}$

i.e $\alpha=4\,\&\,\beta=6$ $\quad\therefore$ y(least) =6 $\therefore$K=6, so $K=\beta$

3. Let $h(x)=g(x)-4f(x)$ Verity the roll's theorem in (2,4)

Now, $n(2)=g(2)-4f(2)=0-4\times 8=-32$

$n(4)=g(4)-4f(4)=8-40=-32 \quad \Rightarrow n^1(x)=0$ for at least one $x\in(2,4)$

$\therefore g^1(x)=4f^1(x)$ for at least one $x\in(2,4)$

4. $g^1(x)=f^1\left(\tan^2 x-2\tan x-4\right)2\sec^2 x\left(\tan x-1\right)$

Since $f^{11}(x)>0\Rightarrow f^1(x)$ increasing $\quad \tan^2 x-2\tan x+4=(\tan x-1)^2+3$

$\Rightarrow \tan^2 x-2\tan x+4\ge 3 \Rightarrow f^1\left(\tan^2 x-2\tan x+4\right)\ge f^1(3)=0$

$\left(given\ f^1(3)=0\right)$ Hence $g^1(x)>0$ iff $(\tan x-1)>0 \quad \Rightarrow x\in\left(\frac{\pi}{4},\frac{\pi}{2}\right)$

5. Given parabolas are symmetrical about the line $y=x$ so they have a common normal with slope -1 it meets the parabolas at $\left(\frac{-1}{2},\frac{13}{4}\right),\left(\frac{13}{4},\frac{-1}{2}\right)$ hence the required circle is

$x^2+y^2-\frac{11}{4}x-\frac{11}{4}y-\frac{13}{4}=0$

6. $\lim_{x\to 0^+} f(x) = \lim_{x\to 0^+}[\tan x] + \sqrt{\tan x - [\tan x]} = 0 = f(x)$

$f(x)\, is\, continuous\, at\, x=0$

$\lim_{x\to \frac{\pi}{4}} f(x) = 1 = \lim_{x\to \frac{\pi^+}{4}} f(x) = f\left(\frac{\pi}{4}\right)$

$\therefore f(x)$ is continuous at $x=\frac{\pi}{4}$ it is clear that $f(x)$ is continuous at everywhere in $\left[0,\frac{\pi}{2}\right]$

7. Here $p(m)=m$, $p(p)=p$, $p(c)=c$

The probability of passing in atleast one subjects

$=1-p(\overline{m})p(\overline{c})p(\overline{p}) \qquad =1-(1-m)(1-c)(1-p)$

$\frac{3}{4} = m+p+c-mp-pc-cm+mpc$ -----------(1)

the probability of passing in atleast two subjects

$= p(mpc)+p(mp\overline{c})+p(m\overline{p}c)+p(\overline{m}pc)$

$\frac{1}{2} = mpc + mpc(1-c)+m(1-p)c+(1-m)pc$

$\frac{1}{2} = -2mpc+mp+mc+pc$ ----------(2)

Probability of passing in exactly two subjects

$\frac{2}{5} = mp(1-c)+m(1-p)c+(1-m)pc$

$\frac{2}{5} mp+mc+pc-3mpc$ ------------(3)

Eq (2) –eq(3)

$\frac{1}{2}-\frac{2}{5} = mpc \qquad mpc=\frac{1}{10}$

Put $mpc=\frac{1}{10}$ in eq(2) $mp+pc+mc=\frac{1}{2}+\frac{1}{5}=\frac{7}{10}$

Put $mpc=\frac{1}{10}$ and $mp+pc+mc=\frac{1}{2}+\frac{1}{5}=\frac{7}{10}$

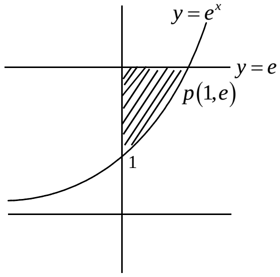
Put $mpc=\frac{1}{10}$ and $mp+pc+mc=\frac{7}{10}$ in eq(1)

$\frac{3}{4}=m+p+c-\frac{7}{10}+\frac{1}{10} \qquad m+P+c=\frac{27}{20}$ ….. $\overline{b}$

8. the line $y=e$ meets the curve $y=e^x$ in $p(1,e)$ and the y-axis in (0,1), then

Area (shaded area)$=\int_0^1 (e-e^x)dx$

$=e(1)-(e-1)=1$

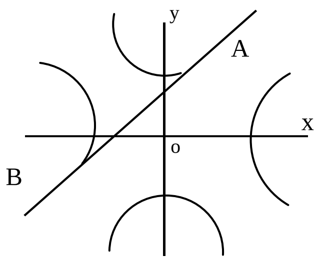


So I is true Also, area = $\int_1^e \log_e y dy \quad (\because y = e^x \to x = \log_e y$

Area $= \int_1^e \log_e (e+1-y) dy \left(\because \int_a^b f(x) dx = \int_a^b (a+b-x) dx \right)$

Hence B,D are also correct

9. $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ And $\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1$



Tangent to (1) $y = mx \pm \sqrt{a^2m^2 - b^2}$

If this is also tangent to $\frac{x^2}{(-b)^2} - \frac{y^2}{(-a)^2} = 1$

Then $a^2m^2 + b^2 = (-b^2)m^2 - (-a^2) = a^2 - b^2m^2$

$(a^2 - b^2)m^2 = a^2 - b^2 \quad \Rightarrow m = 1$

Hence four common tangent are $y = \pm x \pm \sqrt{a^2 - b^2}$

10. $f(x) = x^2 + \int_0^x e^{-(x-t)} f(x-(x-t)) dt \qquad f(x) = x^2 + e^{-x} \int_0^x e^t f(t) dt$

Differentiating both the sides

$e^x f(x) + e^x . f^1(x) = x^2 e^x + 2xe^x + e^x f(x)$

$f^1(x) = x^2 + 2x \qquad f(x) = \int (x^2 - 2x) dx \qquad = \frac{x^3}{3} + x^2 + c$

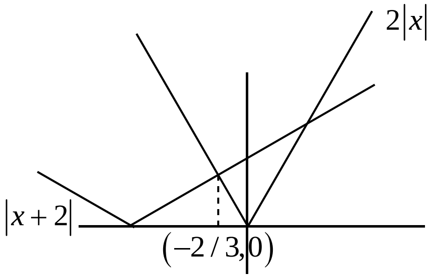
$f(0) = 0 \Rightarrow c = 0 \qquad$ So $f(x) = \frac{x^3}{3} + x^2$

11. we have $f(x) = 2|x| + |x+2| - \left|2|x| - |x+2|\right|$

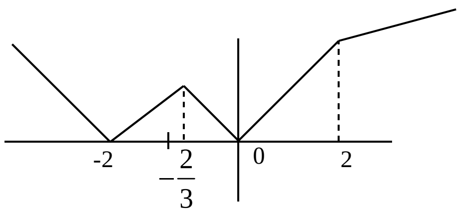
Let $2|x| = p$ & $|x+2| = q \qquad f(x) = p + q - |p-q|$

$= 2\min(p,q) \qquad f(x) = 2\min(2|x|, |x+2|)$

If we draw the graph



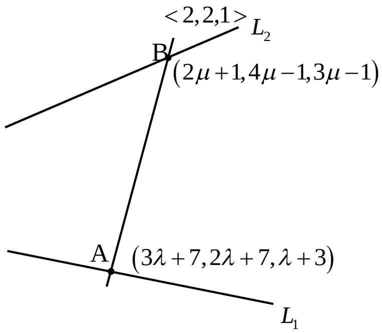
Graph of $2\min\left(2|x|,|x+2|\right)$



Function is not differentiable at 4 point

12. general point on $L_1 \equiv (3\lambda+7, 2\lambda+7, \lambda+3)$

General point on $L_2 \equiv (2\mu+1, 4\mu-1, 3\mu-1)$



DR of line joining the point A and B

$< 3\lambda-2\mu+6,\ 2\lambda-4\mu+8, \lambda-3\mu+4 >$

$\because$ DR of $AB \equiv < 2,2,1 >$ (given)

$$\frac{3\lambda-2\mu+6}{2}=\frac{2\lambda-4\mu+8}{2}=\frac{\lambda-3\mu+4}{1}$$

On solving $\lambda=2,\ \mu=0$

$A(13,11,5)\ \ B(1,-1,-1)$

$AB=\sqrt{144+144+36}=\sqrt{324}=18$

So $\frac{AB}{2}=(9)$

13. The number of students answering atleast r questions in correctly is 2^{n-r}

$\therefore$ the number of students answering exactly $r\,(1 \le r \le n-1)$ questions in correctly is

$2^{n-r}-2^{n-(r+1)}$

Also the number of students answering all question wrongly is $2^{\circ}=1$ so total number of wrong answer is

$1.\left(2^{n-1}-2^{n-2}\right)+2\left(2^{n-2}-2^{n-3}\right)+3\left(2^{n-3}-2^{n-4}\right)+---+(n-1)\left(2^{1}-2^{\circ}\right)+n.2^{\circ}$

$2^{n-1}+2^{n-2}+2^{n-3}+----+2+2^{\circ}=4095$

$2^n - 1 = 4095$ $\quad 2^n = 4096$ $\quad 2^n = 2^{12}$ $\quad n = 12$ $\quad$ So $\dfrac{n}{4} = \dfrac{12}{4} = 3$

14. If we expend a summation ${}^{3n}C_1 - 3\,{}^{3n}C_3 + 3^2\,{}^{3n}C_5 - 3^3\,{}^{3n}C_7 ---$

For above series $\left(1+i\sqrt{3}\right)^n = 2^n\left[\cos\dfrac{n\pi}{3} + i\sin\dfrac{\pi}{3}\right]$

Let $n = 2m \quad m \in I^+$ Replace $n = 6m$

$2^{6m}\left[\cos 2m\pi + i\sin 2m\pi\right] + \left(1+i\sqrt{3}\right)^{6m}$

$2^{6m} = \left(1+i\sqrt{3}\right)^{6m} = 1 + {}^{6m}C_1\left(i\sqrt{3}\right) + {}^{6m}C_2\left(i\sqrt{3}\right)^2 + {}^{6m}C_3\left(i\sqrt{3}\right)^3 + --- + {}^{6m}C_{6m}\left(i\sqrt{3}\right)^{6m}$

Equation real and imaginary pant

$\sqrt{3}\left[{}^{6m}C_1 - {}^{6m}C_3 3 + {}^{6m}C_5 3^2 - {}^{6m}C_7 3^3 + ---\right] = 0$

So $\sum_{r=1}^{k}(-3)^{r-1}\,{}^{3n}C_{2r-1} = 0$ $\quad$ Where $k = \dfrac{3n}{2}$

15. $\lim_{x\to 0}\dfrac{1-\cos^n(1-\cos x)}{(1-\cos x)^2}.\left(\dfrac{1-\cos x}{x^2}\right)^2.\dfrac{x^4}{\tan^m x} = 1$

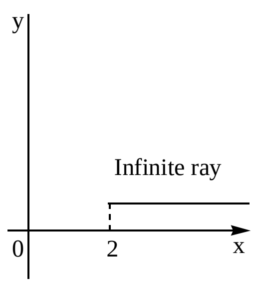
m=4 and n/2.1/4=1

$\Rightarrow n = 8$ $\quad \Rightarrow \dfrac{n}{m} = 2$

16. TO 17. (i) OR=AR

$\Rightarrow |x=0| + |y-0| = |x-1| + |y-2|$ $\quad \Rightarrow |x| + |y| = |x-1| + |y-2|$

$\because 0 \le x < 1$ and $0 \le y < 2$ $\quad \therefore x + y = -(x-1) - (y-2)$ $\quad \Rightarrow 2x + 2y = 3$



(ii) $\because$ OS=BS

$\Rightarrow |x-0| + |y-0| = |x-2| + |y-3|$

$\Rightarrow |x| + |y| = |x-2| + |y-3|$ $\quad \because x \ge 2$ and $0 \ge y < 3$ $\quad \therefore x + y = x - 2 + 3 - y$

$\Rightarrow 2y = 1$ $\quad \therefore y = \dfrac{1}{2}$

18. TO 19. A) $\alpha^2 + \beta^2 = 5$

$3\left(\alpha^5 + \beta^5\right) = 11\left(\alpha^3 + \beta^3\right)$ $\quad \dfrac{\alpha^5 + \beta^5}{\alpha^3 + \beta^3} = \dfrac{11}{3}$

$$\frac{\left(\alpha^3 + \beta^3\right)\left(\alpha^2 + \beta^2\right) - \left(\alpha^2\beta^2(\alpha + \beta)\right)}{\alpha^3 + \beta^3} = \frac{11}{3}$$

$$\alpha^2+\beta^2-\frac{\alpha^2\beta^2(\alpha+\beta)}{(\alpha+\beta)\left(\alpha^2+\beta^2-\alpha+\beta\right)}=\frac{11}{3} \qquad 5=\frac{\alpha^2\beta^2}{5-\alpha\beta}=\frac{11}{3}\Rightarrow\frac{25-5\alpha\beta-\alpha^2\beta^2}{5-\alpha\beta^2}=\frac{11}{3}$$

Let $\alpha\beta=t$ then $\frac{25-5t-t^2}{5-t}=\frac{11}{3}$ $75-15t-3t^2=55-11t$, $75-15t-3t^2+11t-55=0$

$$-3t^2-4t+20=0 \quad t=-\frac{4\pm\sqrt{16+240}}{6} \quad t=-\frac{4\pm16}{6} \qquad t=2,-\frac{10}{3}$$

So $\alpha\beta=2,\alpha\beta=-\frac{10}{3}$ If $\alpha\beta=2$ then $\alpha^2+\beta^2=(\alpha+\beta)^2-2\alpha\beta$

$5=(\alpha+\beta)^2-4\Rightarrow(\alpha+\beta)^2=9$ $\qquad \alpha+\beta=\pm3$

Only possible value of $\alpha\beta=2$ $\qquad \alpha+\beta=\pm3$ Ans:b

20. $(A+B)\left(A^2-AB-B^2\right)$

$A^3-A^2B-AB^2+BA^2-B\,AB-B^3$

$A^3-B^3-A^2B-AB^2-ABA+AB^2$

$A^3-B^3-A^2B+A^2B=A^3-B^3$

21. $AB^2=BA$

$A^{-1}AB^2-A^{-1}BA$

$B^2=A^{-1}BA$

$B^4=A^{-1}BA.A^{-1}BA$

$B^4=A^{-1}B^2A$

$B^4=A^{-1}A^{-1}BA.A$

$B^4=\left(A^{-1}\right)^2BA^2$

$B^8=\left(A^{-1}\right)BA^2\left(A^{-1}\right)^2BA^2$

$B^8=\left(A^{-1}\right)^2B^2A^2$

$B^8=\left(A^{-1}\right)^2A^{-1}BA.A^2$

$B^8=\left(A^{-1}\right)^3B(A)^3$

$B^{2^3}=\left(A^{-1}\right)^3B(A)^3$

$B^{2^n}=\left(A^{-1}\right)^nBA^n$

$\because A^6=I$ So $n=6$

$B^{2^6}=B\Rightarrow B^{64}=B$ $\qquad B^{63}=I$ option: c

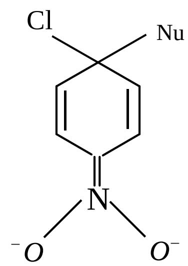
22. $\left(A^3+B^3+C^3\right)(A-B)$

$=A^4-A^3B+B^3A-B^4+C^3A-C^3B=0$

$\left|\left(A^3+B^3+C^3\right)(A-B)\right|=0 \qquad \Rightarrow\left|A^3+B^3+C^3\right|=0. \qquad \because|A-B|\neq0$

Option: a

CHEMISTRY

23.  S-Complex stabilized by $-NO_2$ present ortho & para but not by meta.

24. $E^0_{A^+/A} = -1.50V$ R.P.

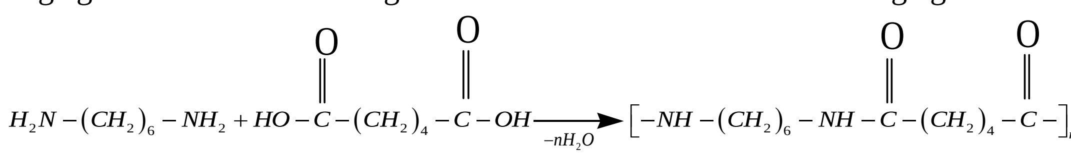
$E^0_{B^{2+}/B} = -0.50V$ R.P.

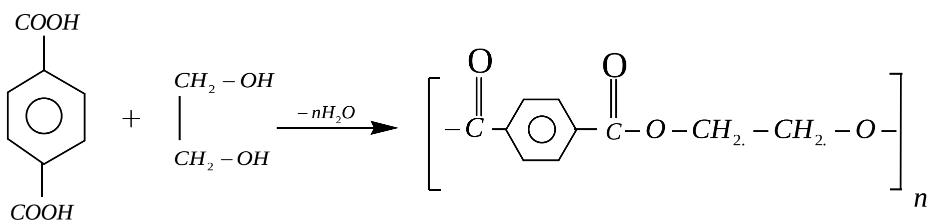
$E^0_{C\ /C^-} = +0.20V$ R.P.

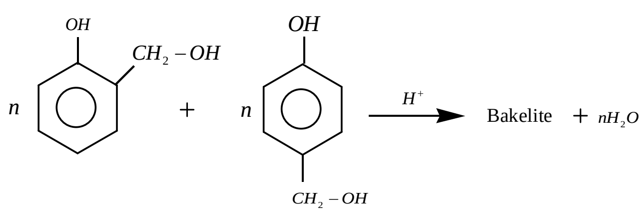
$E^0_{D^{-3}/D^{-2}} = -0.70V$ R.P

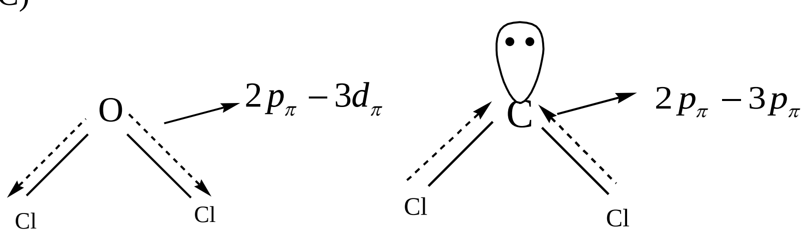
$E^0_{D^{-2}/D^{-3}} = +0.70V$ R.P.

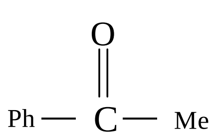
Oxidising agent is one which have greatest R.P. thus D^{-2} is a best reducing agent.

25. A) 

B) 

C) 

26. 

27.  methyl carbonyl & α H-atom at sp^3 α -Catom.

28. conceptual

29. A) Comproportionation
B) Comproportionation
C) Disproportionation

D) Comproportionation

30. A)Chlorobenzene is o & p director

B)Phenol in mild basic medium is highly activating & show diazo coupling reaction.

C) $AlCl_3$ show rearrangement of cation so cummene major product.

D)Free radical substitution takes place at benzylic site.

31. B,C(Calculate α H using hyper conjugation)

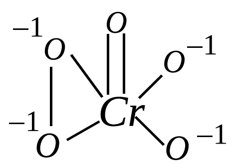
32. A) $[FeCl_4]^- \rightarrow sp^3$ Td

B) $[BrF_4]^- \rightarrow square\ planar$ $sp^3d^2(4+2)$

C) $[Cu(CN)_4]^{3-} \rightarrow sp^3$ Td

D) $[AuCl_4]^- \rightarrow dsp^2$ $square\ planar$

33.



34. $\Delta S = nR\ \ln\frac{P_1}{P_2}$

$\Delta S = 30$

$P_1 = e^4$

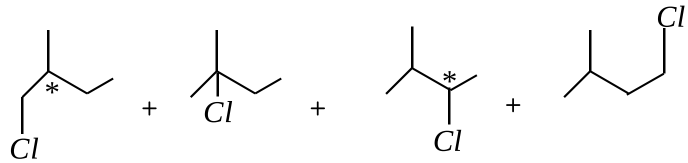
$P_2 = e^1$

$\Delta n = 5\times R\ \ln\frac{e^4}{e^1}$

$= 5\times R[\ \ln e^4 - \ln e^1]$

$= 5\times R\times[4-1]$

$= 5\times 2\times 3 = 30cal$



(2) (1) (2) (1)

35.

36. $M(AB)_3$ exist in facial and meridional isomers. Both are optically active

37. $E_1 = 0.0591\left[pKa + \log\frac{a}{b}\right]$

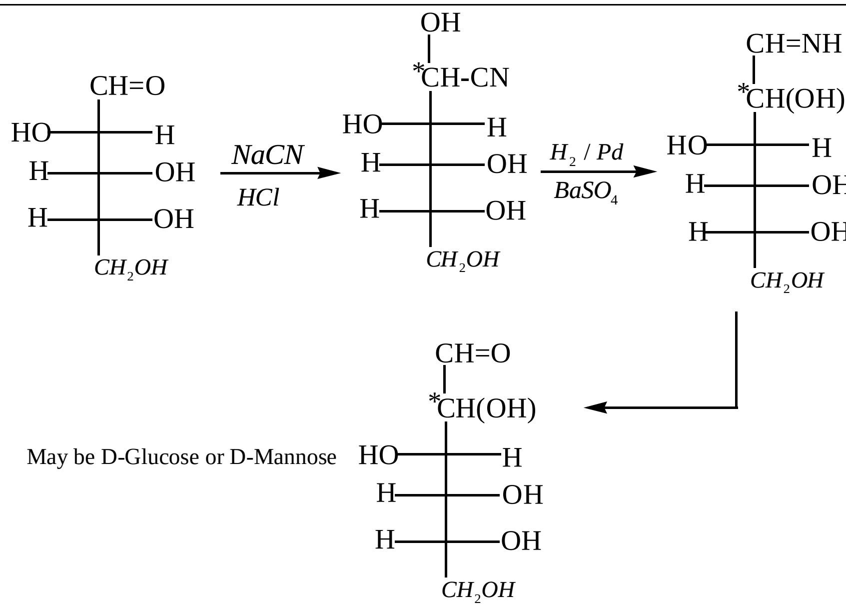
$E_2 = 0.0591\left[pKa + \log\left(\frac{a}{b}\right)\right]$

$E_1 = 0.591(pH)$ $E_2 = 0.0591(pH)\ for(SHE)$

$E_1 + E_2 = 0.0591[2\times pKa]$

$pKa = \frac{E_1+E_2}{2\times 0.0591} = pH = 6.0$

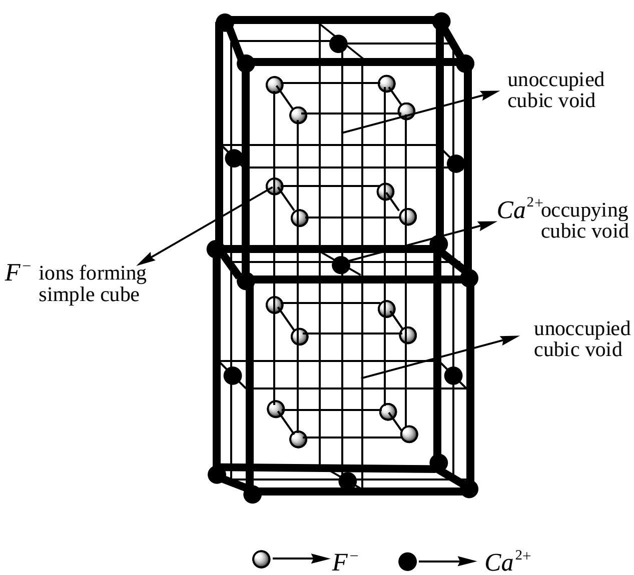
38. In osazone formation C_1 & C_2 both carbon's are involved rest of the skelton is identical.



39.

40. Mirror image of D-Galactose is L-Galactose.

41.



Radius ratio for body centred cubic void is 0.732 to 1. Since radius ratio of $\left(\dfrac{r_{Ca^{+2}}}{r_{F^-}}\right) = 0.8$ Ca^{+2} will occupy cubic void, but they occupy alternate cubic void (half of cubical void) (each Ca^{+2} is surrounded by $8F^-$ ion forming a cube). In expanded view this structure appears like that Ca^{+2} are forming a FCC lattice and F^- occupy all tetrahedral void.

42. $a = 2[83+167] = 500\,pm$

$$\delta = \frac{Z \times M}{N_A \times a^3 \times 10^{-30}} = \frac{4 \times M}{6.02 \times 10^{23} \times [500]^3 \times 10^{-30}} = 4$$

M=75.25 gm/mole.

43. conceptual

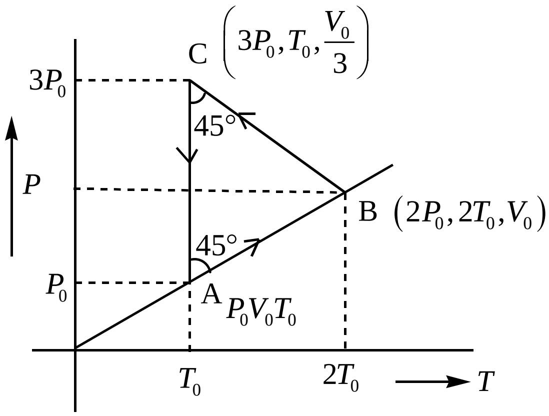
44. conceptual

PHYSICS

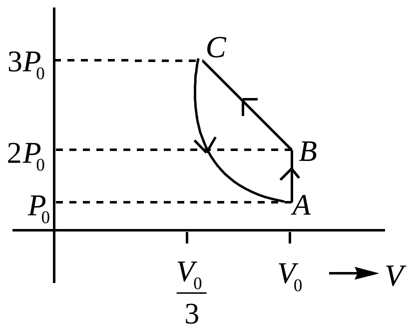
45. $1200(g+a)=\frac{1}{2}\left(2.4\times10^{8}\times3\times10^{-4}\right)$

or $a=10m/s^{2}$

46.



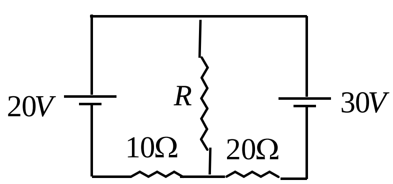
Correspond p-v curve for above process



C A is rectangular hyperbola

47. the given fig can be redrawn is

For $P_{\max}$, $R=\frac{10\times20}{10+20}\Omega=\frac{20}{3}\Omega$



48. $\rho=\frac{\pi r^{2}R}{\rho}=\frac{\frac{22}{7}\times(0.26)^{2}\times64}{156}$

$\frac{\Delta\rho}{\rho}=\frac{2\times0.2}{0.26}+\frac{2}{64}+\frac{0.1}{156}\left[\frac{2\Delta r}{r}+\frac{\Delta R}{R}+\frac{\Delta\rho}{\rho}\right]$

$\frac{\Delta\rho}{\rho}\times100=18.57\%$

49. The focus F is parallel to the line

$y=\frac{4}{3}x+C$ …….(1)

The particle moves along the line

$y=-\frac{kx}{4}+\frac{3}{4}$....... (2)

Work done is zero if the force is perpendicular to the displacement, i.e, if lines (1) and (2) are perpendicular each other. Thus the product of their slopes = -1, i.e,

$\frac{4}{3}\times\left(-\frac{k}{4}\right)=-1\Rightarrow k=3$

50. $V=\frac{work}{charge}$. Threfore $[V]=\frac{[ML^2T^{-2}]}{[AT]}$

$=[ML^2T^{-3}A^{-1}]$

$\therefore [k]=[V]\times[r]$

$=[ML^2T^{-3}A^{-1}]\times[L]$

$=[ML^3T^3A^{-1}]$

Now $E=-\frac{dV}{dr}=-\frac{d}{dr}\left(\frac{k}{r}\right)=\frac{k}{r^2}$

Hence the correct choices are (b) and (c)

51. For conservation of momentum and conservation of total energy, we have

$mu=(M+m)v....(1)$

Also $\frac{1}{2}mu^2=\frac{1}{2}(M+m)v^2+\frac{1}{2}kx^2....(2)$

$1=\frac{(M+m)v^2}{mu^2}+\frac{\frac{1}{2}kx^2}{\frac{1}{2}mu^2}$

From equation (1), we have $\frac{v}{u}=\frac{m}{(M+m)}$

Using this in eq.(2) we get

$n=\frac{\frac{1}{2}kx^2}{\frac{1}{2}mu^2}=\frac{M}{(M+m)}$

Thus the correct choices are (b) and (c).

52. The capacitors are in series, so the combined capacitance is $C'=C/2$. Therefore, energy stored is $U=\frac{1}{2}C'V^2=\frac{1}{4}CV^2$ so the correct choices are (b) and (c).

53. $F_1=k_1x, F_2=k_2x.$

Work done $W_1=\frac{1}{2}k_1x^2\ and\ W_2=\frac{1}{2}k_2x^2$

$\therefore \alpha=\frac{W_1}{W_2}=\frac{k_1}{k_2}$

When the springs are stretched by the same force F, the extensions in springs A and B are $x_1\ and\ x_2$ respectively which are given by

$$F = k_1 x_1 = k_2 \; or \; \frac{x_1}{x_2} = \frac{k_2}{k_1} ....(i)$$

Work done $W_1 = \frac{1}{2} k_1 x_1^2 \; and \; W_2 = \frac{1}{2} k_2 x_2^2$

$$\therefore \frac{W_1}{W_2} = \frac{k_1}{k_2} . \frac{x_1^2}{x_2^2} ......(ii)$$

Using (i) and (ii) we get

$$\beta = \frac{W_1}{W_2} = \frac{k_1}{k_2} . \frac{k_2^2}{k_1^2} = \frac{k_2}{k_1}$$

54. Conceptual (fact based)

55. If ρ is the density of the material of each sphere, then the mass of the sphere of radius r is

$M_1 = \frac{4\pi}{3} r^3 \rho$ and the mass of the sphere of radius $2r$ is $M_2 = \frac{4\pi}{3} (2r)^3 \rho$

Distance between their centre is $d = r + 2r = 3r$

Now $F = \frac{GM_1 M_2}{d^2} = \frac{G \times \left(\frac{4\pi}{3} \right) r^3 \rho \times \frac{4\pi}{3} (2r)^3 \rho}{9r^2}$

Which gives $F \alpha \; r^4$, which is correct is (d)

56. If a source emitting light of wavelength λ goes away from the earth, the apparent wavelength λ' of the light reaching the earth is given by

$$\frac{\lambda'}{\lambda} = 1 + \frac{\upsilon}{c}$$

Where υ is the speed of the source of light and c the speed of light. The increase in wavelength $\Delta\lambda = \lambda' - \lambda$ is given by

$$\frac{\Delta\lambda}{\lambda} = \frac{\upsilon}{c}$$

Here $\frac{\Delta\lambda}{\lambda} = 5\% = \frac{5}{100} \; and \; c = 3 \times 10^8 ms^{-1}$.

Therefore,

$$\upsilon = 3 \times 10^8 \times \frac{5}{100} = 1.5 \times 10^7 \; ms^{-1}$$

Hence $x = 7$

57. The time constant of the circuit is

$$\tau = \frac{L}{R} = \frac{100 \times 10^{-3}}{50} = 2 \times 10^{-3}$$

= 2 millisecond

Current at time t is given by

$$I = I_o \, e^{-t/\tau}$$

Where I_o is the steady current. Therefore, time for I to fall to $I_o / 2$ is

$$e^{-t/\tau} = \frac{1}{2} or \; e^{t/\tau} = 2 \; or \; t = \tau ln(2)$$

Hence x = 2

58. When the sphere rolls down the plane, its acceleration is given by

$$a = \frac{g\sin\theta}{1+\frac{I}{MR^2}}$$

Where K is the radius of gyration of the sphere about its diameter, Now, the moment of inertia of the sphere about its diameter is

$I = \frac{2}{5}MR^2$,

Therefore, $a = \frac{g\sin\theta}{1+\frac{2}{5}} = \frac{5}{7}g\sin\theta.......(i)$

For rolling without sliding, the frictional force f provides the necessary torque τ which is given by

τ =force X moment arm = fr

But $\tau = I\alpha\ where\ \alpha$ is the angular acceleration of the sphere. Thus, $I\alpha = fR$. Also, linear acceleration $a = \alpha R$ therefore,

$$f = \frac{1\alpha}{R} = \frac{Ia}{R^2} = \frac{2}{5}Ma \quad \left(\because I = \frac{2}{5}MR^2\right)$$

Now, force of friction $= \mu \times$ normal reaction $= \mu Mg\cos\theta$. Thus $\mu Mg\cos\theta = \frac{2}{5}Ma$

Or $a = \frac{5}{2}\mu g\cos\theta.......(ii)$

Equating (i) and (ii) we have

$$\frac{5}{7}g\sin\theta = \frac{5}{2}\mu g\cos\theta\ or\ \mu = \frac{2}{7}\tan\theta$$

Hence the correct choice is (d)

59. Peak value of current is

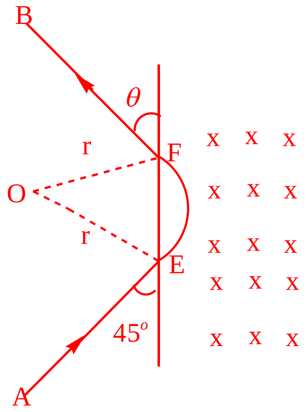
$$I_o = \sqrt{(3)^2+(4)^2} = 5A$$

$$\therefore I_{rms} = \frac{I_o}{\sqrt{2}} = \frac{5}{\sqrt{2}}A$$

60. $r = \frac{m\upsilon}{qB}$. Substituting the given values and solving

We get r= 0.1m

61. $EF = 2r\cos 45^o = \sqrt{2}r = \frac{\sqrt{2}}{10}m$



62. $r = \frac{1}{4\pi\varepsilon_0 mr} \cdot \frac{q_1 q_2}{(2kE)}$

$v^2 = \frac{q_1 q_2}{4\pi\varepsilon_0 mr} = \frac{1.6\times10^{-19}\times1.6\times10^{-19}\times9\times10^{9}}{10^{-5}\times2\times1.67\times10^{-27}}$ $\quad v = 8.3\times10^6\ m/s$

$r = \frac{mv}{qB}$ or $B = \frac{2\times1.67\times10^{-27}\times8.9\times10^{6}}{1.6\times10^{-19}\times1.25}$ $\quad B = 1.39mT$

63. $\Delta E = \Delta mc^2$

$\Delta E_1 + \Delta E_2 = \frac{0.023213\times1.66\times10^{-27}\times(3\times10^8)^2}{1.6\times10^{-19}}$

$= 21.6Mev$

64 to 66.

For string $T = fi = \frac{Mg}{4}$

Acceleration of block $a_1 = \frac{mg - mg/2}{m} = \frac{g}{2}$ *down*

Acceleration of string $a_s = 2a_1 = g\,[upward]$

Acceleration of bead $a_b = \frac{mg - \frac{mg}{4}}{m} = \frac{3g}{4}$ *downward*

Then $a_{rel} = a_s + a_b = \frac{3g}{4} + g$

Hence $t = \sqrt{\frac{2l}{a_{rel}}} = \sqrt{\frac{2\times4l}{7q}}$