

Question Paper

Physics Multiple Correct (Maximum Marks: 32)

Question No. 1

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

We have a faulty barometer. When faulty barometer reads 69 cm of Hg, true barometer reads 73 cm of Hg and when faulty barometer reads 70 cm of Hg, true barometer reads 75 cm of Hg. Choose the correct option(s). (Assume temperature stays constant and in every situation length of the faulty barometer outside the Hg is same.) (use $\sqrt{96} = 9.8$)

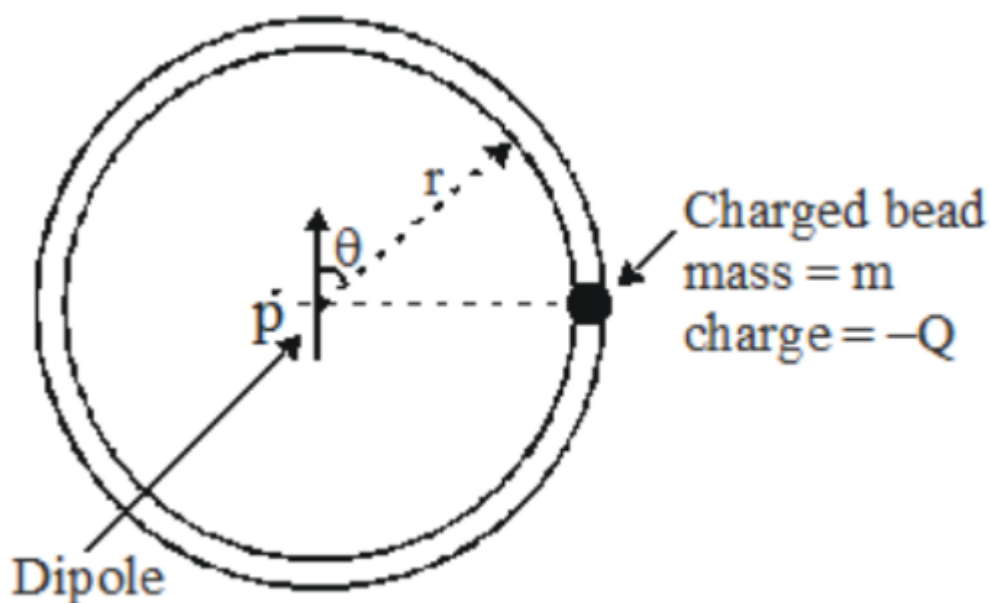
- A. Total length of the faulty barometer is 74 cm
- B. Total length of the faulty barometer is 75 cm
- When reading of true barometer is 70 cm of Hg reading of faulty barometer
- C. is 67.1 cm of Hg
- When reading of faulty barometer is 65 cm of Hg reading of true barometer
- D. is 70 cm of Hg

Question No. 2

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

A small charged bead can slide on a circular frictionless, insulating wire frame. A point like dipole is fixed at the centre of circle, dipole moment is \vec{p} . Initially the bead is on the plane of symmetry of the dipole. Bead is released from rest. Ignore the effect of gravity. Mark the correct options



Magnitude of velocity of bead as function of its angular position is

A. $\sqrt{\frac{Qp \cos \theta}{2\pi\epsilon_0 m r^2}}$

B. Normal force exerted by the string on bead is zero at all points

If the wire frame were not present bead executes circular motion and returns

C. to initial point after tracing a complete circle.

Bead would move along a circular path until it reached the opposite its

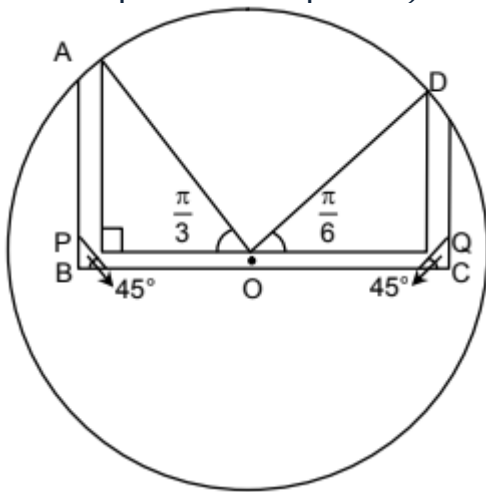
D. starting position and then executes periodic motion

Question No. 3

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

There is a planet of radius R and uniform density ρ . A thin tunnel $ABCD$ is dug as shown in figure. Walls of tunnel offer zero friction. At end B and end C plates inclined at angle 45° is fixed. A particle of mass m is released from end A of tunnel. All collisions (Wherever occur are elastic). Choose the correct options. (O is the centre of planet. Neglect all other gravitation effects except interaction between particle and planet.)



A. Maximum speed the particle during consequent motion is $R\sqrt{\frac{4\rho G}{3}}$

B. Maximum speed the particle during consequent motion is $R\sqrt{\frac{2\rho G}{3}}$

C. Time period of resulting motion of the particle is $3\sqrt{\frac{3\pi}{4\rho G}}$

D. Time period of resulting motion of the particle is $2\sqrt{\frac{\pi}{4\rho G}}$

Question No. 4

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

A particle tied at one end of an inextensible string of length R , whose other end is fixed. Particle is performing circular motion in vertical plane. Ratio of maximum to minimum speed is λ . Choose the correct options.

A. Speed at the top most point is $\sqrt{\left(\frac{4\lambda^2}{\lambda^2-1}\right)gR}$

B. Speed at the top most point is $\sqrt{\left(\frac{4}{\lambda^2-1}\right)gR}$

C. Ratio of maximum to minimum tension is $\left(\frac{5\lambda^2-1}{5-\lambda^2}\right)$

D. Ratio of tension in string to weight when string is horizontal is $2\left(\frac{\lambda^2-1}{\lambda^2+1}\right)$

Question No. 5

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

A metal cylinder of 5 kg is heated electrically by a 20 W heater in a room at 20°C . The cylinder temperature rises uniformly to 30°C in 5 minute and finally becomes constant at 45°C . Assuming that the rate of heat loss is proportional to the excess temperature over the surroundings. Choose the correct options :

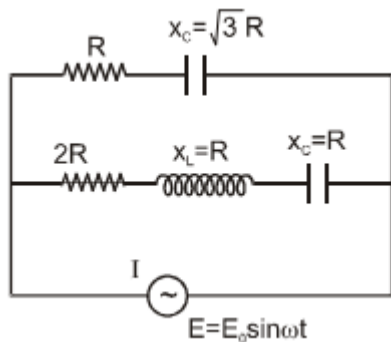
- A. The rate of loss of heat of cylinder to surrounding at 25°C is 4 W
- B. The rate of loss of heat of cylinder to surrounding at 45°C is 20 W
- C. The rate of loss of heat of cylinder to surrounding at 25°C is 8 W
- D. The rate of loss of heat of cylinder to surrounding at 45°C is zero

Question No. 6

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Choose the correct options regarding the AC circuit given in the figure: (Symbols have their usual meaning)



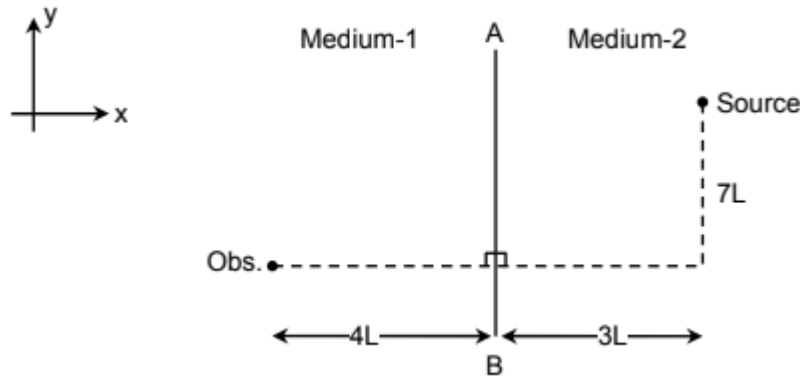
- A. Equivalent impedance of the circuit is $\frac{2R}{\sqrt{3}}$
- B. Power factor of the circuit is $\frac{\sqrt{3}}{2}$
- C. Average power for complete cycle is $\frac{3E_0^2}{8R}$
- D. Effective reactance of the circuit is $\frac{R}{\sqrt{3}}$

Question No. 7

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

AB is the boundary that divides two media 1 and 2 having bulk modulus in the ratio 3 : 4 and density in the ratio 4 : 3. Speed of sound in medium 1 is 300 m/s source is stationary and observer can move with max speed 50 m/s . Frequency of sound produced by source is f_0 . Assume the sound wave also to follow Fermat's principle of least time. Choose the correct option(s):



To observe maximum frequency observer should walk at an angle

A. $\tan^{-1}\left(\frac{3}{4}\right)$ with x -axis

To observe maximum frequency observer should walk at an angle $\tan^{-1}(1)$

B. with x -axis

C. Maximum frequency that can be heard by observer is $\frac{8}{7}f_0$.

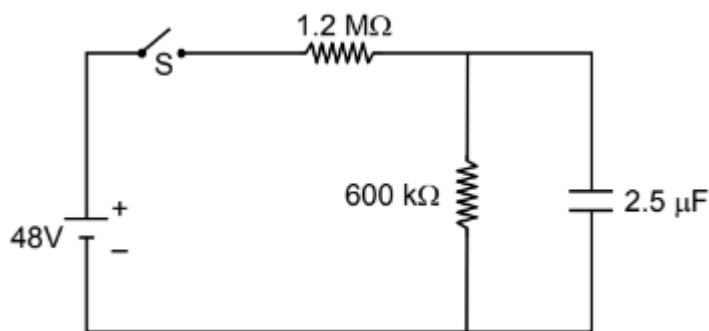
D. Maximum frequency that can be heard by observer is $\frac{7}{6}f_0$.

Question No. 8

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

In the circuit shown in figure capacitor was initially uncharged switch is closed at $t = 0$. Select correct alternatives.



A. The initial battery current immediately after switch S is closed is $40\mu\text{A}$

B. The battery current, long time after switch S is closed is $\frac{80}{3}\mu\text{A}$

C. The time after which current through capacitor becomes half is $\ln 4$ sec.

D. The current through the $600\text{k}\Omega$ as a function of time is $\frac{80}{3}(1 - e^{-t})\mu\text{A}$.

Physics Paragraph Type (Maximum Marks: 12)

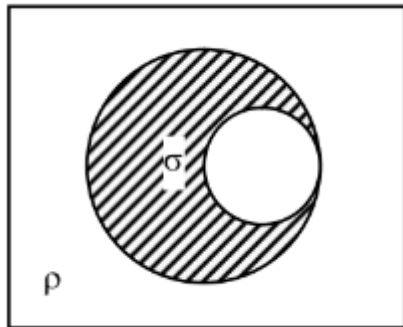
Question No. 1

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Passage:

A uniform solid sphere of density σ and radius R has a spherical cavity of radius $\frac{R}{2}$ between the centre and surface of the sphere. It is immersed in a tank containing liquid of density ρ with the liquid level $\frac{R}{4}$ above the sphere top. The sphere is released from rest at the position shown with centre of cavity and the centre of the sphere at the same horizontal level. It is observed that centre of mass of sphere stays at rest.

**Question:**

Relation between ρ and σ is :

- A. $\frac{\sigma}{\rho} = \frac{8}{7}$
- B. $\frac{\sigma}{\rho} = \frac{7}{8}$
- C. $\frac{\sigma}{\rho} = 1$
- D. $\frac{\sigma}{\rho} = \frac{16}{15}$

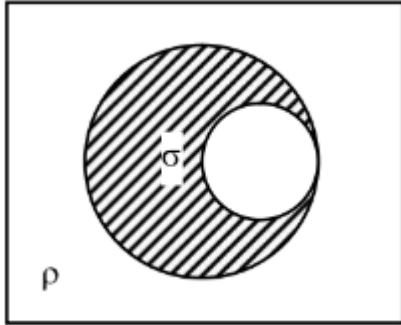
Question No. 2

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Passage:

A uniform solid sphere of density σ and radius R has a spherical cavity of radius $\frac{R}{2}$ between the centre and surface of the sphere. It is immersed in a tank containing liquid of density ρ with the liquid level $\frac{R}{4}$ above the sphere top. The sphere is released from rest at the position shown with centre of cavity and the centre of the sphere at the same horizontal level. It is observed that centre of mass of sphere stays at rest.

**Question:**

Maximum kinetic energy attained by the sphere during the motion is :

- A. $\frac{1}{21} \pi R^4 \rho g$
- B. $\frac{2}{21} \pi R^4 \rho g$
- C. $\frac{3}{21} \pi R^4 \rho g$
- D. $\frac{4}{21} \pi R^4 \rho g$

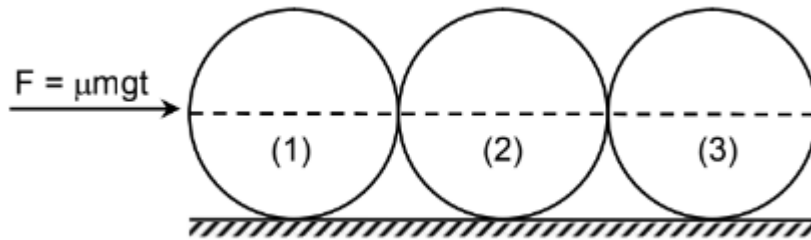
Question No. 3

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Passage:

Three identical uniform solid cylinders each of mass M and radius R are in contact and kept on a rough horizontal surface. Coefficient of friction between cylinder-1 and surface is μ , between cylinder-2 and surface is 2μ and between cylinder-3 and surface is 3μ .



There is no friction between cylinders. A horizontal time varying force $F = \mu mgt$, here t in sec, starts acting on cylinder-1, exactly at the horizontal level of centers of cylinder from $t = 0$. Answer the following two questions:

Question:

How long after $t = 0$, cylinder-1 will start slipping?

- A. 5sec
- B. 9sec
- C. 17sec
- D. 24sec

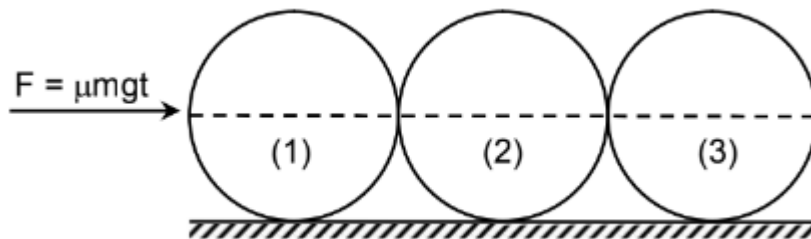
Question No. 4

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There is no friction between cylinders. A horizontal time varying force $F = \mu mgt$, here t in sec, starts acting on cylinder-1, exactly at the horizontal level of centers of cylinder from $t = 0$. Answer the following two questions:

Question:

How long after $t = 0$, cylinder-3 will start slipping?

- A. 5sec
- B. 9sec
- C. 17sec
- D. 24sec

Physics Numerical (Maximum Marks: 24)

Question No. 1

Numerical Type

The answer has to be filled into the input box provided below.

A trinary star system has time period $T = 3$ year, while the distance between its components is 2 astronomical unit. If mass of the sun is represented by M_s , then the total mass of this multiple star system will be $\frac{\alpha}{\beta} M_s$. Find minimum value of $\beta - \alpha$.

Note: (1) System of three star, orbiting around centre of mass of system, is called trinary star system, for simplicity assume all three components to be identical.

(2) 1 astronomical unit = distance between earth and sun.

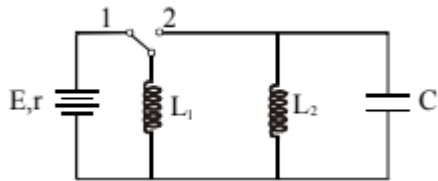
(3) 1 year = time period of earth to complete one full revolution around sun

Question No. 2

Numerical Type

The answer has to be filled into the input box provided below.

A circuit shown consists of two inductors of inductances L_1 and L_2 , a capacitor of capacitance C , a battery of electromotive force E and internal resistance r and a switch. Initially the switch was in position 1 for a long time. Find the maximum current (in A) in the inductor L_2 after the switch is thrown to position 2 ? (Given : $E = 5\text{ V}$, $L_1 = 4\text{mH}$, $L_2 = 1\text{mH}$, $r = 2\Omega$)



Question No. 3

Numerical Type

The answer has to be filled into the input box provided below.

Two rods of different materials having coefficients of thermal expansion α_1 , α_2 and Young's module Y_1 , Y_2 respectively are fixed between two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of the rods. If $\alpha_1 : \alpha_2 = 2 : 3$, the thermal stressed developed in the two rods are equal provided $Y_1 : Y_2$ is equal to $k : 2$. Find the value of k .

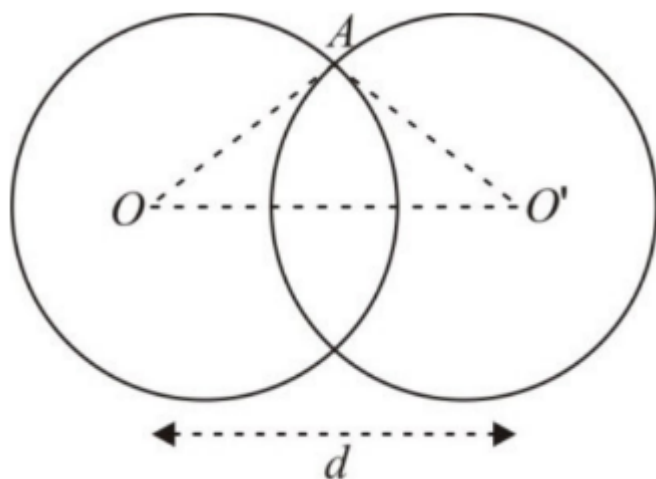
Question No. 4

Numerical Type

The answer has to be filled into the input box provided below.

A hoop of radius R rests on a smooth horizontal surface. A similar hoop moves past it at a constant velocity v . The velocity v_A of the upper point of intersection of the hoops as a function of the distance d between their centres is $\frac{v}{k\sqrt{1-(\frac{d}{2R})^2}}$

assuming that the hoops are thin and the second hoop is in contact with first hoop as it moves past the latter. Find the value of k .



Question No. 5

Numerical Type

The answer has to be filled into the input box provided below.

A light ray incident at angle of incidence ' i ' in medium-1 is partly reflected in medium-1 and partly refracted in medium-2 with angle between reflected and refracted rays being $\frac{\pi}{2}$. Boundary of medium-1 and medium-2 is straight. If the light ray is incident at the same angle of incidence ' i ' in medium-2, there is no refraction to medium-1, then the condition imposed on angle i is given by $\cos i < \frac{\sqrt{\alpha-\beta}}{\gamma}$. Find minimum value of $\alpha + \beta + \gamma$.

Question No. 6

Numerical Type

The answer has to be filled into the input box provided below.

Moseley's law for K_α photon is given by $\sqrt{\bar{\nu}} = a(Z - b)$ where a is a universal constant and b is a screening constant. Moseley's logic helps us assume $b = 1$ for K_α photon. If there is a percentage error $= 10^{-2}$ in the measurement of ' b ' due to actual orbital configuration of an atom, then the relative error in the measurement of ν if $Z = 51$ is $p \times 10^{-q}$. Find value of $p+q$ (p is a natural number)

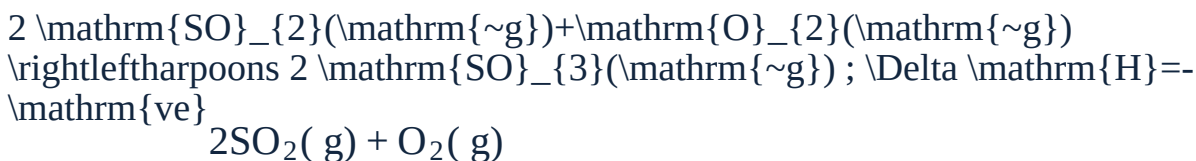
Chemistry Multiple Correct (Maximum Marks: 32)

Question No. 1

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Making of $\text{SO}_3(\text{g})$ by contact process using suitable catalyst is an exothermic process



Which of these is true on increasing pressure?

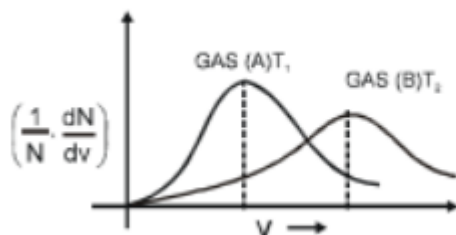
- A. Reaction shifts forward to attain new equilibrium.
- B. Average molar mass of gaseous mixture increases.
- C. Partial pressure of SO_3 , SO_2 & O_2 will increase.
- D. Concentration of SO_3 increases whereas concentration of SO_2 & O_2 decreases.

Question No. 2

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

According to Maxwell's distribution of molecular speeds, for the below graph drawn for two different samples of gases A and B at temperature T_1 and T_2 respectively, which of the following statements is/are INCORRECT :



- If $T_1 = T_2$, then molecular mass of gas B (M_B) is
 - A. greater than molecular mass of gas A (M_A) .
- If molecular mass of gas A (M_A) is equal to molecular mass of gas B (M_B) , then $T_1 > T_2$.
- If $T_1 < T_2$, then molecular mass of gas B (M_B) is
 - C. necessarily less than molecular mass of gas A (M_A) .
- If gas A is O_2 and gas B is N_2 , then considering them to be ideal gases, T_1 is
 - D. necessarily less than T_2 .

Question No. 3

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

In the electrolysis of alumina, cryolite is added to :

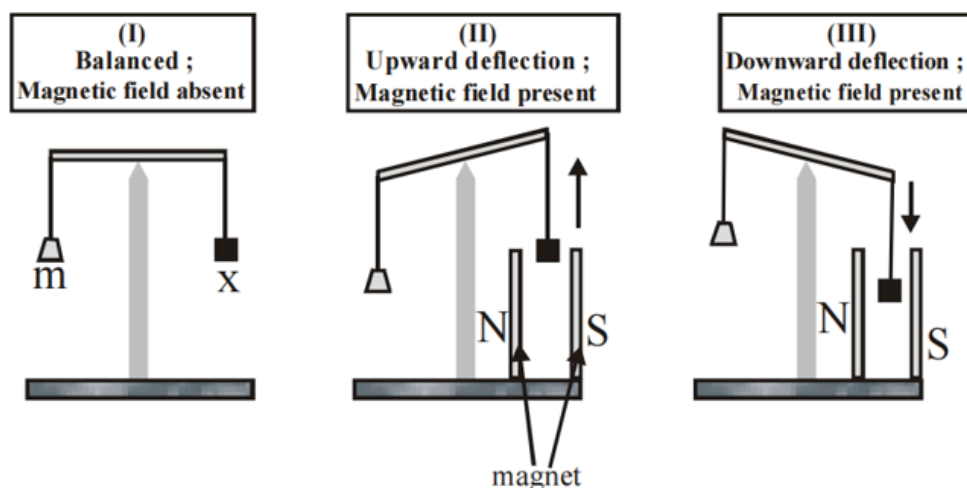
- A. Lower the melting point of alumina
- B. Increase the electrical conductivity
- C. Minimise the anode effect
- D. Remove impurities from alumina

Question No. 4

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

In an experiment, m grams of a compound \mathbf{X} (gas/liquid/solid) taken in a container is loaded in a balance as shown in figure I below. In the presence of a magnetic field, the pan with \mathbf{X} is either deflected upwards (figure II), or deflected downwards (figure III), depending on the compound \mathbf{X} . Identify the correct statement(s)



- If \mathbf{X} is $\text{H}_2\text{O}(\text{ell})$, deflection of the
 - A. pan is upwards.
- If \mathbf{X} is $\text{K}_4[\text{Fe}(\text{CN})_6](\text{s})$, deflection of the pan is upwards.
- If \mathbf{X} is $\text{O}_2(\text{~g})$, deflection of the pan is
 - C. downwards.
- If \mathbf{X} is $\text{C}_6\text{H}_6(\text{ell})$, deflection of the
 - D. pan is downwards.

Question No. 5

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Saturated solution $\text{Co}^{2+} \left[\text{Fe}(\text{CN})_6 \right]^{-1}$ is taken in an electrolytic cell of cell constant 0.3 cm^{-1} . If conductivity of saturated solution of $\text{Co}^{2+} \left[\text{Fe}(\text{CN})_6 \right]^{-1}$ & water used to make solution is $2.2 \times 10^{-6} \text{ S cm}^{-1}$ and $4 \times 10^{-7} \text{ S cm}^{-1}$ respectively, & molar conductance of $\text{Co}^{+2} \left[\text{Fe}(\text{CN})_6 \right]^{-4}$ ions are $80 \text{ S cm}^2 \text{ mol}^{-1}$ & $440 \text{ S cm}^2 \text{ mol}^{-1}$ respectively then

Solubility of $\text{Co}^{2+} \left[\text{Fe}(\text{CN})_6 \right]^{-1}$ is $3 \times 10^{-6} \text{ mole} /$

A. dm^3

K_{SP} of $\text{Co}^{2+} \left[\text{Fe}(\text{CN})_6 \right]^{-1}$ is $1.08 \times 10^{-16} \text{ mole}^3$

B. $/ \text{dm}^9$

Ionic mobility of Co^{+2} of this solution increases on

C. increasing potential difference across the terminal of the cell.

D. On increasing temperature conductivity of this solution increases.

Question No. 6

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Which of the following ions can be separated by using NH_4Cl and NH_4OH ?

A. Fe^{2+} and Cr^{3+}

B. Cr^{3+} and Mg^{2+}

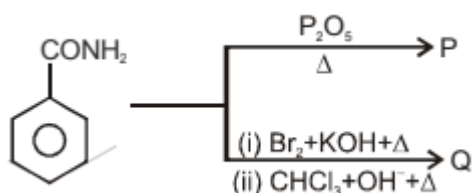
C. Cr^{3+} and Co^{2+}

D. Al^{3+} and Ba^{2+}

Question No. 7

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.



Which statement(s) is/are correct :

A. Reduced product of (P) and (Q) will be metamers to each other.

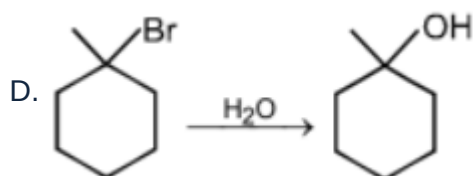
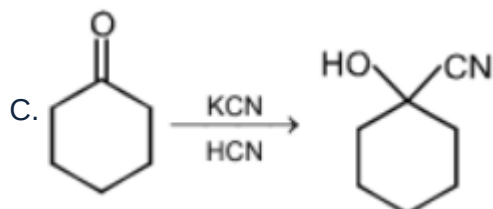
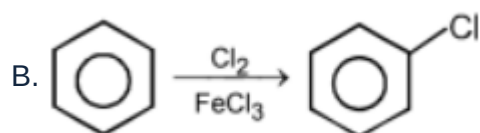
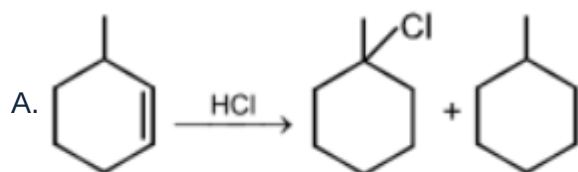
- By dry distillation of hydrolysed products of (P) with $(\text{Ca}(\text{OH})_2)$, gives benzophenone.
- Hydrolysed product of (Q) , reacts with $(\text{NaNO}_2 + \text{HCl})$ followed by reaction with phenol, gives orange red dye.
- Electrophile involved in the formation of (Q) is dichlorocarbene.

Question No. 8

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Which of the following reactions involve a carbocation intermediate?



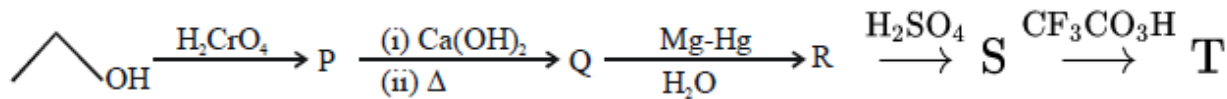
Chemistry Paragraph Type (Maximum Marks: 12)

Question No. 1

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Work on the given reaction sequence and answer the following questions :



Product Q $\xrightarrow{[\Delta] \{ \text{Conc HC1.} \}}$ Final Product

Final product obtained is :

- A. $\backslash(\mathrm{CH}_3-\mathrm{CH}_2\mathrm{COOH})$
 $\backslash(\mathrm{CH}_3-\underset{|}{\mathrm{CH}}\mathrm{CH}_3)$
 B. $\{\stackrel{\mathrm{OH}}{|}{\mathrm{C}}\}-\mathrm{Cl}$
 $\backslash(\mathrm{CH}_3-\underset{|}{\mathrm{CH}}\mathrm{CH}_3)$
 C. $\{\mathrm{C}\}=\mathrm{CH}-\mathrm{COCH}_3$
 $\backslash(\mathrm{CH}_3-\underset{|}{\mathrm{CH}}\mathrm{CH}_3)$
 $\{\mathrm{C}\}=\mathrm{CH}-\mathrm{CO}-\mathrm{CH}=\underset{|}{\mathrm{CH}}$
 D. $\mathrm{CH}_3\{\mathrm{C}\}-\mathrm{CH}_3$

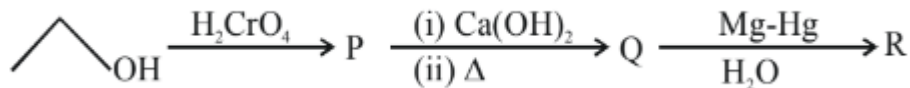
Question No. 2

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Paragraph:

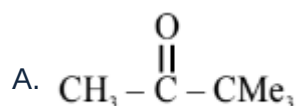
Work on the given reaction sequence and answer the following questions:

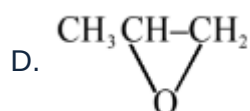
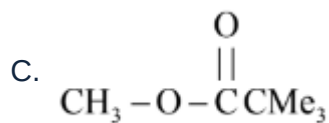
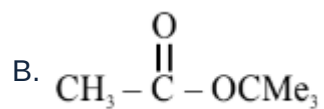


Question:

$$\text{Product } \mathrm{R} \stackrel{\mathrm{H}_2}{\mathrm{SO}_4} \longrightarrow \mathrm{S} \stackrel{\mathrm{CF}_3}{\mathrm{CO}_3} \longrightarrow \mathrm{H} \longrightarrow \mathrm{T}$$

Final product T of above reaction is:





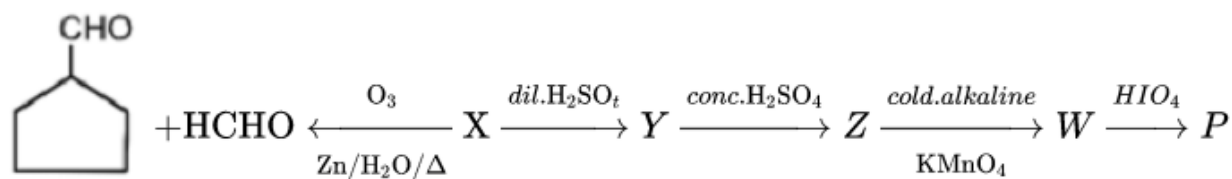
Question No. 3

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Paragraph:

Observe the following sequence of reaction and answer the related questions.



Question:

The product \$P\$ will show positive test with :

- A. Tollen's reagent
- B. I_2 / NaOH
- C. 2,4-D.N.P
- D. All A, B & C

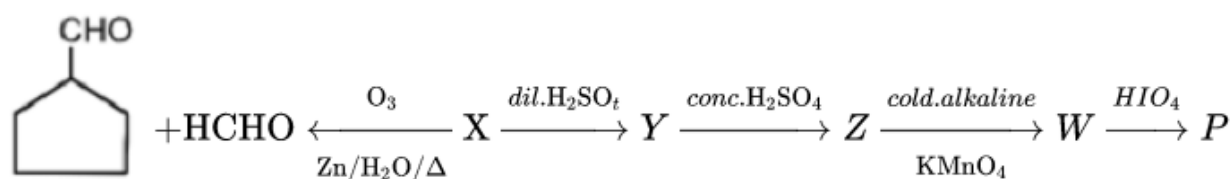
Question No. 4

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Paragraph:

Observe the following sequence of reaction and answer the related questions.



Question:

How many Double bonds in Z?

- A. 1
- B. 2
- C. 0
- D. 3

Chemistry Numerical (Maximum Marks: 24)

Question No. 1

Numerical Type

The answer has to be filled into the input box provided below.

Paragraph:

Ice that burns! Yes, there is such a thing. It is called methane hydrate. Bacteria in the sediments on the ocean floor consume organic material and generate methane gas. Under high-pressure and low-temperature conditions, methane forms methane hydrate, which consists of single molecules of the natural gas trapped within crystalline cavities/cages formed by frozen water molecules. A lump of methane hydrate looks like a gray ice cube, but if one puts a lighted match to it, it will burn. The main characteristics of structure of methane hydrate are dodecahedra formed from 20 water molecules. The unit cell of the crystal can be thought as a body-centered cubic arrangement built from these dodecahedra which are almost spherical objects. The dodecahedra are connected via additional water molecules located on the faces of the unit cell. Two water molecules can be found within each face of the unit cell. The unit cell has an edge dimension of 1.182 nm . There are two types of cavities in this structure. One is the internal space (X) in the dodecahedra. These are somewhat smaller than the other type of voids (Y), of which there are 6 for each unit cell. Similar hydrate can also be formed with other gases such as chlorine and noble gases.

Question:

How many water molecules are there in a unit cell of crystal?

Question No. 2

Numerical Type

The answer has to be filled into the input box provided below.

The relative reactivity of 1° , 2° , 3° hydrogen's towards chlorination is $1: 3.8: 5$. The percentages of 2° monochlorinated products obtained from 2-methylbutane is (mark answer to nearest integer)

Question No. 3

Numerical Type

The answer has to be filled into the input box provided below.

In how many of the following, atoms are arranged in linear manner around central atom (underlined atom) ?

$\underline{\mathrm{I}}_3^{-1}$,
 $\underline{\mathrm{BO}}_3^{-1}$ (non - cyclic form),
 $\underline{\mathrm{Si}}\mathrm{O}_2$, $\underline{\mathrm{Sn}}\mathrm{Cl}_2$,
 $\underline{\mathrm{Hg}}\mathrm{Cl}_2$,
 $\underline{\mathrm{Xe}}\mathrm{F}_2$,
 $\underline{\mathrm{S}}\mathrm{O}_2$

Question No. 4

Numerical Type

The answer has to be filled into the input box provided below.

How many of the following molecules or ions may act as a multidentate ligand?

CO_3^{2-}	NO_3^-	edta	$[\mathrm{N}(\mathrm{CH}_2\text{---}\mathrm{COO})_3]^{3-}$
$\mathrm{C}_2\mathrm{O}_4^{2-}$	SO_4^{2-}	$\mathrm{CH}_3\mathrm{COCHCOCH}_3^-$	gly
$\mathrm{CH}_3\mathrm{C}\equiv\mathrm{N}$	SCN^-	dmg	dipy

Question No. 5

Numerical Type

The answer has to be filled into the input box provided below.

E_{Cell}° for the cell

$\text{Pt}(s) | \text{Fe}^{2+}(aq) || \text{Fe}^{3+}(aq) | \text{MnO}_4^{-}(aq), \text{H}^{+}(aq) | \text{Mn}^{2+}(aq) | \text{Pt}$ is 0.788 Volt

Given :

$\Delta G^{\circ} \text{ for } \text{H}_2 \text{O}(\text{ell}) = -230 \text{ kJmol}^{-1}$

$\Delta G^{\circ} \text{ for } \text{Fe}^{3+}(aq) = -10.2 \text{ kJmol}^{-1}$

$\Delta G^{\circ} \text{ for } \text{Mn}^{2+}(aq) = -229 \text{ kJmol}^{-1}$

$\Delta G^{\circ} \text{ for } \text{Fe}^{2+}(aq) = -84 \text{ kJmol}^{-1}$

Magnitude of ΔG°

for $\text{MnO}_4^{-}(aq)$ in kJ

mol^{-1} is $x \times 10^2$ then ' x ' is

(Give your answer as nearest integer)

Question No. 6

Numerical Type

The answer has to be filled into the input box provided below.

A hydrogen electrode placed in an aqueous solution of 0.1 M BCl (a salt of weak base and strong acid) and 10.0 M BCl has oxidation potential values 0.115 V and 0.180 V at 25°C . What is the pK_a value of B^{+} ?

Mathematics Multiple Correct (Maximum Marks: 32)

Question No. 1

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

For a differentiable function $f(x)$ if $f(x-y)$, $f(x)$ $f(y)$ and $f(x+y)$ are in AP for all. x , y and $f(0) \neq 0$, then

- A. $f'(2) = f'(-2)$
- B. $f(2) + f(-2) = 0$
- C. $f(4) = f(-4)$
- D. $f'(4) + f'(-4) = 0$

Question No. 2

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

For a (3×3) invertible matrix A satisfying the characteristic equation $(\det(A)^3 + \det(pA)^2 + \det(qA) - \det(rI) = 0)$, which of the following is/are true [Here $\operatorname{tr}(A) = \operatorname{trace}(A)$ of matrix (A) , $\operatorname{det}(A) = \operatorname{det}$ erminant value of matrix (A)]

- A. $(p = -\operatorname{tr}(A))$
 $(q = \frac{(\operatorname{tr}(A))^2 - \operatorname{tr}(A^2)}{2})$
- B. $\operatorname{tr}(\det(A)^2) = 2$
- C. $(\det(A)^{-1} = \frac{-2(\det(A) - \operatorname{tr}(A))}{\det(A) - \det(I)})$
- D. $(\det(A))^2 - \operatorname{tr}(\det(A)^2) = 2$

Question No. 3

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

In $\triangle ABC$, $a=11$ and $\sin A = \frac{3}{7}$ where ' a ' is the side opposite to $\angle A$ and $0 < A < \frac{\pi}{2}$. If the side length of $\triangle ABC$ are $11, b, c$ where $B = \frac{\pi}{2}$

- A. circumradius R of $\triangle ABC$ is equal to $\frac{77}{6}$
inradius r of $\triangle ABC$ is equal to (11)
- B. $(\sqrt{2})\left(\frac{\sqrt{5}-\sqrt{2}}{3}\right)$
- C. area of $\triangle ABC$ is equal to $\frac{121\sqrt{10}}{3}$
the value of $\sin 2A + \sin 2B + \sin 2C$ is equal to $\frac{24\sqrt{10}}{3}$
- D. $\{7\}$

Question No. 4

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

Let $\vec{a}, \vec{b}, \vec{c}$ be three vectors each of magnitude $\sqrt{3}$ and the angle between each pair of them is $\frac{\pi}{3}$. If $\vec{b} \times \vec{c} + \vec{c} \times \vec{a} = x\vec{a} + y\vec{b} + z\vec{c}$ where x, y, z are scalars, then

- volume of parallelepiped formed by $\vec{a}, \vec{b}, \vec{c}$ is $\frac{3}{\sqrt{3}}$
- A. $\sqrt{3}\sqrt{2}$
- B. the value of x is $\frac{\sqrt{3}}{\sqrt{2}}$
- C. $x^2 + y^2 + z^2 \leq \sqrt{21}$
Number of integral co-ordinates (x, y, z) satisfying $x^2 + y^2 + z^2 \leq 12$ is 125
- D. ≤ 12

Question No. 5

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

If points of intersection of three non-concurrent lines $(x+2y=3)$, $(x-y=1)$ and $(x+3y=5)$ lies on a circle and one of the line is diameter of that circle, then:

- A. sum of possible values of (a) is 5
- B. there will be unique value of (a)
- C. $(\left(\frac{-1}{7}, \frac{11}{7}\right))$ may be centre of the circle
- D. $(\left(\frac{1}{14}, \frac{23}{14}\right))$ may be centre of the circle

Question No. 6

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

A circle is drawn having centre at $C(0,2)$ and passing through focus (S) of the parabola $y^2=8x$, if radius (CS) intersects the parabola at point P , then

- A. distance of point P from directrix is $(8-4\sqrt{2})$
- B. distance of point C from point P is $(6\sqrt{2}-8)$
- C. angle subtended by intercept made by circle on directrix at its centre is $\pi/2$
- D. point P is the mid-point of C and S

Question No. 7

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

If A, B are two 4×4 matrices with real entries such that $|A-B| \neq 0$ and they satisfies the equation $\mathrm{A}^2 - 2\mathrm{B} + \mathrm{I}_4 = \mathrm{O}_4$, $\mathrm{B}^2 - 2\mathrm{A} + \mathrm{I}_4 = \mathrm{O}_4$, then

- A. $\mathrm{A} \neq \mathrm{I}$
- B. $|\mathrm{A} + \mathrm{B}| = 16$
- C. $|\mathrm{A} + \mathrm{I}|^2 = 256$
- D. $\mathrm{A} + \mathrm{B} = 2\mathrm{I}_4$

Question No. 8

One or More Options Correct Type

The question has multiple options out of which ONE or MORE is/are correct.

If E and F are two independent events; such that $P(E \cap F) = \frac{1}{6}$, $P(E^c \cap F^c) = \frac{1}{3}$ and $(P(E)-P(F))(1-P(F)) > 0$, then

- A. $P(E) = \frac{1}{2}$
- B. $P(E) = \frac{1}{4}$
- C. $P(F) = \frac{1}{3}$

D. $P(F) = \frac{2}{3}$

Mathematics Paragraph Type (Maximum Marks: 12)

Question No. 1

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Paragraph:

Consider the area S_n bounded by x -axis, $y = e^{-x} \sin x$ between $x = n\pi$ and $x = (n+1)\pi$, where $x \geq 0$

Question: The value of S_0 , is

- A. $\frac{1}{2} \left(1 + e^{\pi} \right)$ sq units
- B. $\frac{1}{2} \left(1 + e^{-\pi} \right)$ sq units
- C. $\frac{1}{2} \left(1 - e^{-\pi} \right)$ sq units
- D. $\frac{1}{2} \left(e^{\pi} - 1 \right)$ sq units

Question No. 2

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Paragraph:

Consider the area S_n bounded by x -axis, $y = e^{-x} \sin x$ between $x = n\pi$ and $x = (n+1)\pi$, where $x \geq 0$

Question: $\sum_{n=0}^{\infty} S_n$ is equal to

- A. $\frac{1 + e^{\pi}}{1 - e^{-\pi}}$
- B. $\frac{1}{2} \frac{\left(1 + e^{-\pi} \right)}{\left(1 - e^{-\pi} \right)}$
- C. $\frac{1}{2} \left(1 - e^{-\pi} \right)$
- D. none of these

Question No. 3

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Paragraph:

Let n be a non-negative integer. Also $b_n = \int \frac{x^n}{\sqrt{a^2 - x^2}} dx, (a > 0)$. We can find relation among I_n, I_{n-1}, I_{n-2} etc. by integration by parts. $I_1 = -\frac{(a^2 - x^2)^{3/2}}{3}$. Now answer the following:

Question: If $I_n = -\frac{x^{n-1}}{(a^2 - x^2)^{3/2}} + A x^n + B I_{n-2}$ where A and B are constants, then A must be equal to

- A. $\frac{n-1}{2}$
- B. $\frac{n}{2}$
- C. $\frac{n+1}{2}$
- D. $\frac{n+2}{2}$

Question No. 4

Only One Option Correct Type

Each question has multiple options out of which ONLY ONE is correct.

Paragraph:

Let n be a non-negative integer. Also $b_n = \int \frac{x^n}{\sqrt{a^2 - x^2}} dx, (a > 0)$. We can find relation among I_n, I_{n-1}, I_{n-2} etc. by integration by parts. $I_1 = -\frac{(a^2 - x^2)^{3/2}}{3}$. Now answer the following:

Question: In the above question, B must be equal to

- A. $\frac{n-1}{n+2}$
- B. $\frac{n-1}{n+1}$
- C. $\frac{n-1}{n}$
- D. 1

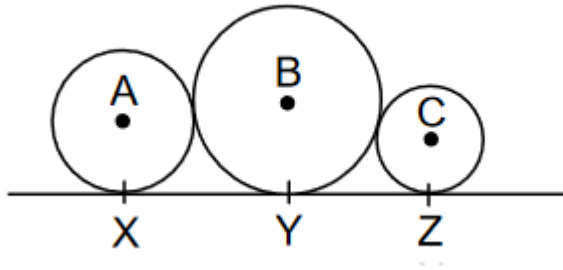
Mathematics Numerical (Maximum Marks: 24)

Question No. 1

Numerical Type

The answer has to be filled into the input box provided below.

The figure shows three circles with centres \$A\$, \$B\$ and \$C\$ and line \$L\$ which is a tangent to the circles at \$X\$, \$Y\$ and \$Z\$ respectively. Suppose \$XZ=40\text{ cm}\$, and \$AC=41\text{ cm}\$, and area of quadrilateral \$ACZX\$ is \$300\text{ cm}^2\$. If the area of \$\Delta ABC\$ is denoted by \$\Delta\$ then \$([\Delta]-170)\$ is (where \$[]\$ denotes greatest integer function)



Question No. 2

Numerical Type

The answer has to be filled into the input box provided below.

The value of $\sum_{r=1}^{\infty} \frac{\left(12r^2+1\right)\left(64r^6-48r^4+12r^2-1\right)}{\left(12r^2+1\right)\left(64r^6-48r^4+12r^2-1\right)}$ is :

Question No. 3

Numerical Type

The answer has to be filled into the input box provided below.

The equation of the side \$BC\$ of \$\triangle ABC\$ is \$x=2\$. If the altitude through \$A\$ meets the circumcircle of \$\triangle ABC\$ at \$P(7,-2)\$, then the absolute value of the sum of the \$x\$ and \$y\$-coordinate of the orthocentre of \$\triangle ABC\$ is equal to:

Question No. 4

Numerical Type

The answer has to be filled into the input box provided below.

If range of the function \$f(x)=\sin^{-1} x+2 \tan^{-1} x+x^2+4 x+1\$ is \$[p, q]\$, then the value of \$(p+q)\$ is:

Question No. 5

Numerical Type

The answer has to be filled into the input box provided below.

The distance of the point $(1,1,1)$ from the plane $x+y+z=1$ measured parallel to the line $\frac{x-2}{1}=\frac{y-3}{2}=\frac{z-4}{3}$ is k , where $\frac{3}{k}\sqrt{14}$ is

Question No. 6

Numerical Type

The answer has to be filled into the input box provided below.

Tangents are drawn from the point (α, β) to the hyperbola $3x^2 - 2y^2 = 6$ and are inclined at angles θ and ϕ to the x -axis. If $\tan \theta \tan \phi = 2$, then value of $2\alpha^2 - \beta^2$ is: