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INDIAN ASSOCIATION OF PHYSICS TEACHERS

NATIONAL STANDARD EXAMINATION IN ASTRONOMY (NSEA)2023

(QUESTION PAPER CODE 42)

Date : 25/11/2023 **Time : 120 Minute** **Maximum Marks: 216**

Write the question paper code (mentioned above) on YOUR OMR Answer Sheet (in the space provided), otherwise your Answer Sheet will NOT be evaluated, Note that the same Question paper code appears on each page of the question paper.

INSTRUCTIONS

1. Use of mobile phone, smart watches, and iPad during examination is STRICTLY **PROHIBITED.**

2. In addition to this question paper, you are given OMR Answer Sheet along with candidate's copy.

3. On the OMR sheet, make all the entries carefully in the space provided ONLY in BLOCK CAPITALS as well as by properly darkening the appropriate bubbles.
Incomplete/ incorrect/ carelessly filled information may disqualify your candidature.

4. On the OMR Answer sheet, use only **BLUE or BLACK BALL POINT PEN** for making entries and filling bubbles.

5. Your **Ten-digit roll number and date of birth** entered in the OMR Answer sheet shall remain your login credentials (means login id and password respectively) for accessing your performance/result in National Standard Examination in Astronomy – 2023.

6. Question paper has two parts. In part A1 (**Q. No.1 to 48**) each question has four alternatives, out of which only one is correct. Choose the correct alternative (s) and fill the appropriate bubbles(s), as shown.

Q.No.22 (a) ● (c) (d)

In part A2 (**Q. No. 49 to 60**) each question has four alternative out of which any number of alternative (s) (1, 2, 3, or 4) may be correct. You have to choose all correct alternative(s) and fill the appropriate bubbles(s), as shown

Q.No.54 (a) ● (c) ●

7. For **Part A1,** each correct answer carries 3 marks whereas 1 mark will be deducted for each wrong answer. In **Part A2,** you get 6 marks. If all the correct alternative are marked. No negative marks in this part.

8. Rough work should be done only in the space provided. There are __printed pages in this paper.

9. Use of **non-programmable scientific** calculator is allowed

10. No candidate should leave the examination hall before the completion of the examination.

11. After submitting answer paper, take away the question paper & candidate's copy of OMR for your reference
Please DO NOT make any mark other than filling the appropriate bubbles properly in the space provided on the OMR answer sheet.
OMR answer sheets are evaluated using machine, hence CHANGE OF ENTRY IS NOT ALLOWED, Scratching or overwriting may result in wrong score.
DO NOT WRITE ON THE BACK SIDE OF THE OMR ANSWER SHEET.

Name of Student :...

Batch : ....

Enrolment No. | | | | | | | | | | | | | | | | |

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INDIAN ASSOCIATION OF PHYSICS TEACHERS

NATIONAL STANDARD EXAMINATION IN ASTRONOMY (NSEA) 2023

PAPER CODE -42

Date of Examination – 25th November, 2023

SOLUTIONS

Attempt All Sixty Questions

(NSEA) PART : A–1

ONLY ONE OUT OF FOUR OPTIONS IS CORRECT, BUBLE THE CORRECT OPTION.

[:Q.1] Sunspots are

[:A] relatively cool compared to the photosphere

[:B] related to convection cells

[:C] related to the Sun's electric field

[:D] cyclonic storms similar to Jupiter's great red spot

[:ANS] **A**

[:SOLN] Sunspots are cooler than the surface sun.

[:Q.2] A planet moves fastest in its orbit

[:A] when it is in opposition

[:B] when it is closest to the Sun

[:C] the greater its mass

[:D] when it is farthest from the Sun

[:ANS] **B**

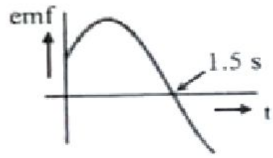
[:SOLN] Angular momentum of planet remains constant.

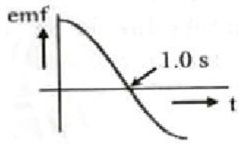
L = mvr = Constant

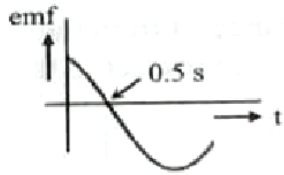
vr = Constant

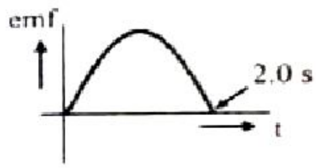
v is maximum when r is minimum.

[:Q.3] A square loop of side 10 cm and resistance 0.5Ω is placed vertically in the east – west (x – z) plane. A uniform magnetic field of strength B = 0.17' is set up across the plane of the coil in the north – south direction. The coil is rotating about a vertical axis $\left(\vec{\omega} \| \hat{k}\right)$ through its center at the rate of one rotation per 4 second. At time t = 0, the plane of the coil makes an angle $\theta = +45°$ with the east west (x – z) plane. The correct schematic diagram giving the emf induced in the coil is

[:A] 

[:B] 

[:C] 

[:D] 

[:ANS] **C**

[:SOLN] $\phi_B = B_H A \cos\left(\frac{2\pi}{4}t + \frac{\pi}{4}\right)$

$$e = \frac{-d\phi_B}{dt} = B_H A \frac{\pi}{2} \sin\left(\frac{\pi}{2}t + \frac{\pi}{4}\right) = e_o \sin\left(\frac{\pi}{2}t + \frac{\pi}{4}\right)$$

Correct group is (A)

[:Q.4] In 1912 Henrietta Leavitt making observation of Cepheid variable stars in the Magellanic clouds discovered the period luminosity relation – fainter stars have shorter periods. The relation between the apparent magnitude m (the measured magnitude of a star situated at its actual distance D pc) and its absolute magnitude M (its magnitude if located at a distance of 10 pc) is given by the magnitude distance relation m – M log D – 5 . Here D is the distance in parsec. The distance from Milky Way to the Andromeda galaxy is 765 kpc. The observed period luminosity relation determined by observations in the K band for Cepheid variables in the Andromeda galaxy is $m_K = -3.26(\log P - 1) + 18.73$ with slope – 3.26 and zero – point 18.73. For Cepheids in the Milky Way $M_k = -3.26(\log P - 1) + c$ where c is approximately

[:A] -5.69

[:B] 5.67

[:C] +18.73

[:D] -10.67

[:ANS] **A**

[:SOLN] The relation between the apparent magnitude m & it's obsolute magnitude M is given by

$m - M = 5 \log D - 5$

Where, D is in parsec

& given that, $m_K = 3.26 (\log P - 1) + 18.73$

& $M_K = -3.26 (\log P - 1) + C$

Here

$m_K - M_K = 5 \log D - 5$

& D is given 765 KPC

$= 765 \times 10^3$ PC

$\Rightarrow M_K = m_K + 5 - 5\log D$

$M_K = -3.26(\log P - 1) + 18.73 + 5 - 5\log(765 \times 10^3)$

$\Rightarrow M_K = -3.26(\log P - 1) - 5.69$

So,

$C = -5.69$

[:Q.5] A Red Giant star of mass $M_{RedGiant}$ and a White Dwarf star of mass $m_{WhiteDwarf}$ from a binary system and are rotating in circular orbits around their common centre of mass with a period of one year. The White Dwarf is orbiting just within the photosphere of the Red Giant star. The Red Giant has radius of 3.6 AU. An estimate for the mass of the Red Giant star in solar mass units is (note the $m_{WhiteDwarf} << M_{RedGiant}$)

[:A] 188

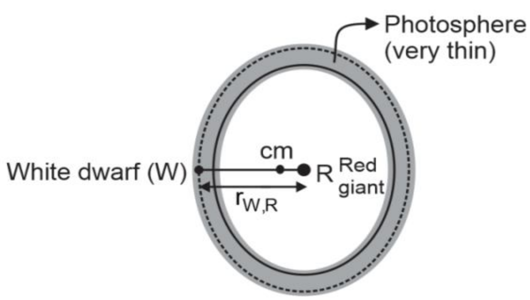
[:B] 94

[:C] 47

[:D] 13

[:ANS] **C**

[:SOLN]



According to question the time period of binary system = 1 year

Which is equal to time period of revolution of earth around sun.

Therefore ,

$T_{binary\ system} = T_{earth,\ sun}$

$$\frac{2\pi}{\sqrt{G(M_R + m_W)}} r^3_{W,R} = \frac{2\pi}{\sqrt{GM_S}} r^3_{e,S}$$

Here, $r_{R,W} = 3.6\,\text{Au}$ and $r_{e,S} = 1\,\text{Au}$

Therefore, $\frac{M_R + m_W}{M_S} = \left(\frac{r_{W,R}}{r_{e,S}}\right)^3$

But $m_W << M_R$

$\therefore \frac{M_R}{M_S} = \left(\frac{3.6}{1}\right)^3 = 46.66 \approx 47$

[:Q.6] The relation R on Z the set of integers, defined by $(x, y) \in R$ if and only if $xy \neq 0$ is

[:A] Reflexive, symmetric and transitive

[:B] Reflexive, symmetric but not transitive

[:C] Symmetric, transitive but not reflexive

[:D] Transitive, reflexive but not symmetric

[:ANS] **C**

[:SOLN] $x \cdot x \neq 0 \rightarrow$ Not true for all $x \in Z$

(False for $x = 0$)

Let $xy \neq 0$, then $yx \neq 0 \rightarrow$ Always true

Let $xy \neq 0$, $yz \neq 0$, then $xz \neq 0 \rightarrow$ Always true

[:Q.7] A is a 3×3 non – singular matrix such that $A^4 = 4A$. What is the determinant of A?

[:A] 0

[:B] 4

[:C] 16

[:D] 64

[:ANS] **B**

[:SOLN] $A^4 = 4A$

$\Rightarrow |A^4| = |4A|$

$\Rightarrow |A|^4 = 4^3|A|$

$\Rightarrow |A|^4 - 64|A| = 0$

$\Rightarrow |A|\left(|A|^3 - 64\right) = 0$

Since A is non-Singular

$\therefore \quad |A| = 4$

[:Q.8] In spectroscopy doublet lines are closely spaced spectral lines the arise from transitions from a common fundamental state to states which differ only in their total angular momentum value. If a source of light is moving away from us the light from the source will appear shifted to the longer wavelength (red) side of the spectrum. The shift is quantified by the redshift $z-\frac{\Delta\lambda}{\lambda}=\frac{v}{c}$, where λ is the observed wavelength of the spectral line when the emitting source is at rest with respect to the observer and $\Delta\lambda$ is the observed shift in the wavelength. Hubble observed the spectral lines of galaxies not very close to us are redshifted. A galaxy is showing a redshift of z = 0.005. The observed wavelength separation, in nanometre. Of the sodium doublet ad 589 and 589.6 nm and of the potassium doublet at 766.5 and 769.9 nm in the spectrum of the galaxy are respectively

[:A] 0.603, 3.417

[:B] 0.003, 0.017

[:C] 38.33, 29.45

[:D] 38.33, 38.5

[:ANS] **A**

[:SOLN] $\Delta\lambda = z\lambda$

$\lambda^1 - \lambda = z\lambda$

$\lambda^1 = (z+1)\lambda$

Separation between observed wave length of doublet-

$\Delta\lambda^1 = (z+i)\lambda_2 - (z+1)\lambda_1$

$\Delta\lambda^1 = (z+1)(\lambda - \lambda_1)$

For sodium doublet-

$\Delta\lambda^1 = (0.005+0.1)(589.6-589)$

$\Delta\lambda^1 = 1.005 \times 0.6 = 0.603$ nm

For potassium doublet

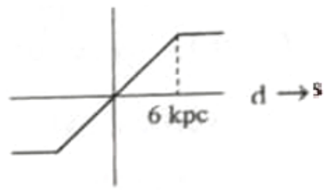
$\Delta\lambda^1 = 1.005 \times [769.9 - 766]$

= 1.005 × 3.4

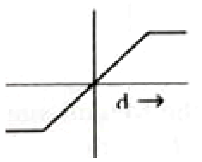
= 3.417 nm

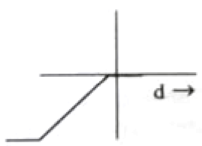
→ a

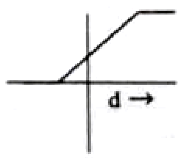
[:Q.9] The rotation curve of a spiral galaxy gives the 'instantaneous' local mean tangential velocity in the plane of the galaxy of stars / gas clouds in the galaxy lying along a line through the centre of the galaxy, with respect to the distant quasars as observed from the centre of the galaxy. The following is a schematic diagram of the rotation curve of a particular spiral galaxy.

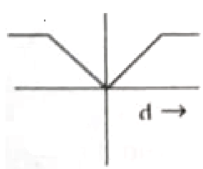


As measured from a star orbiting at a distance r = 8 kilo parsec from the centre, which one of the following diagrams gives a schematic representation of the mean tangential velocity v(d) with which objects at various distances d from the star, along the line joining the star to the centre of the galaxy, will appear to move with respect to the distant quasars?

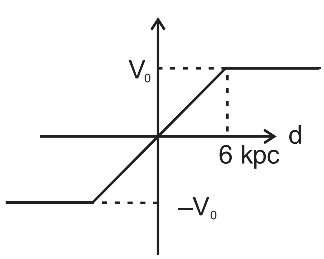
[:A] 

[:B] 

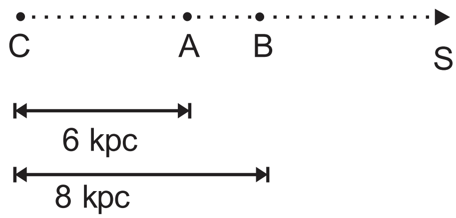
[:C] 

[:D] 

[:ANS] **B**

[:SOLN] 

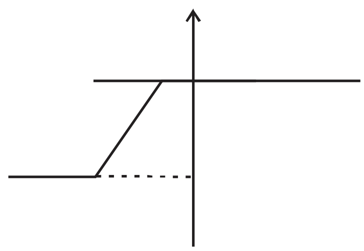
Let C : Centre of Galaxy



All points to the right of A have the same velocity.

→ with respect to B, all the points with position $(-2\text{ kpc}, \infty)$ will have zero velocity.

So, The whole graph would be shifted downward by v_0 when seen with respect to B.



[:Q.10] The number of real values of θ that satisfy the equation $\sin^2\theta - 5\sin\theta + 6 = 0$ is

[:A] 0

[:B] 1

[:C] 2

[:D] 3

[:ANS] **B**

[:SOLN] $\text{Sin}^2\theta - 5\sin\theta + 6 = 0$

$\Rightarrow \sin^2\theta - 3\sin\theta - 2\sin\theta + 6 = 0$

$\Rightarrow \sin\theta(\sin\theta - 3) - 2(\sin\theta - 3) = 0$

$\Rightarrow (\sin\theta - 3)(\sin\theta - 2) = 0$

$\Rightarrow \sin\theta = 3, 2 \rightarrow$ This is not possible as range of sinx ix [–1, 1]

[:Q.11] If z is a complex number such that $\frac{z-2}{z+2} = i$, the value of $|z|$ is

[:A] 0

[:B] 1

[:C] 2

[:D] 3

[:ANS] **C**

[:SOLN] $\frac{(x-2)+iy}{(x+2)+iy}=i$

$(x-2)+iy=(x+2)i-y$

$X-2=-y \quad x+2=y$

$x-y=-2$

$x+y=2$

$2x=0$

$x=0 \;;\; y=2$

$z=x+iy \;;\; z=2i$

$|z|=2$

[:Q.12] The number of positive divisors of 202300 is

[:A] 8

[:B] 18

[:C] 26

[:D] 54

[:ANS] **D**

[:SOLN] $202300=2^2\times5^2\times7\times17^2$

No. of ⊕ ve Divisors = $(2+1)(2+1)(1+1)(2+1)$

$=3\times3\times2\times3=54$

[:Q.13] For what values of a and b is the following function continuous at x = 2 ?

$$f(x)=\begin{cases} ax^2+bx+1 & \text{if } x\geq 2 \\ 3 & \text{if } x=2 \\ bx^2-ax-11 & \text{if } x<2 \end{cases}$$

[:A] a = 1, b = 9

[:B] a = 2, b = 12

[:C] a = -1 ,b = 3

[:D] a = -3, b = -3

[:ANS] **C**

[:SOLN] $4a+2b+1=3$; $4a+2b=2$; $2a+b=1$ ....(i)

$-2a+4b-11=3$; $-2a+4b=14$; $a-2b=-7$ ....(ii)

$2a+b=1$ .....(i) $\times 2$

$a-2b=-7$ .....(ii)

$5a=-5$

: a = –1 b = 3

[:Q.14] The value of the integral $\int_0^{\pi} |\cos 2x|\,dx$ is

[:A] 0

[:B] 1

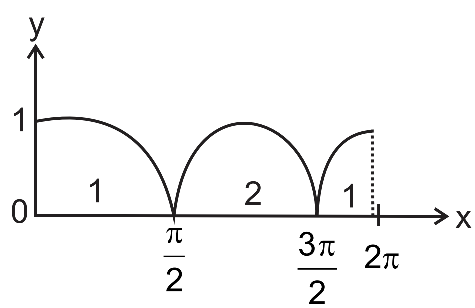
[:C] 2

[:D] 3

[:ANS] **C**

[:SOLN] $\int_0^{\pi} |\text{Cos}\,2\,x|\,dx$

Let 2 x = t $\Rightarrow$ 2dx = dt $\Rightarrow \frac{1}{2}\int_0^{\pi} |\text{Cos}\,t|\,dt = (1+2+1)/2 = (4)/2 = 2$



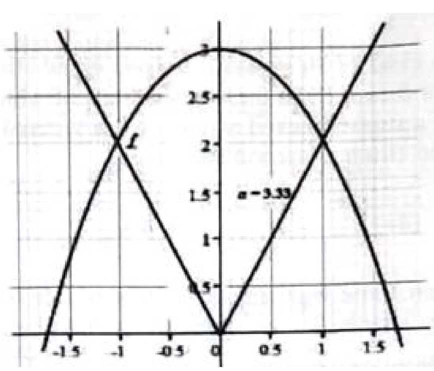
[:Q.15] The area bounded by $y=3-x^2$ and $y=2|x|$ is

[:A] $\frac{5}{3}$

[:B] $\frac{8}{3}$

[:C] $\frac{10}{3}$

[:D] $\frac{16}{3}$



[:ANS] **C**

[:SOLN] Area of region $= 2\int_0^1 \left(3 - x^2 - 2x\right) dx$

$$= 2\left[3x - \frac{x^3}{3} - x^2\right]_0^1$$

$$= 2\left[3 - \frac{1}{3} - 1\right] = \frac{10}{3}$$

[:Q.16] Two unbiased dice are thrown simultaneously. What is the probability that both the dice show prime numbers?

[:A] $\frac{7}{36}$

[:B] $\frac{1}{12}$

[:C] $\frac{1}{6}$

[:D] $\frac{1}{4}$

[:ANS] **D**

[:SOLN] Both are independent so probability $= \frac{3}{6} \times \frac{3}{6} = \frac{1}{4}$

[:Q.17] The differential equation $\frac{dy}{dx} = \frac{y}{x}$ represents

[:A] a family of concurrent straight lines

[:B] a family of straight lines passing through (1, 1)

[:C] a family of straight lines parallel to X – axis

[:D] a family of straight lines parallel to Y – axis

[:ANS] **B**

[:SOLN] $\frac{dy}{dx} = \frac{y}{x}$

$$\frac{dy}{y} = \frac{dx}{x}$$

$$\int \frac{dy}{y} = \int \frac{dx}{x}$$

$$\ln y = \ln x + \ln c$$

$$\therefore\ y = cx$$

Family of straight lines which are concurrent at (1,1)

[:Q.18] The volume of a magical right circular cylinder of fixed height changes at a constant rate. Initially, the base radius was 3 units and it changed to 6 units in 3 seconds. What is the radius of the base at time t ?

[:A] $3\sqrt{\pi t+1}$

[:B] $3\sqrt{t+1}$

[:C] $3\sqrt{t+\pi}$

[:D] $3\sqrt{\pi t+\pi}$

[:ANS] **B**

[:SOLN] $\frac{dy}{dt}=k \Rightarrow v=kt+c$

At t = 0, r = 3, v = $9\pi h$

At t = 3, $r=\pi 6^2 h=36\pi h$

$36\pi h=3k+9\pi h \quad \therefore k=9\pi h$

At t second v = kt + c

$\therefore \pi r_1^2 h=9\pi ht+9\pi h$

$r_1^2=9t+9$

$\therefore r_1=3\sqrt{t+1}$

[:Q.19] The Lane Emden equation $\frac{1}{x^2}\frac{d}{dx}\left(x^2\frac{dy}{dx}\right)+y^n=0$, is the governing equation for a crude model for a star. Here the star is treated as a sphere of gas with a polytropic equation of state. The differential equation admits exact solution for polytropic index n = 0, 1 and 5 as $y(x)=1-\frac{x^2}{6},\frac{\sin x}{x}$ and $\frac{1}{\sqrt{1+\frac{x^2}{3}}}$. The value of $x=x_0$ is such that $y(x_0)=0$ defines the surface of the star. The quantity $R=\frac{x_0^3}{3\left|-x^2\frac{dy}{dx}\right|_{x_0}}$ gives $\frac{\rho_{central}}{\rho_{average}}$ the ratio of the central density to the average density for the model star. $\left|-x^2\frac{dy}{dx}\right|_{x_0}$ means the value of $-x^2\frac{dy}{dx}$ evaluated at x_0. The value of R for n = 0, 1 are

[:A] $1, \frac{\pi}{3}$

[:B] $\sqrt{6}, \frac{\pi}{3}$

[:C] $\propto, \frac{\pi^2}{3}$

[:D] $1, \frac{\pi^2}{3}$

[:ANS] **D**

[:SOLN] *

[:Q.20] The logistic map interatively maps x_{n+1} to $n_n (n = 0, 1, 2 \ldots \ldots \ldots. \ldots. \ldots.)$ through the equation $x_{n+1} = \lambda x_n (1 - x_n)$. Consider the two different initial values: $x_0 = 0.25$ and $x_0' = x_0 + 0.01 = 0.26$. For $\lambda = 3.25$, the difference between the second iterates $(x_2' - x_2)$ is approximately

[:A] 0.01

[:B] –0.01

[:C] 0.02

[:D] 0.001

[:ANS] **A**

[:SOLN] $x_{n+1} = 3.25 \times x_n (1 - x_n)$

At n = 0

$x_1 = 3.25 \times x_0 (1 - x_0) = 0.609375$

At n = 1

$x_2 = 0.7736$

$x_0^1 = x_0 + 0.01 = 0.26$

$x_1^1 = 0.6253$

$x_2^1 = 0.7613 \quad \therefore x_2^1 - x_2 \approx 0.01$

[:Q.21] In a class of 40 students 25 have opted Hindi as second language (event A). 35 students got first class (event B) in the examinations of which 20 had taken Hindi as second language. It is found that a student picked at random has secured first class. The probability P(A/B) that this student has taken Hindi as second language is

[:A] $\frac{4}{7}$

[:B] $\frac{5}{8}$

[:C] $\frac{7}{8}$

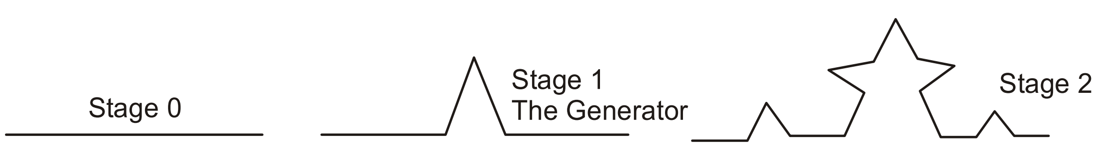
[:D] $\frac{1}{2}$

[:ANS] **A**

[:SOLN] $P(A) = \frac{25}{40} = \frac{5}{8}, P(B) = \frac{35}{40} = \frac{7}{8}$

$P(A \cap B) = \frac{20}{40} = \frac{1}{2}, \therefore P(A/B) = \frac{P(A \cap B)}{P(A)} = \frac{4}{7}$

[:Q.22] When a line segment/square/cube of side length L is measured using a line segment/square/cube of side length ℓ, the number N of line segments/square/cubes covering the original line segment/square/cube is given by $\left(\frac{L}{\ell}\right), \left(\frac{L}{\ell}\right)^2, \left(\frac{L}{\ell}\right)^3$ respectively. Define the dimension of an object as $D = [-\log(N)/\log(\ell)]$ as $\ell \to 0$. Then n = 0, n = 1 and n = 2 steps of iteration of the process of obtaining the fractal curve called a Koch curve, of stretching and bending the middle one third of a line segment (of length L) into a triangle shape of side length L/3 is shown in the figure; in the second (n = 2) iteration each of the 4 line segments of length L/3 will have their middle one third stretched and bend into triangle shapes of side $\ell = L/(3 \times 3)$. After n iterations the total number N of line segments of length $\ell = L/3^n$ making up the figure will be 4^n. The dimension D of the Koch curve, obtained as $n \to \infty$ (i.e. as $\ell \to 0$) is



[:A] $\frac{\log 4}{\log 3}$

[:B] $\log\left(\frac{4}{3}\right)$

[:C] 1

[:D] 1.3

[:ANS] **A**

[:SOLN]*

[:Q.23] Consider the two sets G = {1, i, – i, –1} and G' = $\{R_{\pi/2}, R_{\pi}, R_{3\pi/2}, R_{2\pi}\}$, where R_θ stands for rotation of a square by angle θ in the anticlockwise direction about an axis through its centre and perpendicular to its plane. If product of two elements of G is taken by complex multiplication and the product of two elements of G' are taken as $R_\theta\, R_\varphi = R_{\theta+\varphi}$, then, under which of the following mapping between G and G' do the product relations hold unchanged?

[:A] $\begin{pmatrix} g_1 & \to & g_1' \\ g_2 & \to & g_2' \\ g_3 & \to & g_3' \\ g_4 & \to & g_4' \end{pmatrix}$

[:B] $\begin{pmatrix} g_1 & \to & g_4' \\ g_2 & \to & g_1' \\ g_3 & \to & g_3' \\ g_4 & \to & g_2' \end{pmatrix}$

[:C] $\begin{pmatrix} g_1 & \to & g_3' \\ g_2 & \to & g_4' \\ g_3 & \to & g_1' \\ g_4 & \to & g_2' \end{pmatrix}$

[:D] $\begin{pmatrix} g_1 & \to & g_2' \\ g_2 & \to & g_3' \\ g_3 & \to & g_4' \\ g_4 & \to & g_1' \end{pmatrix}$

[:ANS] **B**

[:SOLN] $G=\{1, i, -i, -1\}$

$$G'=\left\{R_{\pi/2}, R_{\pi}, R_{\frac{3\pi}{2}}, R_{2\pi}\right\},\ \text{as}\ R_{\theta}=\cos\theta+i\sin\theta$$

$1\rightarrow 2\pi$

$i\rightarrow \pi/2$

$-i\rightarrow 3\pi/2$

$-1\rightarrow \pi$

$\therefore g_1\rightarrow g_4', g_2\rightarrow g_1', g_3\rightarrow g_3', g_4\rightarrow g_2'$

[:Q.24] The objective of a reflecting telescope is a concave mirror of focal length 750 mm. To double the magnification, a concave lens of focal length 20 mm is placed near the focus of the primary mirror. What should be the position of the eyepiece focus from the concave lens?

[:A] 10 mm away from mirror

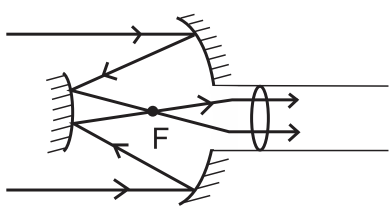
[:B] 10 mm towards mirror

[:C] 20 mm away from mirror

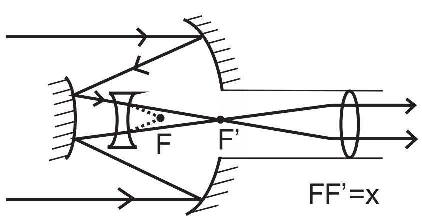
[:D] 20 mm towards mirror

[:ANS] **A**

[:SOLN]



When lens is introduced



For concave lens-

F is object and F' is image

Let OF = x then OF'=Mx

= 2x

From lens formula

$$\frac{1}{2x} - \frac{1}{x} = -\frac{1}{20}$$

$$\frac{-1}{2x} = \frac{-1}{20}$$

x = 10 mm

[:Q.25] On the basis of Bohr of atomic structure, the total energy required to remove both electrons from the helium atom in its ground state is 79 eV. How much energy is required to ionize helium I,e to remove the first electron?

[:A] 79.0 eV

[:B] 54.4 eV

[:C] 39.5 eV

[:D] 24.6 Ev

[:ANS] **D**

[:SOLN] Energy required to remove second electron

$$= 13.6 \times \frac{Z^2}{n^2} = 54.4 \text{ eV}$$

→ energy required to remove first e° = (79 – 54.4) eV

= 24.6 eV

[:Q.26] Five positive charges, each of magnitude q, are arranged symmetrically on the circumference of circle of radius r. The magnitude to the electric field E at the center of the circle is

[:A] Zero

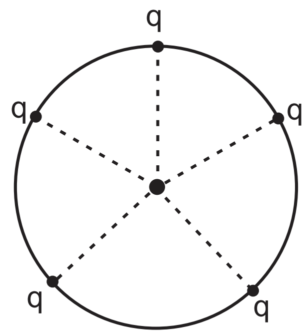
[:B] $\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

[:C] $\frac{1}{\pi\varepsilon_0}\frac{q}{r^2}$

[:D] $\frac{5}{4\pi\varepsilon_0}\frac{q}{r^2}$

[:ANS] **A**

[:SOLN]



Due to mutual repulsion, separate between changes will be identical they will stay summetrical

As they are summetrical, so

$\vec{E}_{net} = 0$

[:Q.27] A particle is constrained to move along a circle of radius R = 1.0 m. At certain instant of time, the speed of the particle is 1.0 m/s and the speed is increasing at the rate of 1.0 m/s^2. The angle (in radian) between the velocity and the acceleration vectors of the particle is

[:A] Zero

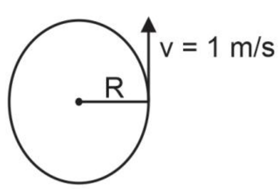
[:B] $\frac{\pi}{6}$

[:C] $\frac{\pi}{4}$

[:D] $\frac{\pi}{2}$

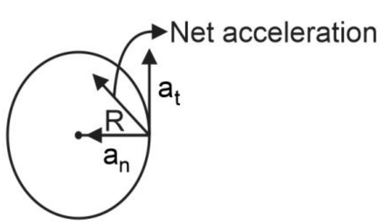
[:ANS] **C**

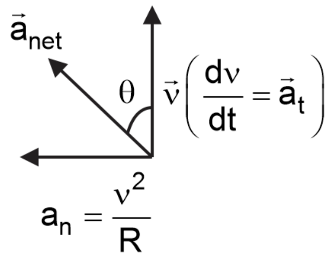
[:SOLN]



$\Rightarrow R = 1m$

$\frac{dv}{dt} = 1 m/s^2$



$\Rightarrow$ 

$$\Rightarrow \quad \tan\theta = \frac{|\vec{a}_n|}{|\vec{a}_t|} = \frac{v^2}{R\left(\frac{dv}{dt}\right)} = \frac{1^2}{1\times 1}$$

$$\tan\theta = 1$$

$$\Rightarrow \quad \theta = \frac{\pi}{4} \quad \text{Ans.}$$

[:Q.28] A certain amount of helium gas is expanded adiabatically to one and half times of its initial volume. If the initial temperature is 27°C, the final temperature of the gas will be

[:A] + 3.6°C

[:B] – 5.8°C

[:C] – 10.9°C

[:D] – 44.1°C

[:ANS] **D**

[:SOLN] Adiabatic process : $Tv^{\gamma-1} = \text{constant}$

For (helium) (Monoatomic) $r = \frac{5}{3}$

$$\Rightarrow \quad T_i v_i^{\gamma-1} = T_f v_f^{\gamma-1} \quad \left[\text{given that } v_f = \frac{3}{2} v_i\right]$$

$$\Rightarrow \quad T_i = 27°C = 273 + 27 = 300K$$

$$\Rightarrow \quad (300K)(v_i)^{\frac{5}{3}-1} = T_f (v_f)^{\frac{5}{3}-1}$$

$$\Rightarrow \quad (300K)\left(\frac{2}{3}\right)^{2/3} = T_f$$

$$\Rightarrow \quad T_f = 228.9K$$

$$\Rightarrow \quad T_f = 228.9 - 273 = -44.1°C$$

[:Q.29] Absorbing a neutron, $^{235}_{92}U$ undergoes fission producing two fragments in the intermediate atomic mass range namely $^{89}_{36}Kr$ and $^{144}_{56}Ba$ along with three neutrons and energy. By what factor is the size of the produced $^{144}_{56}Ba$ nucleus smaller that of the $^{235}_{92}U$ nucleus?

[:A] 0.61

[:B] 0.72

[:C] 0.78

[:D] 0.85

[:ANS] **D**

[:SOLN] Fission reaction,

$${}_{92}U^{235} + {}_0n^1 \to {}_{56}Ba^{144} + {}_{36}Kr^{89} + 3\,{}_0n^1 + Q$$

$$\text{Volume Size ratio} = \frac{4\pi R_{Ba}^3}{4\pi R_U^3} = \left(\frac{R_{Ba}}{R_U}\right)^3$$

And we know that $R^3 \propto A$ atomic m_{ay}.

$$\Rightarrow \left(\frac{R_{Ba}}{R_U}\right)^3 = \left(\frac{A_{Ba}}{Au}\right) = \frac{144}{235} = 0.61$$

and size ratio mean radius

ratio i.e. $\frac{R_{Ba}}{R_U} = (0.61)^{1/3} = 0.85$

[:Q.30] A small wooden block of mass 2 kg is dropped from a height h = 40 cm on a vertical spring of force constant k = 1960 N/m. The maximum compression of the spring is

[:A] 0.1 cm

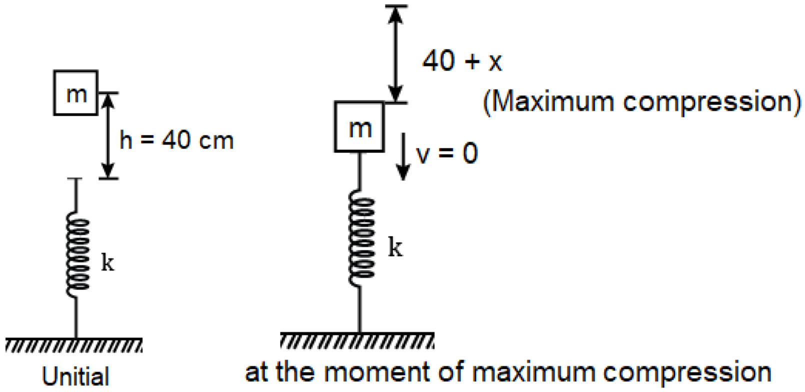
[:B] 1.0 cm

[:C] 10.0 cm

[;D] 23.0 cm

[:ANS] **C**

[:SOLN] Given that, m = 2 kg, h = 0.4 m and k = 1960 N/m



So, By work energy theorem,

$\Delta K \cdot E + \Delta U = 0$ (All forces are com.... have)

$\Rightarrow \quad 0 + \Delta U_{spring} + \Delta U_{gravity} = 0$

$\Rightarrow \quad 0 + \left(\frac{1}{2}kx_1^2 - 0\right) + \left(-mg(0.4 + x)\right) = 0$

$\Rightarrow \quad kx^2 - 2mgx - 2mg(0.4) = 0$

After solving we will get

X = 0.1 m = 10 cm

[:Q.31] The intensity level of a particular sound source is increased by 10 dB, the corresponding change is the amplitude of the sound wave is

[:A] $\sqrt{10}$ times

[:B] $10\sqrt{10}$ times

[:C] 10 times

[:D] 100 times

[:ANS] **A**

[:SOLN] As we know that for sound wave

(Intensity) $\propto$ (Amplitude)^2

$\Rightarrow$ Let unitial intensity = I_0

Then, according to Question

Intensity level is increased by 10 dB

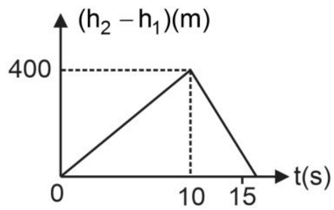
i.e. $10\log\left(\frac{I_f}{I_0}\right) = 10\log\left(\frac{I_i}{I_0}\right) + 10$

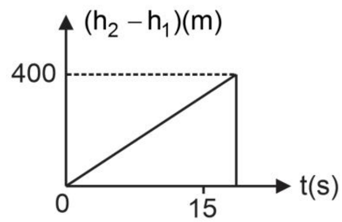
$\Rightarrow \quad 10\log\left(\frac{I_f}{I_i}\right) = 10$

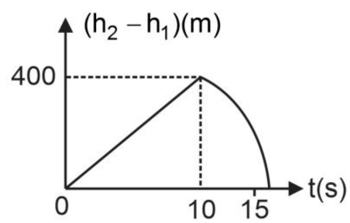
$\Rightarrow \quad \frac{I_f}{I_i} = 10$

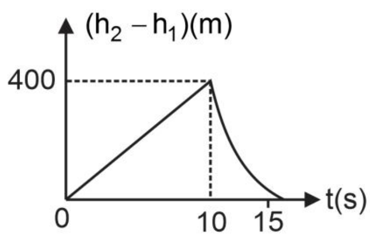
So, $\frac{I_f}{I_i} = \left(\frac{A_f}{A_i}\right)^2 \Rightarrow \sqrt{10} = \frac{A_f}{A_i} \Rightarrow \sqrt{10}$ times

[:Q.32] Two stones of equal mass are thrown vertically up simultaneously from the edge of a cliff 400 m high with initial speeds of $v_1 = 10\,\text{ms}^{-1}$ and $v_2 = 50\,\text{ms}^{-1}$ respectively. Which of the following graphs best represents the time variation of relative position [height $(h_2 - h_1)$] of the second stone with respect of the first? (Assume that the stones are not obstructed at the cliff while going down and do not rebound after hitting the ground. Also ignore the small horizontal separation between the stones as well as air resistance, take g = 10 ms^{-2})

[:A]


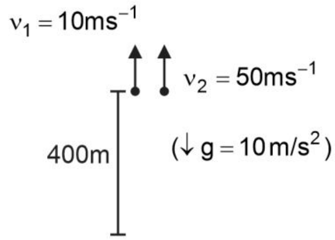
[:B]


[:C]


[:D]


[:ANS] **C**

[:SOLN]



Motion of first particle is straight line with respect to second particle till the first particle strikes ground at a time given by

$$-400 = 10t - \frac{1}{2}\times 10 \times t^2$$

$\Rightarrow$ $t^2 - 2t - 80 = 0$

$\Rightarrow$ $t^2 - 10t + 8t - 80 = 0$

$t = 10, -8x$

Thus, distance covered by second particle with respect to first particle in 10 seconds is

$|S_{12}| = (\nu_{21})\,t = (50-10)\times 10$ (become relation acceleration till that moment = 0)

$\Rightarrow$ $= 40 \times 10 = 400\,m$

Similarly time taken by second particle to strike the ground is given by,

$$-400 = 50t - 5t^2$$

$\Rightarrow$ $t^2 - 10t - 80 = 0$

$t = 15.247$

Thus, for graph,

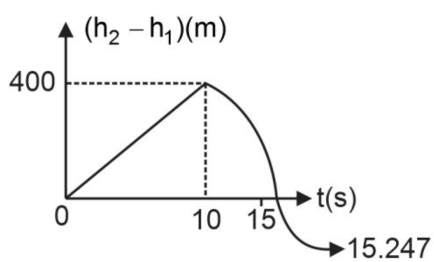
For $t \le 10$

$y_2 - y_1 = 40t$

and for $t > 10$

$$y_2 - y_1 = h_2 - h_1 = 400 + \left(50t - \frac{1}{2}gt^2\right) - 400$$

$h_2 - h_1(m)$



[:Q.33] A crow is sitting on a standard electric power line. The crow is not affected by the potential drop across its feet because

[:A] it has non-conducting pads at the bottom of its feet

[:B] the potential drop is too small for any significant current to flow through its body

[:C] the crow is carefully sitting on the neutral line

[:D] none of the above

[:ANS] **B**

[:SOLN] Potential difference between two points in an electric field –

$\Delta V = Ed$

As the separation between the feet of the crow is very small there fore potential difference is also very small. As a result small current passes through the body of crow.

[:Q.34] Standing waves have been produced in a 51 cm long, open end organ pipe with just one node with-in the pipe. The wavelength of the sound wave, which forms a standing wave in the same organ pipe such that there are three nodes within the pipe, is

[:A] 68 cm

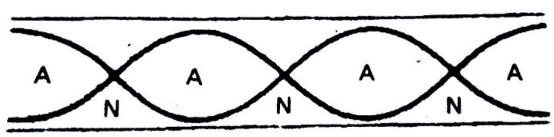
[:B] 51 cm

[:C] 34 cm

[:D] 20.4 cm

[:ANS] **C**

[:SOLN]



$l = \frac{3}{2}\lambda$

Here $\ell = 51\,\text{cm}$

Therefore $\lambda = \frac{102}{3} = 34\,\text{cm}$

[:Q.35] For the air-glass interface if the Brewster angle (polarizing angle) is ϕ_p, then the critical angle (i_e) for the glass-air interface is expressed as

[:A] $\sin^{-1}(\tan\phi_p)$

[:B] $\cos^{-1}(\tan\phi_p)$

[:C] $\sin^{-1}(\cot\phi_p)$

[:D] $\cos^{-1}(\cot\phi_p)$

[:ANS] **C**

[:SOLN] Form Brewster law,

$\tan\phi_p = \mu$

Now, critical angle is given as

$$\theta_c = \sin^{-1}\left(\frac{1}{\tan\phi_p}\right)$$

$$= \sin^{-1}(\cot\phi_p)$$

[:Q.36] A gas in equilibrium attains a state of equipartition, wherein every active degree of freedom of every particle has on the average the same energy. In particular, the average translational kinetic energy will be the same for every particle; it will be equal to $\frac{3}{2}kT$ where, k is the Boltzmann constant and T is the temperature of the gas in kelvin. Consider air at 300 kelvin. If the root mean square velocity of oxygen molecules are respectively

[:A] $\left(0, \frac{\nu_{rms}}{2\sqrt{3}}\right)$

[:B] $(0, 0.94\nu_{rms})$

[:C] $\left(\frac{3}{2}\nu_{rms}, 1.07\nu_{rms}\right)$

[:D] $(0, 0.875\nu_{rms})$

[:ANS] **B**

[:SOLN] As velocity of gas molecules are in random direction therefore sum of velocity will be zero thus average value of velocity of gas molecules will be zero.

The rms velocity of gas molecule is given as

$$V_{rms} = \sqrt{\frac{3RT}{M}}$$

$$V_{rms} \propto \frac{1}{\sqrt{M}}$$

$$\frac{(V_{rms})_{O_2}}{(V_{rms})_{N_2}} = \sqrt{\frac{M_{N_2}}{M_{O_2}}}$$

A/c to question, $(V_{rms})_{N_2} = V_{rms}$

$\therefore \quad (V_{rms})_{O_2} = \sqrt{\frac{28}{32}} V_{rms} = \sqrt{\frac{7}{8}} V_{rms}$

$(V_{rms})_{O_2} = \sqrt{0.875}\, V_{rms}$

$(V_{rms})_{O_2} = 0.94\, V_{rms}$

[:Q.37] Formation of the iron peak elements $^{56}_{26}$Fe, $^{56}_{27}Co$ and $^{56}_{28}$Ni by nuclear fusion marks the end of energy production in a star. If the mass (1.4 solar masses) the core cannot be supported by the degeneracy pressure of the electrons and will collapse to form a neutron star. Matter is crushed to nuclear densities with protons combining with electrons as $P^+ + e^- \rightarrow n + \nu_e$. Neutron stars whose masses are not too high are supported by neutron degeneracy pressure pressure against gravitational collapse. The number of neutrinos released, when a neutron star of 1.4 solar masses forms, is approximately.

[:A] 7.77×10^{56}

[:B] 1.74×10^{57}

[:C] 8.68×10^{56}

[:D] 8.38×10^{57}

[:ANS] **B**

[:SOLN] $n = \frac{1.4 M_{\odot}}{M_{neutrion}}$

$= \frac{1.4 \times 2 \times 10^{30}}{1.67 \times 10^{-27}}$

$\cong 1.74 \times 10^{57}$

[:Q.38] The Seebeck coefficient of a material characterizes the voltage built up when a small temperature gradient is set up across it. It is defined by the relation $S = \frac{V_{left} - V_{right}}{T_{left} - T_{right}}$. Only the relative Seebeck coefficients of materials may be determined Since, connecting a voltmeter introduces other voltages. The relative Seebeck coefficients of some elemental materials in $\mu V / K$ are: (A) Aluminium: 3.5 (B) Carbon: 3 (C) Sodium : – 2 (D) Platinum: 0. The absolute Seebeck coefficient of Platinum is – 5 μV at room temperature. The combination of two metals which will give maximum voltage difference when used to make a thermocouple is

[:A] (a, d)

[:B] (c, d)

[:C] (a, c)

[:D] (b, c)

[:ANS] **C**

[:SOLN] Be have assumed reference metal as O, with respect to which Seebeck coefficient of different metals are given. Now according to question,

$S_{Pt,0} = 0 \quad S_{Pt} = -5$

$S_{Pt} - S_O = S_{Pt,O}$

$-5 - S_O = S_{Pt,O}$

$S_O = -5$

$\therefore S_{A\ell} = S_{A\ell,O} + S_O$

$= 3.5 - 5 = -1.5\,\mu\nu/k$

$S_C = S_{C,O} + S_O$

$= 3 - 5 = -2\,\mu\nu/k$

$S_{Na} = S_{Na,O} + S_O$

$= -2 - 5 = -7\frac{\mu\nu}{m}$

The potential difference thermo couple is given by Taylor's formula,

$$\Delta V = \left(\frac{\partial V}{\partial t}\right)_1 \Delta T + \left(\frac{\partial V}{\partial t}\right)_2 (-\Delta T)$$

In a thermo couple as we go through element -1, Let temperature increases by ΔT then when be comeback to initial point through element - 2 temperature decreases by ΔT .

$$\Delta V = (S_1 - S_2)\Delta T$$

Thus, for ΔV to be maximum, difference between absolute Seebeck coefficient must be maximum. Thus, pair of element will be Na and Al.

[:Q.39] The mean power received per unit area just outside Earth's atmosphere from the Sun known as the solar constant, is 1.362 kilowatt per square meter (kW/m^2). For receiving this much power per unit area at Earth, the Sun, if it is radiating like a black body, must have a surface temperature of

[:A] 5349 K

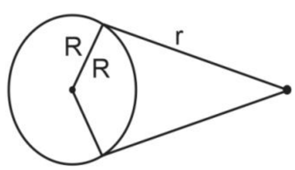
[:B] 5779 K

[:C] 5709 K

[:D] 5479 K

[:ANS] **B**

[:SOLN] $C = 1.362\ \text{kw/m}^2$



$$C = 6\left(\frac{4\pi R^2}{4\pi r^2}\right)^2 \times T^4 \quad \text{(Stefan's law)}$$

R = Radius of sun

r = Distance of earth to sun

$$\Rightarrow T^4 = \frac{C \times \left(\frac{r^2}{R^2}\right)^2}{6} (6 \rightarrow \text{sigma})$$

$$= \frac{1.362 \times 10^3 \left(\frac{r}{R}\right)^2}{5.67 \times 10^{-8}}$$

$$\Rightarrow \boxed{T \approx 5800}$$

So, option 'b' is correct.

[:Q.40] Venus has an equatorial radius of 6052 km. The semi-major axis of its orbit around the Sun is 0.72 AU. The smallest diameter of the primary mirror/lens (objective) of an optical telescope to be used to just resolve the Venus disc during the transit of Venus is approximately.

[:A] 200 cm

[:B] 20 cm

[:C] 10 cm

[:D] 0.25 cm

[:ANS] **D**

[:SOLN] $\theta = \frac{\text{arc}}{\text{Radius}}$

$\theta = \frac{6052 \times 2}{0.28\text{AU}}$

$\theta = \frac{6052 \times 200}{28 \times 1.496 \times 10^8}$ radian

$\theta = \frac{1.22\lambda}{D}$

$\frac{6052 \times 200}{28 \times 1.496 \times 10^8} = \frac{1.22 \times 500 \times 10^{-9}}{D}$

$D \Rightarrow \frac{1.22 \times 500 \times 10^{-9} \times 10^8 \times 28 \times 1.496}{6052 \times 200}$

$\Rightarrow \frac{25551.68 \times 10^{-1}}{6052 \times 200}$

$D = 0.021\,\text{m} \times \frac{1}{10} = 0.0021\,\text{m}$

D = 0.21 cm approx.

[:Q.41] The Earth's atmosphere is transparent across the most of the optical region and ………. region of the electromagnetic spectrum. Choose the correct option to fill the blank.

[:A] ultraviolet

[:B] X-ray

[:C] Some portions of the radio wave

[:D] gamma–ray

[:ANS] **A**

[:SOLN] (Ultraviolet)

[:Q.42] It is given that the pupil of the human eye is about 5 mm (in diameter). How many times more light-gathering power does a telescope with a primary mirror of diameter about 20 cm (8 inches) have than the human eye?

[:A] 4 times

[:B] 16 times

[:C] 40 times

[:D] 1600 times

[:ANS] **D**

[:SOLN] Light gathering power

$$= \pi R^2$$

$$= \frac{\pi d^2}{4}$$

So, $\Rightarrow L \propto d^2$

$$\frac{L_1}{L_2} = \frac{d_1^2}{d_2^2} = \left(\frac{5 \times 10^{-3}}{20 \times 10^{-2}}\right)^2$$

$$\frac{L_1}{L_2} = \left(\frac{5}{200}\right)^2 = \frac{1}{1600}$$

$$\Rightarrow \boxed{L_2 = 1600 L_1}$$

i.e. 1600 times.

[:Q.43] An astronomer observes a spectral emission line from a galaxy at a wavelength of 600 nm. This same spectral line is measured in the laboratory using a stationary source and is seen to have wavelength 500 nm. The speed of the galaxy toward or away from Earth. (in units of the speed of light c) is equal to

[:A] 0.2 c moving away from Earth

[:B] 0.2 c moving toward Earth

[:C] 0.9 c moving away from Earth

[:D] 1.0 c moving toward Earth

[:ANS] **A**

[:SOLN] From Doppler shift

$$\frac{\Delta\lambda}{\lambda} = \frac{V}{C}$$

$$\Rightarrow \frac{100}{500} = \frac{V}{C}$$

$$\Rightarrow \boxed{V = 0.2C}$$

It is moving away from earth.

[:Q.44] An astronomer observes that Polaris is 40 degrees above her northern horizon. What can you say about the longitude of her location from her observations?

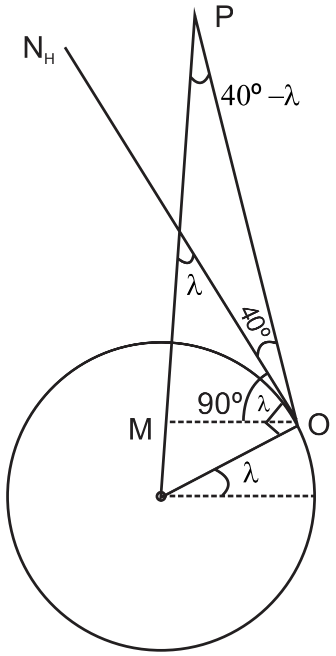
[:A] nothing

[:B] that it is 40 degrees north

[:C] that is is 50 degrees south

[:D] that it is 40 degrees east

[:ANS] **B**



[:SOLN]

In ΔPMO –

$40^\circ - \lambda + 130^\circ - \lambda + 90^\circ = 180^\circ$

$2\lambda = 80^\circ$

$\lambda = 40^\circ \rightarrow$ North

[:Q.45] The spectrum of a cloud of cool gas seen against a bright background black body would show

[:A] bright lines (emission spectrum) against a continuum spectral emission background

[:B] a continuous spectrum

[:C] dark line (absorption lines) against a continuum emission background

[:D] either bright of dark lines, depending on distance, against a continuum emission background

[:ANS] **C**

[:SOLN] Since bright background black body will absorb some of wavelength from spectrum therefore these will be dark line (absorption line) against a continuum emission background.

[:Q.46] If a star has a parallax of one–eighth of a second of arc, its distance from the earth is

[:A] 2,06,265 astronomical units

[:B] eight light years

[:C] one-eighth parsec

[:D] eight parsec

[:ANS] **D**

[:SOLN] ∵ Relation between a star's distance (d) and its parallax angle (P) is

$$d = \frac{1}{P} = \frac{1}{1/8} = 8 \text{ per sec}$$

[:Q.47] The elemental composition of the Sun, by mass, is about

[:A] 50% metals, 50% hydrogen

[:B] 71% hydrogen, 27% helium, 2% others

[:C] 75% helium, 20% hydrogen, 5% others

[:D] 75% carbon, 25% helium

[:ANS] **B**

[:SOLN] Elemental composition of sum, by mass is 71% hydrogen, 27% helium, 2% others

[:Q.48] Which of the following planets has essentially no atmosphere ?

[:A] Venus

[:B] Mercury

[:C] Jupiter

[:D] Mars

[:ANS] **B**

[:SOLN] Mercury has essentially no atmosphere because it is very near to sum

(NSEA) PART : A–2

ANY NUMBER OF OPTIONS 4, 3, 2 OR 1 MAY BE CORRECT

MARKS WILL BE AWARDED ONLY IF ALL THE CORRECT OPTIONS ARE BUBBLED.

[:Q.49] Consider the LPP (Linear Programming Problem) Max Z = x + y subject to the constraints $x + 3y \geq 6$, $y \leq 3$, $x + y \leq 4$, $y \geq 0$ Which of the following is/are true ?

[:A] x = 1, y = 2 is a feasible solution of the LPP

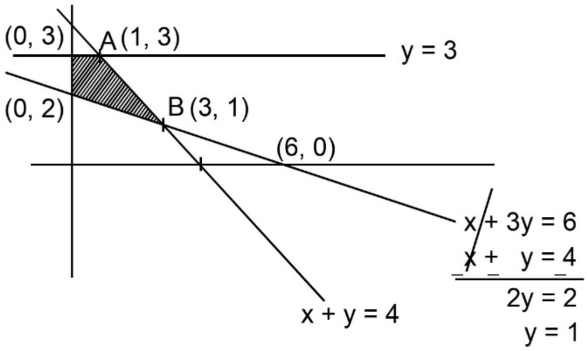
[:B] x = 2, y = 2 is an optimal solution of the LPP

[:C] The only optimal solutions of the LPP are x = 1, y = 3 and x = 3, y = 1

[:D] x = 3, y = 1 is an optimal solution of the LPP

[:ANS] **ABD**

[:SOLN]



	Point	Valne
Z = x + y	(0,3)	(3)
	(0,2)	(2)
	(0, 2)	(4) (M)
	(1, 3)	(4) (M)

∵ Point A& B both have same (M = 4). So line AB is set of optimal sol^n from A to B.

∵ (2, 2) lies on line AB So, (B)/(D) correction

∵ (1,2) ∈ feasible Region So (1, 2) is feasible sol^n

So (A) Also true.

[:Q.50] For vectors A, B & C in three dimensional Euclidean space, let AB = A × B stand for the cross product, [A, B] = AB – BA for the commutator of A & B and {A, B, C} = (AB)C – A(BC) for the associator of A, B & C. Then which of the following relations hold true ?

[:A] $A^2 = 0$ for $A \neq 0$

[:B] [A, B] = 0 for $A \neq B$ and $A, B \neq 0$

[:C] {A, B, C} = 0 for $A \neq B \neq C$ and $A, B, C \neq 0$

[:D] A(BC) + B(CA) + C(AB) = 0 for $A \neq B \neq C$ and $A, B, C \neq 0$

[:ANS] **(AD)**

[:SOLN] (A) $\vec{A}^2 = \vec{A} \times \vec{A} = 0$ so (A) Correct

(B) $\left[\bar{A},\bar{B}\right] = \bar{A}\times\bar{B} - \bar{B}\times\bar{A} = \bar{A}\times\bar{B} - \bar{B}\times\bar{A}$

$\left(\vec{A} = \lambda\vec{B}\right)$

So (B) false

(C) $\left\{\bar{A},\bar{B},\bar{C}\right\} = \left(\bar{A}\,\bar{B}\right)\bar{C} - \bar{A}\left(\bar{B}\,\bar{C}\right)$

$= \left(\vec{A}\times\vec{B}\right)\times\vec{C} - \vec{A}\times\left(\vec{B}\times\vec{C}\right)$

$= \left(\vec{A}\cdot\vec{C}\right)\vec{B} - \left(\vec{C}\cdot\vec{B}\right)\vec{A} - \left(\bar{A}\cdot\bar{C}\right)\vec{B} + \left(\bar{A}\cdot\bar{B}\right)\vec{C}$

$= \left(\bar{A}\cdot\bar{B}\right)\vec{C} - \left(\bar{C}\cdot\bar{B}\right)\vec{A}$

$= \vec{B}\times\left(\vec{C}\times\vec{A}\right)$ (c) false.

(D) $\bar{A}\times\left(\bar{B}\times\bar{C}\right) + \bar{B}\times\left(\bar{C}\times\bar{A}\right) + \bar{C}\times\left(\bar{A}\times\bar{B}\right)$

$= \left(\bar{A}\cdot\bar{C}\right)\bar{B} - \left(\bar{A}\cdot\bar{B}\right)\bar{C} + \left(\bar{B}\cdot\bar{A}\right)\bar{C} - \left(\bar{B}\cdot\bar{C}\right)\bar{A}$

$+\left(\bar{C}\cdot\bar{B}\right)\bar{A} - \left(\bar{C}\cdot\bar{A}\right)\bar{B}$

= 0 So (D) true.

[:Q.51] An artificial satellite is moving in an orbit around the Earth with orbital period of 8 hours, from west to east, with its orbit making an angle of 30º with equator. An observer on the equator will see it

[:A] again after 6 hour, moving from east to west

[:B] again after about 11 hours, moving from west to east

[:C] going up to about 46.8º from the equatorial plane

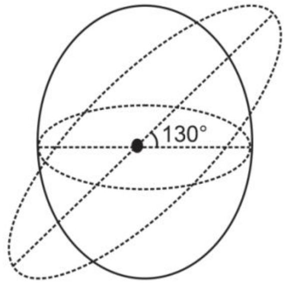
[:D] going up to about 43.2º from the equatorial plane

[:ANS] **B**

[:SOLN] ∵ Orbital period of the Earth is 24 hours.

From west to east.

∴ In half rotation (12 hour), satellite will make one and half rotation



∴ Approx 11 hours can be answer.

[:Q.52] A particle of mass 'm' is moving under the influence of a central force; the correct statement(s) is/are

[:A] The motion always remains constrained to be in a plane

[:B] The trajectory will always be elliptical

[:C] The total angular momentum remains constant

[:D] The torque about the force center is always zero

[:ANS] **ACD**

[:SOLN] ∵ Due to central for path will be either circular or elliptical path in a plane.

∵ Central force pass through force centre.

∴ Torque = 0 and hence angular momentum is conserved.

[:Q.53] When a raw poori round (kneaded wheat dough rolled into thin rounds) is slipped into hot oil and the hot oil is swished immediately over it repeatedly, the poori puffs up because

[:A] the dough has comparatively low heat conductivity

[:B] hot oil causes a crust to form

[:C] the density of steam is low.

[:D] the matrix of proteins in the dough formed during kneading helps trap gases

[:ANS] **C**

[:SOLN]

[:Q.54] Two positively charged conducting spheres A and B with +Q charge on each, are placed on the x-axis at (a, 0) and (–a, 0), A very small metallic ball with charge +q is gently placed at the origin (midway between the two spheres). The small ball with charge +q, in the middle is

[:A] in stable equilibrium if constrained to move only along x-axis

[:B] in unstable equilibrium if constrained to move only perpendicular to the x-axis

[:C] always in unstable equilibrium

[:D] always in neutral equilibrium

[:ANS] **AB**

[:SOLN]

[:Q.55] Consider the electromagnetic radiation emitted by two stars. The hoter star will

[:A] emit more radiation at all wavelengths

[:B] have a higher frequency of peak emission in its spectrum

[:C] radiate energy at more than one wavelength

[:D] exhibit a continuous spectrum

[:ANS] **ABCD**

[:SOLN]

[:Q.56] Because of the precession of the axis of rotation of Earth

[:A] the Polaris is not always our 'pole star'

[:B] the average length of a sidereal day changes slowly with time

[:C] the declinations of the stars change slowly with time

[:D] the Vernal Equinox moves with respect to the stars

[:ANS] **ACD**

[:SOLN]

[:Q.57] A planet orbits the Sun at a distance of 4.0 AU from the Sun. the orbital speed(V_0) and the time period (T) of the planet are approximately

[:A] V_O = 7.92 km/s

[:B] V_O = 14.93 km/s

[:C] T = 4 years

[:D] T = 8 years

[:ANS] **BD**

[:SOLN]

[:Q.58] The rotation period of a spherical moon about its own axis is equal to its period of revolution round its parent planet. Which of the following statements is/are true ?

[:A] If the orbital and spin angular momentum vectors of the moon are parallel to each other then, the moon will always show the same portion of its surface to the planet

[:B] If the spin angular momentum vector of the moon lies in its orbital plane, then every portion of the surface of the moon may be seen from the planet.

[:C] If the orbital and spin angular momentum vectors of the moon are antiparallel with respect to each other then, viewed from the planet, the moon will appear to be non-rotating

[:D] If the spin angular momentum vector of the moon lies in its orbital plane, then, viewed from the planet, the moon will appear to be rotating with a higher angular speed

[:ANS] **ACD**

[:SOLN] *

[:Q.59] The true statement(s) for the function f(x) = $\begin{cases} \frac{\sin|x|}{|x|} & \text{if } x \neq 0 \\ 0 & \text{if } x = 0 \end{cases}$ is/are

[:A] $\lim_{x\to 0} f(x)$ exists

[:B] $\lim_{x\to 0} f(x)$ does not exist

[:C] f is differentiable at x = 0

[:D] f has removable discontinuity at x = 0

[:ANS] **AD**

[:SOLN] $f(x) = \left[\begin{array}{ll} \left\{ \frac{\sin|x|}{|x|} = \left\{ \frac{\sin x}{x} \right. \right. & \text{if } x \neq 0 \\ \quad 0 & \text{if } x = 0 \end{array} \right.$

$\lim_{x\to 0} \frac{\sin x}{x} = 1$

So limit exits

$\because \quad f(0) = 0 \neq 1$ so

Discontinuous at x = 0 & will be removable discontinly of isolated point type.

[:Q.60] Consider the differential equation $x\frac{dy}{dx} + 3y = x^3$. Which of the following is/are true ?

[:A] $3x^3$ is an integrating factor of this equation

[:B] $y = \frac{x^3}{6} + \frac{2023}{x^3}$ is a solution of this equation

[:C] $y = \frac{x^3}{6} - \frac{8}{2023x^3}$ is a solution of this equation

[:D] The equation is a homogeneous differential equation

[:ANS] **BC**

[:SOLN] $x\frac{dy}{dx} + 3y = x^3$

$\frac{dy}{dx} + \left(\frac{3}{x}\right)y = x^2$

I.F = $e^{3\int \frac{1}{x}dx} = x^3$

Sol^n; $y.x^3 = \int x^5 dx + c$

$y.x^3 = \frac{x^6}{6} + C$

$y = \frac{x^3}{6} + \frac{c}{x^3}$