NATIONAL ENTRANCE SCREENING TEST

NEST 2021

Participant ID	
Participant Name	
Test Center Name	
Test Date	14/08/2021
Test Time	2:30 PM - 6:00 PM
Subject	NEST 2021

Section : **Biology**

Q.1 Some characteristic features [presence (+) and absence (-)] of certain organisms belonging to various categories **P**, **Q**, **R**, **S** and **T** are listed (Table). The category that best satisfy the options is

Characteristics	P	Q	R	S	T
Membrane-bound organelles	-	+	+	+	-
Introns	-	+	+	+	-
Cell wall	+	+	+	+	+
Flagella/cilia	+	+	-	-	-
Chlorophyll-a	-	+	-	+	-
Mode of nutrition	Heterotrophic	Autotrophic	Heterotrophic	Autotrophic	Autotrophic

Ans

✗ 1.

P-Monera; **Q**-Cyanobacteria; **R**-Protista; **S**-Fungi; **T**-Plantae

✗ 2.

P-Fungi; **Q**-Protista; **R**-Monera; **S**-Plantae; **T**-Cyanobacteria

✗ 3.

P-Monera; **Q**-Plantae; **R**-Fungi; **S**-Protista; **T**-Cyanobacteria

✓ 4.

P-Monera; **Q**-Protista; **R**-Fungi; **S**-Plantae; **T**-Cyanobacteria

Question Type : **MCQ**
Question ID : **4146641078**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.2

A double-stranded DNA template with sequence 5'GCCATGAACTAGCTTCGATC-GATGCTTGCCTACGTCAGTC3' was PCR-amplified using forward (5'GAACTA3') and reverse (5'ACGTAG3') primers. Given the size and sequence of the new PCR fragment produced (Table), the correct combination from the options is

DNA fragment length	DNA fragment sequence
(i) 30	(k) 5'GAACTAGCTTCGATCGATGCTTGCCTACGT3'
(ii) 18	(l) 5'GCTTCGATCGATGCTTGCCTACGT3'
(iii) 35	(m) 5'CTTGATCGAAGCTAGCTACGAACGGATGCAGTCAG3'
(iv) 24	(n) 5'GCTTCGATCGATGCTTGC3'

Ans

1. ✗ iv and l
2. ✗ iii and m
3. ✗ ii and n
4. ✓ i and k

Question Type : **MCQ**
Question ID : **4146641074**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.3 An angiosperm plant of genotype **ppQqRRSS** pollinates another plant with genotype **PPQQRRss**. If the genes are not linked, the genotype of the embryo and endosperm in the resulting seeds will be

Ans

✗ 1.

embryo: **PPQQRRss**; endosperm: **PppQQqRRRSSs**

✗ 2.

embryo: **PpQqRRSs**; endosperm: **PPPQQqRRRSss**

✓ 3.

embryo: **PpQqRRSs**; endosperm: **PPpQQqRRRSss**

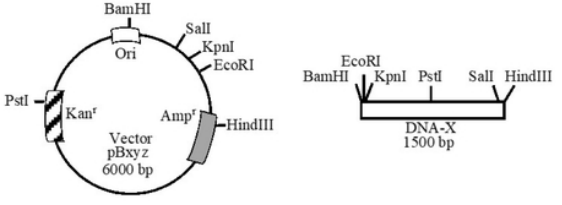
✗ 4.

embryo: **PPQQRRss**; endosperm: **PPpQQqRRRSss**

Question Type : **MCQ**
Question ID : **4146641071**
Status : **Answered**
Chosen Option : **2**
Marks : **-1**

Q.4 In four separate experiments (Table), a vector DNA pBxyz (6000 bp) and a DNA-X (1500 bp) fragment was digested with the indicated restriction enzymes. Both, the digested vector and DNA-X were purified and ligated. *Amp*^{r} represents the ampicillin resistant gene and *Ori* is the origin of replication. The resultant recombinant vector was transformed into *Escherichia coli* cells and incubated in a liquid nutrient medium with ampicillin for 24 hours at 37°C. Based on the restriction enzymes used for cloning, choose the correct option.

Experiment No.	Restriction enzymes used
1	*Bam*HI and *Sal*I
2	*Eco*RI and *Sal*I
3	*Kpn*I and *Hind*III
4	*Kpn*I and *Sal*I



Ans ✗ 1.

In experiment **4**, the transformed *Escherichia coli* will be ampicillin sensitive, and the recombinant vector cannot be isolated from these cells.

✓ 2.

In experiment **2**, the transformed *Escherichia coli* will be ampicillin resistant, and the recombinant vector can be isolated from these cells.

✗ 3.

In experiment **1**, the transformed *Escherichia coli* will be ampicillin resistant, and the recombinant vector can be isolated from these cells.

✗ 4.

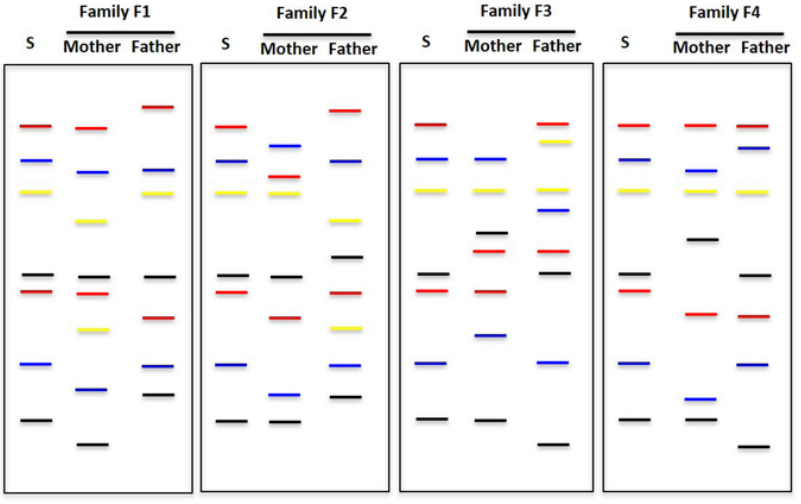
In experiment **3**, the transformed *Escherichia coli* will be ampicillin sensitive, and the recombinant vector can be isolated from these cells.

Question Type : **MCQ**
Question ID : **4146641073**
Status : **Answered**
Chosen Option : **2**

Marks : **2.5**

Q.5

DNA fingerprinting was performed on a human skeleton (**S**) to identify a missing person reported by four different families (**F1**, **F2**, **F3** and **F4**). Four short tandem repeat (STR) loci were independently PCR-amplified using DNA isolated from the family members and **S**. The diagram represents PCR products after gel electrophoresis showing the four STR loci (red, blue, yellow and black coloured lines). Based on these results, the family to which **S** relates is



Ans

✔ 1. **F3**

✘ 2. **F4**

✘ 3. **F1**

✘ 4. **F2**

Question Type : **MCQ**
Question ID : **4146641072**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.6 *Passiflora* plant produces toxic glucosides that protect its leaves from several insects. However, *Heliconius* caterpillars sequester these compounds for their own benefit. Thereby, it gains access to food that few insects can eat. Moreover, *Passiflora* leaves produce yellow spots that resemble *Heliconius* eggs. *Heliconius* butterflies avoid laying eggs on those leaves that already have eggs or yellow spots ensuring hatching of fewer caterpillars per leaf. Thus, *Passiflora* with these yellow spots are less likely to be eaten. In addition, *Passiflora* secretes abundant nectar that attracts ants responsible for caterpillar mortality. Given these interactions, the correct option is

Ans ✗ 1.

Mutualistic relationship exists between *Passiflora* and *Heliconius* caterpillars.

✗ 2.

The interaction between *Passiflora* and *Heliconius* caterpillars is commensalism.

✗ 3.

An invasive glucoside-resistant ant population will not affect *Heliconius* numbers.

✓ 4.

This is a typical example of co-evolution between *Passiflora* and *Heliconius*.

Question Type : **MCQ**
Question ID : **4146641069**
Status : **Answered**
Chosen Option : **4**
Marks : **2.5**

Q.7 Sterilization is the process in which all living organisms, including microbial endospores, are destroyed. A disinfectant is an antimicrobial agent used on inanimate objects such as an instrument. An antiseptic is an antimicrobial agent used on the skin externally. Antibiotics are administered either topically, orally or intravenously and can cause side-effects. Based on this information, the correct option is

Ans ✔ 1.

Viruses are destroyed by sterilization of inanimate objects, and not by antibiotics.

✘ 2.

Antibiotics work equally well on bacteria, fungi, and viruses.

✘ 3.

In contrast to antiseptics, an antibiotic is specific to a single species of microorganism.

✘ 4.

Disinfectants and antiseptics completely destroy all forms of life.

Question Type :	**MCQ**
Question ID :	**4146641068**
Status :	**Answered**
Chosen Option :	**3**
Marks :	**-1**

Q.8 The family tree of Lemurs split off from the Last Common Primate Ancestor (LCPA) as 'wet-nosed monkeys', while the other branch of 'dry-nosed monkeys' eventually gave rise to the human lineage. Thus, Lemurs are ancient evolutionary cousins of humans. While humans entirely depend on vitamin C as a dietary supplement (citrus fruits), Lemurs can synthesize their own. This is an example of divergent evolution wherein Lemurs have retained gene **P**, one of those responsible for vitamin C biosynthesis. The option that best satisfies this information is

Ans ✔ 1.

Humans lost the promoter, but retained rest of the protein coding features in the sequence of gene **P**.

✗ 2.

Horizontal transfer of gene **P** from DNA of dietary citrus fruit conferred vitamin C independence in Lemurs.

✗ 3.

Dry-nosed monkeys do not require vitamin C and therefore have lost the gene **P**.

✗ 4.

Consumption of citrus fruits caused mutations in human gene **P** leading to its loss of function.

Question Type : **MCQ**
Question ID : **4146641077**
Status : **Answered**
Chosen Option : **4**
Marks : **-1**

Q.9 During an excursion, students found a non-woody flowering plant and wanted to classify it either as a monocotyledonous or eudicotyledonous. The option that will **NOT** help them in classifying the plant is

Ans

✗ 1. root architecture

✓ 2. shape of the flower

✗ 3. number of cotyledons

✗ 4. vascular bundle arrangement

Question Type : **MCQ**
Question ID : **4146641070**
Status : **Answered**
Chosen Option : **1**
Marks : **-1**

Q.10 Oxidative phosphorylation is carried out by electron transport chain (ETC) present in the mitochondria of aerobes. The NADH or FADH2 produced in TCA (Kreb's) cycle transfers their electron to the ETC to finally reduce O_2. Based on this information, the correct option is

Ans

✗ 1.

Complex I of ETC is also an enzyme of the TCA cycle.

✗ 2.

Complex I transfers electrons to complex II in the ETC.

✗ 3.

Complex IV is an ATP synthase.

✓ 4.

Complex II does not transfer protons into the inter-membrane space.

Question Type :	**MCQ**
Question ID :	**4146641075**
Status :	**Not Answered**
Chosen Option :	**--**
Marks :	**0**

Q.11 A protein **X** with isoelectric point 6.5 was isolated. It was prepared in three different buffers **P**, **Q** and **R** with pH 4.0, 6.5 and 8.5, respectively. With respect to the net charge on protein **X**, the correct option is

Ans

✗ 1.

Net charge in **P** is positive and negative in both **Q** and **R**.

✗ 2.

Net charge in both **P** and **Q** is positive and negative in **R**.

✗ 3.

Net charge in **P** is positive and in **R** is negative while both positive and negative charges are absent in **Q**.

✓ 4.

Net charge in **P** is positive and in **R** is negative, while both positive and negative charges are present in **Q**.

Question Type : **MCQ**
Question ID : **4146641076**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.12 The 2020 Nobel prize in chemistry was awarded for the CRISPR/Cas9 system. This concept was derived from

Ans

✗ 1.

mechanism of hepatitis C viral entry into host cells.

✗ 2.

hepatitis C viral genome replication system.

✓ 3.

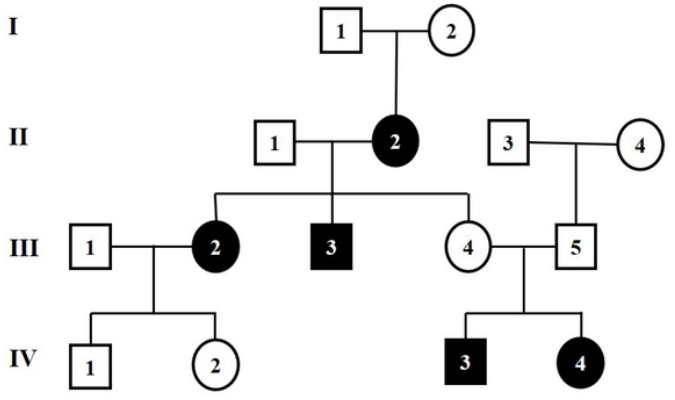
bacterial defence machinery against a viral infection.

✗ 4.

human immune system to fight against the virus.

Question Type :	**MCQ**
Question ID :	**4146641067**
Status :	**Not Answered**
Chosen Option :	**--**
Marks :	**0**

Q.13 In the given pedigree, circles represent females and squares represent males. Filled shapes indicate affected individuals for a particular trait, while unfilled shapes indicate unaffected individuals. Carrier status is not shown in the pedigree. Study the following statements about this pedigree and choose the correct option(s).



Statement **1**- Trait follows X-linked recessive mode of inheritance.
Statement **2**- Trait follows X-linked dominant mode of inheritance.
Statement **3**- Trait follows autosomal recessive mode of inheritance.
Statement **4**- Individual II-1 is a carrier for the trait.
Statement **5**- Individual III-4 is a carrier for the trait.
Statement **6**- Individual I-1 is a carrier for the trait.

Ans

✗ 1. Statements **1** and **6**

✗ 2. Statements **2** and **6**

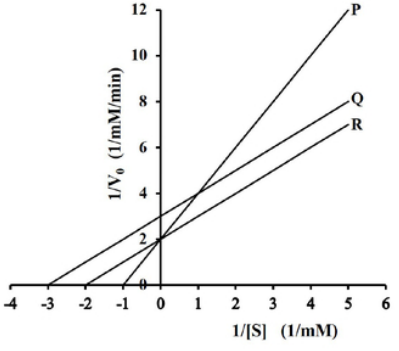
✗ 3. Statements **1** and **4**

✓ 4. Statements **3** and **5**

Question Type : **MSQ**
Question ID : **4146641081**
Status : **Answered**
Chosen Option : **1,2**
Marks : **0**

Q.14

A researcher determined the initial velocity (V_0) of an enzyme in three different reactions (corresponding to lines **P**, **Q** and **R** in the graph) with increasing substrate concentrations ([S]). The results were analyzed using a reciprocal plot where $1/V_0$ is plotted against $1/[S]$ (Graph). Reaction **1** was performed without any inhibitory compound. Reaction **2** was performed with compound-**X** that inhibits enzyme activity by binding to the substrate binding site. Reaction **3** was performed with compound-**Y** that inhibits enzyme activity by binding to a site other than the substrate binding site. If K_m of the enzyme in reaction **1** is 0.5 mM, then the correct statement(s) from the following options is(are)



Ans ✗ 1.

Reaction **1** is **P**, reaction **2** is **Q** and reaction **3** is **R**.

✓ 2.

Reaction **1** is **R**, reaction **2** is **P** and reaction **3** is **Q**.

✗ 3.

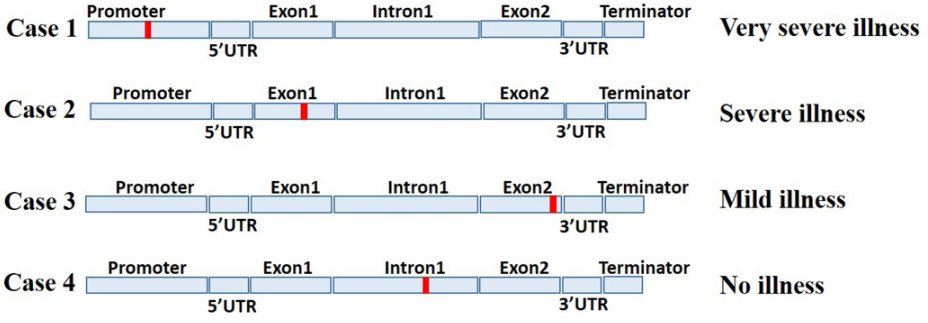
Reaction **1** is **Q**, reaction **2** is **P** and reaction **3** is **R**.

✓ 4.

K_m of reaction **Q** is less than K_m of reaction **R**.

Question Type : **MSQ**
Question ID : **4146641082**
Status : **Answered**
Chosen Option : **1,4**
Marks : **0**

Q.15 The *CENTN1* gene encodes the protein centrin that is localized to the centriolar apparatus. Mutation in this gene may give rise to dysfunctional cilia leading to respiratory disorders with different degrees of severity. Fifty thousand individuals of a Caucasian population with a range of respiratory illnesses were analyzed for mutations in this gene. The red mark on the respective regions of the genes are the positions of the mutations identified (Figure). Given these results, the correct option(s) is(are)



Ans ✗ 1.

In case 4, a truncated protein is made from a normally spliced mRNA resulting in functional cilia, thereby not affecting the individuals

✓ 2.

In case 3, a mutation resulted in a stop codon, resulting in partially functional cilia and hence individuals have mild illness.

✓ 3.

In case 2, an intact mutated or truncated protein is produced resulting in dysfunctional cilia and individuals with severe illness.

✓ 4.

In case 1, the gene is not transcribed, and no protein is produced resulting in dysfunctional cilia and individuals with very severe illness.

Question Type : **MSQ**
Question ID : **4146641079**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.16 During evolution, the mitochondrial genome lost many genes, and some of these got incorporated into the nuclear genome. Proteins synthesized in the cytoplasm are transported to various destinations, including some that are secreted outside the cell. Based on the transport and localization of proteins within cells, the correct option(s) is(are)

Ans ✗ 1.

Proteins secreted outside the cell are not transported via the endoplasmic reticulum.

✗ 2.

All proteins with mitochondrial function are synthesized inside the mitochondria.

✓ 3.

All the proteins having nuclear function are synthesized in the cytoplasm.

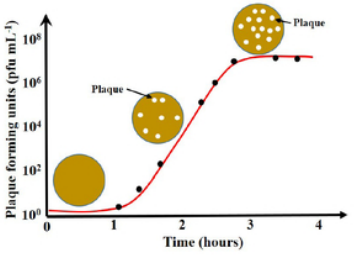
✓ 4.

Some nuclear encoded proteins are transported to the mitochondria.

Question Type :	**MSQ**
Question ID :	**4146641083**
Status :	**Answered**
Chosen Option :	**3,4**
Marks :	**4**

Q.17

Escherichia coli grown in liquid nutrient medium is infected with a virus at a concentration that will result in the entry of a single virus per bacterium. This eventually results in lysis (death) of the *Escherichia coli* cell releasing the viral progeny that can in turn infect neighboring cells. Such a culture is incubated at 37°C, and the cell-free supernatant is sampled every few minutes in order to enumerate the viral progeny. At each time-point, the sampled culture is placed on a solid nutrient medium with a lawn of *Escherichia coli* cells. Each virus multiplies locally giving rise to a colony observed as clear zones (plaques) and measured as the number of plaque-forming units (pfu).



Analyze the graph obtained from this experiment and choose the correct option(s).

Ans

✔ 1.

The initial lag period is the time taken by the viruses to attach and enter the bacterial cells.

✔ 2.

An antibiotic effective against *Escherichia coli* when added at 0.2 hour will not result in any viral progeny.

✘ 3.

When *Escherichia coli* is infected with an attenuated virus, a similar sigmoidal curve should be observed.

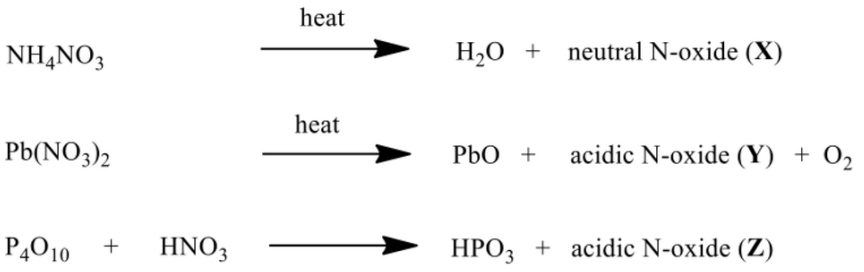
✘ 4.

The slope of this sigmoidal curve is not indicative of rate of viral multiplication.

Question Type : **MSQ**
Question ID : **4146641080**
Status : **Answered**
Chosen Option : **1,3**
Marks : **0**

Section : **Chemistry**

Q.1 Consider the following reactions (unbalanced)



In the N-oxides (X, Y and Z), the oxidation state of nitrogen increases in the order

Ans

✗ 1. $Y < X < Z$

✗ 2. $Z < Y < X$

✗ 3. $X < Z < Y$

✓ 4. $X < Y < Z$

Question Type : **MCQ**
Question ID : **4146641086**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.2

Among the following, the weakest σ-bond is

Ans

✔ 1. N-N

✘ 2. C-C

✘ 3. P-P

✘ 4. Cl-Cl

Question Type : **MCQ**
Question ID : **4146641088**
Status : **Answered**
Chosen Option : **2**
Marks : **-1**

Q.3

To determine the exact amount of acetic acid in a sample, 1.5 g of the sample is titrated against 0.5 N solution of KOH. For the titration, 30 mL solution of KOH is required. The percentage content (weight wise) of acetic acid in the given sample is

Ans

✗ 1. 75 %

✗ 2. 90 %

✓ 3. 60 %

✗ 4. 85 %

Question Type : **MCQ**
Question ID : **4146641084**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.4

Group 16 elements form hydrides of the type H_2E (H_2O, H_2S, H_2Se and H_2Te). The correct statement regarding these hydrides is

Ans ✔ 1.

Enthalpy of dissociation of H-E bond decreases down the group.

✗ 2.

The H-Te-H bond angle is greater than the H-O-H bond angle.

✗ 3.

H_2S is a stronger reducing agent than H_2Se.

✗ 4.

All these hydrides form strong intermolecular hydrogen bonds.

Question Type :	**MCQ**
Question ID :	**4146641087**
Status :	**Answered**
Chosen Option :	**1**
Marks :	**2.5**

Q.5 Compound 'X' ($C_4H_{11}N$) reacts with nitrous acid to form 'Y' ($C_4H_{10}N_2O$). 'X' on reaction with an excess of methyl iodide and then with moist silver oxide followed by heating gives trimethyl amine, propene and water. Compound 'X' is

Ans

✔ 1. N-Methyl-1-propanamine

✗ 2. 2-Methyl-1-propanamine

✗ 3. N,N-Dimethylethanamine

✗ 4. 2-Butanamine

Question Type : **MCQ**
Question ID : **4146641089**
Status : **Answered**
Chosen Option : **3**
Marks : **-1**

Q.6 Metal 'X' reacts with dilute sulphuric acid to liberate gas 'Y'. It also reacts with aq. NaOH to give 'Y'. Metal 'X' is

Ans

✗ 1. Cu

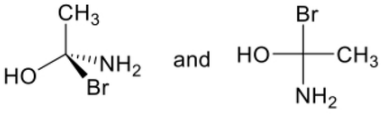
✓ 2. Zn

✗ 3. Fe

✗ 4. Mn

Question Type : **MCQ**
Question ID : **4146641085**
Status : **Answered**
Chosen Option : **4**
Marks : **-1**

Q.7 The compounds represented by the following two structures are



Ans

✔ 1. Enantiomers.

✗ 2. not related to each other.

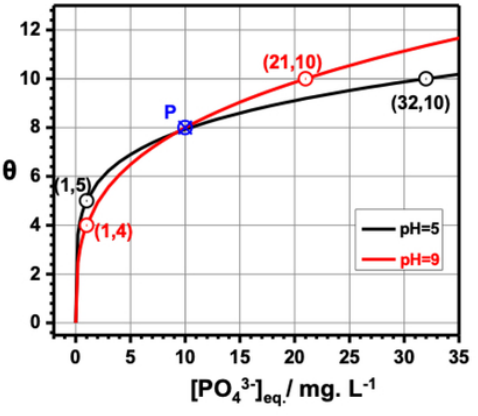
✗ 3. identical.

✗ 4. Anomers.

Question Type : **MCQ**
Question ID : **4146641090**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.8

The Fe_2O_3-TiO_2 composite is used to adsorb the phosphate pollutant in waste water. The adsorption capacity of Fe_2O_3-TiO_2 composite for phosphate ions (θ = mass of phosphate ion in mg / mass of Fe_2O_3-TiO_2 composite in g) from waste water as a function of equilibrium concentration of phosphate ion, i.e. $[PO_4^{3-}]_{eq.}$ at two different pH of waste water at 300 K is shown in the figure below. The isotherms fit to the Freundlich adsorption isotherm. The correct option regarding the isotherm parameters k and n, is



Ans ✔ 1.

Values of k and n at pH 5 are larger than those at pH 9.

✗ 2.

Values of k and n at pH 9 are larger than those at pH 5.

✗ 3.

At the point P in the plots, the values of k and n for both the pH are same.

✗ 4.

Value of k is larger for pH 5 while n is larger for pH 9.

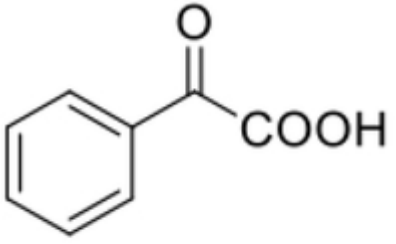
Question Type : **MCQ**
Question ID : **4146641095**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.9

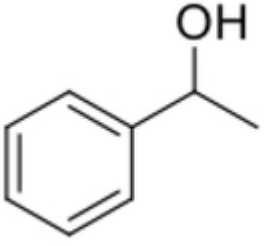
The product of the reaction of styrene ($C_6H_5CH{=}CH_2$) with diborane (B_2H_6), followed by reaction with alkaline hydrogen peroxide is

Ans

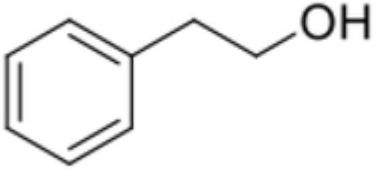
✗ 1.



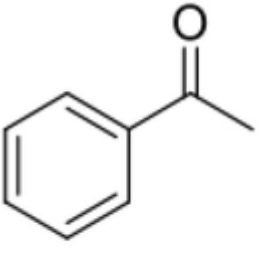
✗ 2.



✓ 3.



✗ 4.



Question Type : **MCQ**

Question ID : **4146641091**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.10

A monoatomic ideal gas kept in a vessel fitted with a piston is expanded irreversibly from its initial state (1 L, 1 atm, at 300 K) to the final state (10 L, 420 K). The enthalpy and entropy changes in the process are, respectively

Ans

✗ 1.

$2494\ \text{J and } 8.314\ [(3/2)\ \ln 1.4 + \ln 10]\ \text{J K}^{-1}$

✗ 2.

$1\ \text{J and } (3\ \ln 1.4 + 2\ \ln 10)/600\ \text{J K}^{-1}$

✗ 3.

$24.6\ \text{L atm and } 0.041\ (3\ \ln 1.4 + 2\ \ln 10)\ \text{L atm K}^{-1}$

✓ 4.

$1\ \text{L atm and } (3\ \ln 1.4 + 2\ \ln 10)/600\ \text{L atm K}^{-1}$

Question Type : **MCQ**
Question ID : **4146641093**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.11 The correct order of the wavelengths of the radiations, associated with the following, is

Ans

✗ 1.

red-light from traffic signal < sodium D-lines < stretching vibration of H_2O < transmission from FM radio

✗ 2.

transmission from FM radio < stretching vibration of H_2O < sodium D-lines < red-light from traffic signal

✓ 3.

sodium D-lines < red-light from traffic signal < stretching vibration of H_2O < transmission from FM radio

✗ 4.

sodium D-lines < stretching vibration of H_2O < red-light from traffic signal < transmission from FM radio

Question Type : **MCQ**
Question ID : **4146641092**
Status : **Answered**
Chosen Option : **4**
Marks : **-1**

Q.12

Consider the following reaction

$$A(g) \rightarrow B(g) + C(g)$$

The following data were obtained in a 500 ml flask at 300 K

Time (s)	Total Pressure (Torr)
0	80
2	120
4	140

The rate of reaction (in Torr s^{-1}) at $t = 8$ s is

Ans

✔ 1. $2.5 \ln 2$

✘ 2. $0.5 \ln 2$

✘ 3. $2.0 \ln 2$

✘ 4. $1.5 \ln 2$

Question Type : **MCQ**
Question ID : **4146641094**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.13

In general, hard acids and hard bases are small in size and non-polarizable, whereas soft acids and soft bases are larger and more polarizable. Interaction between hard-hard or soft-soft species is found to be stronger than that between a hard-soft species. The correct statement(s) is/are

Ans

✔ 1.

Since Cu^{2+} forms $[Cu(NH_3)_4]^{2+}$ more favourably than $Cu(OH)_2$, it shows that Cu^{2+} acts as a soft acid.

✘ 2.

Ag^+ is a soft acid and interacts more strongly with chloride than with iodide ion.

✔ 3.

Soft metal ions tend to form sulfide ores and hard metal ions form oxide ores.

✔ 4.

Assuming CO to be a soft base, its complex formation with Fe is favoured as compared to that with Fe^{3+}.

Question Type :	**MSQ**
Question ID :	**4146641097**
Status :	**Answered**
Chosen Option :	**1,3**
Marks :	**0**

Q.14

The addition of hydrogen bromide to 1,3-butadiene at two different temperatures give two products in different amounts as given below.

In these reactions, the first step is the addition of proton to one of the double bonds to form carbocation. At a lower temperature, the more stable carbocation is immediately attacked by bromide ion to form the product. At the higher temperature there is equilibrium among the products and the reactants, which decides the product. The correct statement(s) is/are

Ans

✔ 1. $q > s$

✔ 2. $r > s$

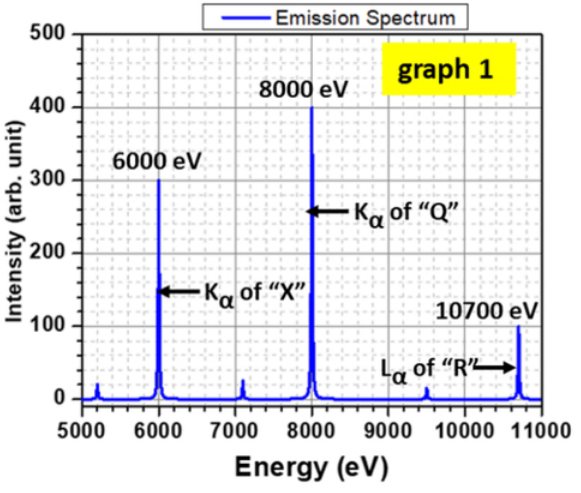
✔ 3.
1-Bromo-2-butene is more stable than 3-bromo-1-butene

✘ 4.
The activation energy required for the formation of 3-bromo-1-butene is higher than that for the formation of 1-bromo-2-butene

Question Type : **MSQ**
Question ID : **4146641098**
Status : **Answered**
Chosen Option : **1,3**
Marks : **0**

Q.15

Graph 1 represents an emission spectrum of an antique species containing various metals (X, Q and R). The peaks marked as K_α are due to transition from the 2p shell to the 1s shell, while the peak marked as L_α is due to transition from the 3d shell to the 2p shell. In multi-electron atoms, the hydrogen atom energy expression can be used if the nuclear charge Z is replaced by (Z-σ), where σ represents the screening or shielding constant. The values for σ that can be taken for the shells involved in K_α and L_α are 2 and 5, respectively. The correct statement(s) is/are



Ans

✔ 1.

The metal X is an essential element in human blood.

✗ 2.

The metal R is an inner transition element.

✔ 3.

$Q(CO)_3$ follows the 18-electron rule.

✗ 4.

The calculated spin-only magnetic moment for X^{2+} ion is 5.92 BM.

Question Type : **MSQ**
Question ID : **4146641100**
Status : **Answered**
Chosen Option : **1,2**

Marks : **0**

Q.16 A chromite ore 'P' reacts with calcined soda to form a yellow coloured solution containing iron(III) oxide and compound 'Q'. This solution is filtered and the filtrate is acidified with sulphuric acid to form an orange solution containing compound 'R', which can be crystallized. In solution, the compounds 'Q' and 'R' are inter-convertible depending on the pH of the solution. 'R' on treatment with potassium chloride forms the product 'S'. The correct statement(s) is/are

Ans ✗ 1.

The chromite ore 'P' contains only Cr and oxide ions.

✗ 2.

The oxidation state of the Cr in 'Q' is +3, whereas in 'R' and 'S' it is +6

✓ 3.

The geometry around Cr in 'Q', 'R' and 'S' is tetrahedral.

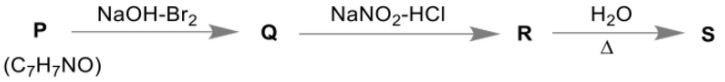
✓ 4.

The acidified 'S' reacts with Fe^{2+} ions and changes them into Fe^{3+} ions.

Question Type : **MSQ**
Question ID : **4146641096**
Status : **Answered**
Chosen Option : **2,3**
Marks : **0**

Q.17

The correct statement(s) based on the reaction scheme given below is/are



Ans ✔ 1.

The compound Q can be reacted with R in the presence of a base to form a dye.

✔ 2.

The compound Q is basic and S is acidic in nature.

✔ 3.

The compound S can be reacted with R in the presence of a base to form a dye.

✘ 4.

The compounds P and Q have the same number of carbon atoms.

Question Type :	**MSQ**
Question ID :	**4146641099**
Status :	**Answered**
Chosen Option :	**3,4**
Marks :	**0**

Section : **Mathematics**

Q.1

The function $f : \mathbb{R} \to \mathbb{R}$ is defined as follows

$$f(x) = \begin{cases} e^{-\frac{1}{|x|}}, & x \neq 0 \\ 0, & x = 0 \end{cases}$$

Then

Ans

✔ 1.

f is differentiable and its derivative is continuous

✗ 2.

f is nowhere continuous on $\mathbb{R}$

✗ 3.

f is continuous but not differentiable

✗ 4.

f is differentiable and its derivative is not continuous

Question Type :	**MCQ**
Question ID :	**4146641106**
Status :	**Not Attempted and Marked For Review**
Chosen Option :	**--**
Marks :	**0**

Q.2 Let $P(h,k)$ with $h > 0, k > 0$ be a point on the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$, (where $a > b > 0$), whose foci are F_1 and F_2. The normal at P intersects the major axis at Q. If $PF_1 : PF_2 = 2 : 1$ then $QF_1 : QF_2$ equals

Ans

✗ 1. $3 : 2$

✗ 2. $1 : 2$

✓ 3. $2 : 1$

✗ 4. $1 : 1$

Question Type : **MCQ**
Question ID : **4146641110**
Status : **Answered**
Chosen Option : **2**
Marks : **-1**

Q.3 A group of 5 students, X, Y, Z, P, Q, have the following combination of two subjects each in their first year of college.
X studies Physics and Mathematics, Y studies Physics and Biology, Z studies Biology and Mathematics, P studies Chemistry and Physics and Q studies Mathematics and Chemistry.
A sixth student R joins this group. If he has a subject in common with each of the other students, then his possible subjects of study are

Ans

✗ 1. Biology and Chemistry

✗ 2. Mathematics and Biology

✓ 3. Mathematics and Physics

✗ 4. Chemistry and Mathematics

Question Type : **MCQ**
Question ID : **4146641102**
Status : **Answered**
Chosen Option : **3**
Marks : **2.5**

Q.4

The number of solution(s) of the equation

$$\sin x = x$$

is/are

Ans

✗ 1. 4

✗ 2. 2

✓ 3. 1

✗ 4. 3

Question Type : **MCQ**
Question ID : **4146641111**
Status : **Answered**
Chosen Option : **3**
Marks : **2.5**

Q.5 The number of positive integers n such that $2^n + 7^n$ is a perfect square is

Ans

✗ 1. 3

✓ 2. 1

✗ 3. 2

✗ 4. 0

Question Type : **MCQ**
Question ID : **4146641112**
Status : **Answered**
Chosen Option : **2**
Marks : **2.5**

Q.6 NISER and CEBS anticipate admission of 200 students in the next semester and plans to offer jointly a number of online courses in both the places. The institutes decide to let each student choose exactly three courses and also do not want any two students to choose the same set of three courses. The minimum number of online courses required to be offered to accomplish this is

Ans

✔ 1. 12

✘ 2. 20

✘ 3. 7

✘ 4. 67

Question Type : **MCQ**
Question ID : **4146641107**
Status : **Answered**
Chosen Option : **1**
Marks : **2.5**

Q.7 If $\tan(\cot x) = \cot(\tan x)$, then one of the possible values of $\sin 2x$ is

Ans

✔ 1. $\dfrac{4}{41\pi}$

✘ 2. $\dfrac{2}{\pi}$

✘ 3. $\dfrac{5}{\pi}$

✘ 4. $\dfrac{3}{\pi^2}$

Question Type : **MCQ**
Question ID : **4146641105**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.8

The set of real numbers $a > 0$ for which the inequality

$$\frac{1}{\sqrt{a}}\int_1^a \left(\frac{3}{2}\sqrt{x}+1-\frac{1}{\sqrt{x}}\right)dx < 4$$

is valid, lie in the interval

Ans

✔ 1. $(0, 4)$

✘ 2. $(0, 2)$

✘ 3. $(2, 3)$

✘ 4. $(1, 4)$

Question Type : **MCQ**
Question ID : **4146641109**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.9 The real values of x for which the points $(1, -1, 2), (2, 0, 3), (4, 2, 5)$ and (x, x, x) are coplanar are:

Ans

1. $-1 \leq x \leq 1$
2. any real value of x
3. $x = 1$ only
4. $x = -1$ only

Question Type : **MCQ**
Question ID : **4146641104**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.10

If $P = \{n, i, s, e, r\}$, $Q = \{n, e, s, t\}$ and $R = \{c, e, b, s\}$, then the number of elements in $(P \cup Q) \times R$ is

Ans

1. 26 ✗
2. 24 ✓
3. 20 ✗
4. 22 ✗

Question Type : **MCQ**
Question ID : **4146641103**
Status : **Answered**
Chosen Option : **2**
Marks : **2.5**

Q.11

Let $d_1, d_2, d_3, \cdots, d_r$ be all the positive divisors of n. If $d_1 + d_2 + \cdots + d_r = 1000$, then

$$\frac{1}{d_1} + \frac{1}{d_2} + \cdots + \frac{1}{d_r}$$

equals

Ans

✔ 1. $\dfrac{1000}{n}$

✘ 2. $\dfrac{r^2}{1000}$

✘ 3. $\dfrac{1000}{n^2}$

✘ 4. $\dfrac{1000}{r^2}$

Question Type : **MCQ**
Question ID : **4146641101**
Status : **Answered**
Chosen Option : **2**
Marks : **-1**

Q.12 Two distinct complex numbers a, b are such that the roots of $x^2 + bx + a = 0$ are squares of the roots of $x^2 + ax + b = 0$. Let $X = \sum_{k=0}^{2022} a^k$ and $Y = \sum_{k=1}^{2022} b^k$. Then $X + Y$ is

Ans

✗ 1. $\sqrt{-1}$

✓ 2. 1

✗ 3. 0

✗ 4. 2

Question Type : **MCQ**
Question ID : **4146641108**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.13

Let $f(n)=\int_0^1 \tan^{-1}(\sqrt[n]{x})dx$ where n is a positive integer. Then

Ans

✗ 1.

$\lim_{n\to\infty}(f(n)+f(n+2))$ exists and is equal to π

✗ 2.

there exists a positive integer n_0 such that $f(n)>f(n+1)$ for all positive integers $n\geq n_0$

✓ 3.

$$f(n)<f(n+1)<\frac{\pi}{4} \text{ for all } n$$

✓ 4.

$\lim_{n\to\infty}(f(n)+f(n+2))$ exists and is equal to $\frac{\pi}{2}$

Question Type :	**MSQ**
Question ID :	**4146641117**
Status :	**Answered**
Chosen Option :	**2,3**
Marks :	**0**

Q.14 Let $\hat{i}, \hat{j}, \hat{k}$ be three mutually orthogonal unit vectors. Let $\vec{x} = \hat{i} + \hat{j}$, $\vec{y} = \hat{j} + \hat{k}$ and $\vec{z} = \hat{k} + \hat{i}$. Then

Ans ✗ 1.

Vectors $\vec{x}$, $\vec{y}$, $\vec{z}$ are mutually orthogonal

✓ 2.

$$\vec{x} + \vec{y} + \vec{z} = 2(\vec{x} \times \vec{y} + \vec{y} \times \vec{z} + \vec{z} \times \vec{x})$$

✓ 3.

$$\vec{x}.\vec{x} + \vec{y}.\vec{y} + \vec{z}.\vec{z} = 2(\vec{x}.\vec{y} + \vec{y}.\vec{z} + \vec{z}.\vec{x})$$

✓ 4.

Vectors $\vec{x}$, $\vec{y}$, $\vec{z}$ are not coplanar

Question Type : **MSQ**
Question ID : **4146641116**
Status : **Answered**
Chosen Option : **1,2**
Marks : **0**

Q.15

The polynomial $p(x) = 2x^5 - 10x + 5$ has

Ans

✗ 1.

one real root and 4 complex roots

✓ 2.

no rational root

✓ 3.

three real roots and 2 complex roots

✗ 4.

only real roots

Question Type :	**MSQ**
Question ID :	**4146641113**
Status :	**Not Answered**
Chosen Option :	**--**
Marks :	**0**

Q.16

Let $f : X \to Y$ be a function. If $P \subset X$ and $Q \subset Y$, define $f(P) = \{f(x) : x \in P\}$ and $f^{-1}(Q) = \{x : f(x) \in Q\}$. Then the true statement/statements is/ are

Ans

✔ 1. $f^{-1}(Q) \cap f^{-1}(R) = f^{-1}(Q \cap R)$

✘ 2. $f(f^{-1}(Q)) = Q$

✔ 3. $f^{-1}(Q) \cup f^{-1}(R) = f^{-1}(Q \cup R)$

✘ 4. $f^{-1}(f(P)) = P$

Question Type : **MSQ**
Question ID : **4146641114**
Status : **Answered**
Chosen Option : **2,4**
Marks : **0**

Q.17

For a square matrix X, let $det(X)$ be the determinant of X and let X^T be the transpose of the matrix X. If P and Q are two 3×3 invertible real matrices, then the correct statement/statements is/are

Ans

✔ 1.

$$det(adj(P)) = [det(P)]^2, \text{ where } adj(P) \text{ is the adjoint of } P$$

✘ 2.

$$det(cP) = c \cdot det(P), \text{ where } c \text{ is a real number}$$

✔ 3.

$$det(QP(Q^T)^{-1}) = det(P)$$

✘ 4.

$$det(P + Q) = det(P^T) + det(Q)$$

Question Type :	**MSQ**
Question ID :	**4146641115**
Status :	**Answered**
Chosen Option :	**4**
Marks :	**0**

Section : **Physics**

Q.1 A car in one dimensional motion with initial speed v_0 is accelerated with constant acceleration a_0 for a distance s. Each time the car travels a distance $s = v_0^2/2a_0$, the acceleration of the car is reduced by a multiplying factor $\lambda < 1$. If the final speed of the car doubles (at a very large distance from the starting point) then the value of λ is

Ans

✗ 1. $4/5$

✗ 2. $1/\sqrt{3}$

✗ 3. $3/4$

✓ 4. $2/3$

Question Type : **MCQ**
Question ID : **4146641120**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.2

Consider two identical circular solenoids, each of length L, radius $\rho \ll L$ and total number of turns N. The solenoids are on the same axis and distance $d \gg L$ apart. The ratio of mutual inductance to self inductance for this system is

Ans

✗ 1. $\frac{\rho^2 N^2 L}{d^3}$

✗ 2. $\frac{\rho^2 L}{d^3}$

✗ 3. $\frac{\rho^2 L}{N^2 d^3}$

✓ 4. $\frac{\rho^2 L}{2d^3}$

Question Type : **MCQ**
Question ID : **4146641122**
Status : **Answered**
Chosen Option : **4**
Marks : **2.5**

Q.3 A scientist found a specimen in which the decay constant of nuclei X and nuclei Y are 9 λ and λ respectively. At $t = 0$ s the number of X and Y nuclei were the same. The ratio of number of X nuclei to that of Y nuclei will reduce to $(1/e)^4$ after a time interval of

Ans

✗ 1. $1/4\lambda$

✗ 2. $1/3\lambda$

✓ 3. $1/2\lambda$

✗ 4. $1/\lambda$

Question Type : **MCQ**
Question ID : **4146641119**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.4 Two point charges q and $-2q$ are located at $(a,0,0)$ and $(0,0,0)$ respectively. Assume that the potential V is vanishing at infinity. The correct statement about the $V = 0$ surface (at finite distance) is:

Ans

✗ 1.

a plane perpendicular to x-axis and passing through $(2a, 0, 0)$.

✗ 2.

a plane perpendicular to x-axis and passing through $(2a/3,0,0)$.

✓ 3.

a sphere centered at $(4a/3, 0, 0)$ and of radius $2a/3$.

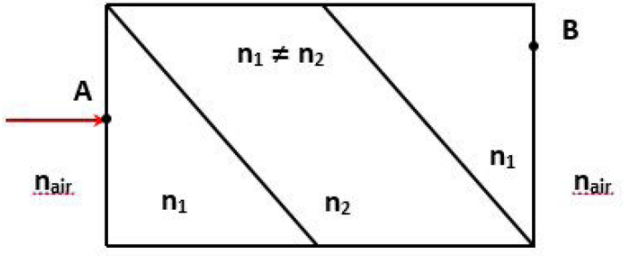
✗ 4.

a cylinder whose axis passes through $(4a/3, 0, 0)$ and of radius $2a/3$.

Question Type : **MCQ**
Question ID : **4146641123**
Status : **Answered**
Chosen Option : **1**
Marks : **-1**

Q.5

A ray of light is incident perpendicularly at point A on a rectangular medium with different refractive indices, n_1 and n_2, in a configuration as shown schematically in the figure. The angle that the emergent ray makes, with respect to normal at point B, is



Ans

✗ 1. greater than $0°$

✗ 2. less than $0°$

✓ 3. $0°$

✗ 4. $\sin^{-1}(n_2/n_1)$

Question Type :	**MCQ**
Question ID :	**4146641118**
Status :	**Answered**
Chosen Option :	**4**
Marks :	**-1**

Q.6 A refrigerator with a 50 W motor is to be used to freeze 2 kg of water at 273 K in an insulated vessel. The outside temperature is 300 K. The smallest possible time to do this is (take the latent heat of fusion of water to be 3.33×10^5 J·kg^{-1})

Ans

✗ 1. 2.51×10^3 s

✗ 2. 2.80×10^3 s

✗ 3. 1.19×10^3 s

✓ 4. 1.31×10^3 s

Question Type : **MCQ**
Question ID : **4146641128**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.7

In a radioactive decay, Plutonium disintegrates to ^{235}U and an α particle. After the disintegration the mass difference between the parent nucleus and the products of the decay is found to be 0.00536 u. The energy of the released α particle is reduced while passing through a Mylar sheet with linear absorption coefficient of 1.40 cm^{-1}. If the energy of the most energetic α particles is to be reduced to 2 MeV the thickness of the Mylar sheet will be

Ans

✔ 1. 0.65 cm

✘ 2. 0.75 cm

✘ 3. 0.85 cm

✘ 4. 0.95 cm

Question Type : **MCQ**
Question ID : **4146641129**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.8 A bimetallic strip of lead and nickel has a total thickness of 8 cm (4 cm each). The strip is straight at a temperature of 300 K. The coefficient of linear expansion of lead is $29 \times 10^{-6}\ K^{-1}$ and that of nickel is $16 \times 10^{-6}\ K^{-1}$. If the strip is heated to 400 K, then the radius of curvature of the strip is close to

Ans

✗ 1. 90 cm

✓ 2. 30 m

✗ 3. 35 cm

✗ 4. 9 m

Question Type : **MCQ**
Question ID : **4146641127**
Status : **Answered**
Chosen Option : **2**
Marks : **2.5**

Q.9 Suppose you are doing a diffraction experiment using a white light source on a piece of grating in which the number of grooves is 10,000 lines per centimeter. After shining this light on the grating a first order diffraction of the shortest and longest wavelengths of light (380 nm and 760 nm) is visible on a screen 2 m away from the grating. The distance between the ends of the rainbow produced on the screen is

Ans

✗ 1. 4.52 m

✓ 2. 1.52 m

✗ 3. 3.15m

✗ 4. 1.15 m

Question Type : **MCQ**
Question ID : **4146641125**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.10

Certain theoretical calculations using quantum and relativistic concepts show that an accelerating observer (with constant linear acceleration) measures a temperature even in empty space. Using dimensional analysis, one can express this temperature in terms of the Boltzmann constant k_B, acceleration a and the fundamental constants of special relativity c and of quantum mechanics h. If temperatures measured by two observers are in the ratio $T_1/T_2 = 9$ then the ratio of their accelerations a_1/a_2 is equal to

Ans

✗ 1. 81

✓ 2. 9

✗ 3. 3

✗ 4. $\sqrt{3}$

Question Type : **MCQ**
Question ID : **4146641124**
Status : **Answered**
Chosen Option : **2**
Marks : **2.5**

Q.11 A mass of 2 Kg hangs vertically from the end of a string of mass 0.4 Kg and length 2 m. The time, a transverse pulse will take to travel from bottom to top is close to,

Ans

✗ 1. $1.8\ \text{s}$

✗ 2. $0.4\ \text{s}$

✗ 3. $2.2\ \text{s}$

✓ 4. $0.2\ \text{s}$

Question Type : **MCQ**
Question ID : **4146641126**
Status : **Answered**
Chosen Option : **4**
Marks : **2.5**

Q.12 Two point beads of mass m each are free to slide on a horizontal rod of length l and mass M. Initially, the beads are at the center of the rod and the rod is spining freely at an angular velocity ω_0 rad.s^{-1} about a vertical axis through its center. Slowly the beads start moving radially out. The spinning frequency of the rod, when the beads fly tangentially off the rod is

Ans

✔ 1. $\dfrac{\omega_0}{1+6m/M}$

✘ 2. $\omega_0(1+6m/M)$

✘ 3. ω_0

✘ 4. $\dfrac{\omega_0}{1+m/M}$

Question Type : **MCQ**
Question ID : **4146641121**
Status : **Not Answered**
Chosen Option : **--**
Marks : **0**

Q.13 In an experiment, 1 kg of water, initially at 283 K is heated to 363 K via two processes. In process I, water is brought into contact with a heat reservoir at 363 K. In process II, water is first brought into contact with a heat reservoir at 323 K and then in contact with another reservoir at 363 K. Assume that the specific heat capacity of water, C is independent of temperature. Choose the correct options from the following. (Note $\ln(363) = 5.8944$; $\ln(323) = 5.7777$; $\ln(283) = 5.6454$)

Ans

✔ 1.

The absolute value of the change in entropy of the reservoir(s) ΔS_R is more in process II than in process I.

✔ 2.

Total entropy change of the heat reservoirs in process II is -0.234 C.

✘ 3.

Change in entropy ΔS_w of water is more in process I than in process II .

✔ 4.

Total entropy change of the universe in process I is 0.0286 C.

Question Type :	**MSQ**
Question ID :	**4146641131**
Status :	**Answered**
Chosen Option :	**3,4**
Marks :	**0**

Q.14 A nozzle is situated at a distance of 5.6 m above the ground level and is pointed up at angle of 45 degrees to the horizontal. The diameter of the nozzle is $1/\sqrt{\pi}$ cm and the jet of water from the nozzle strikes the ground at a horizontal distance of 14 m. Select the correct statement(s).

Ans

✔ 1.

The flow rate of the nozzle is 250 $cm^3 \cdot s^{-1}$.

✔ 2.

At a horizontal distance of 5 m from the initial point, the magnitude of the force on a vertical sheet in the path of the jet is 1.25 N.

✘ 3.

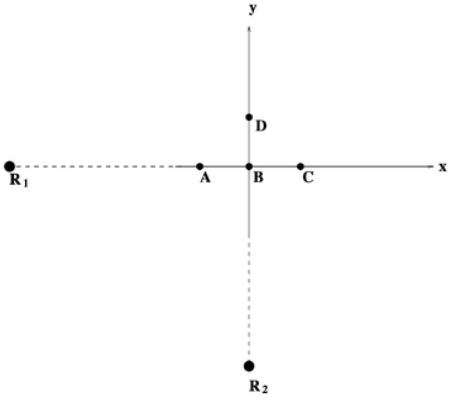
The speed of the water just before reaching the ground is 10 $m \cdot s^{-1}$.

✘ 4.

The initial speed of the water is 1 $m \cdot s^{-1}$.

Question Type :	**MSQ**
Question ID :	**4146641130**
Status :	**Answered**
Chosen Option :	**3**
Marks :	**0**

Q.15 Consider four identical monochromatic wave sources A,B,C,D (as shown in the figure) which produce plane waves of same wavelength λ. Sources A,B and C lie in a line, with B at the origin and A,C being $\pm\frac{\lambda}{2}$ from the origin. Initially the source D is at a distance λ from the origin but later it is moved to a distance $\lambda/2$ from the origin. Two receivers R_1 and R_2 are kept at equal large distance $r \gg \lambda$ from the origin. Select the correct option(s).



Ans ✗ 1.

If source D is turned off, R_1 picks greater intensity signal than R_2.

✓ 2.

R_2 receives greater intensity signal when the source D is at distance λ.

✓ 3.

Signal intensity at R_2 decreases 4 times when D is moved from λ to $\lambda/2$.

✓ 4.

Signal intensity at R_1 is same whether D is at λ or $\lambda/2$.

Question Type : **MSQ**
Question ID : **4146641132**
Status : **Answered**
Chosen Option : **2,3**
Marks : **0**

Q.16

Consider a universe with modified electrostatics where like charges attract and unlike charges repel. Three positively charged point particles with same charge to mass ratio α interact with each other through the electrostatic force. Total mass of the system is M. The system can move about it's centre of mass with equal distances between all pairs of masses. When the masses are separated by a distance d, the angular frequency of the motion about the centre of the mass is

Ans

✗ 1. proportional to $\sqrt{\alpha}$.

✓ 2. proportional to $1/d^{3/2}$.

✗ 3. proportional to M.

✓ 4. proportional to $\sqrt{M}$.

Question Type : **MSQ**
Question ID : **4146641133**
Status : **Answered**
Chosen Option : **2,3**
Marks : **0**

Q.17

A particle with electric charge e moves in a magnetic field $\vec{B} = -\gamma\vec{r}/r^3$ with velocity $\vec{v}$. Here γ is a non-zero constant and $\vec{r}\cdot\vec{r} = r^2$. Select the correct statement(s).

Ans

✗ 1.

Angular momentum $\vec{L} = m\vec{r} \times \vec{v}$ is a constant of motion.

✓ 2.

Vector $\vec{J} = m\vec{r} \times \vec{v} + e\gamma\vec{r}/r$ is a constant of motion.

✓ 3.

Kinetic energy of the particle is constant.

✓ 4.

Total flux of the magnetic field through a sphere centered at the origin is a non-zero constant.

Question Type :	**MSQ**
Question ID :	**4146641134**
Status :	**Answered**
Chosen Option :	**1,4**
Marks :	**0**