NEST-2025 Answer Keys

Correct answers are ***option A*** in all the questions.

If you have any queries regarding answers, please DO NOT write to anyone at this stage.

You will have a chance to raise your concerns/ queries through an online portal which will open soon.

You will be able to access the portal through the NEST website after logging into your registration account.

1. Change of amino acids in a protein led to formation of a salt bridge, without affecting the overall fold of the protein. Such a change will result in:

    A. a decrease in enthalpy (H) of the protein.

    B. a decrease in melting temperature (T_m) of the protein.

    C. a decrease in stability of the protein.

    D. an increase in free energy change (ΔG) of the protein.

2. Consider the following statements regarding steps involved in the light reaction of photosynthesis.

   (I) Water is oxidized and protons are released in the stroma by photosystem-II.

   (II) Photosystem-I reduces $NADP^+$ to NADPH in the stroma.

   (III) Cytochrome b_6f complex transports protons into the lumen.

   (IV) ATP synthase transports protons from stroma to lumen resulting in ATP synthesis.

   Choose the option with the combination of correct statements.

   A. (II) and (III)

   B. (I) and (II)

   C. (III) and (IV)

   D. (II) and (IV)

3. Malaria, caused by *Plasmodium*, is transmitted by *Anopheles* mosquito. *Plasmodium* transforms into a virulent form **X**, and is stored in the salivary gland of the mosquito. Transmission of **X** into a human host eventually results in recurring chills and high fever. This is caused by a toxic substance **Y** released by the ruptured infected red blood cells. **X** and **Y**, respectively, are:

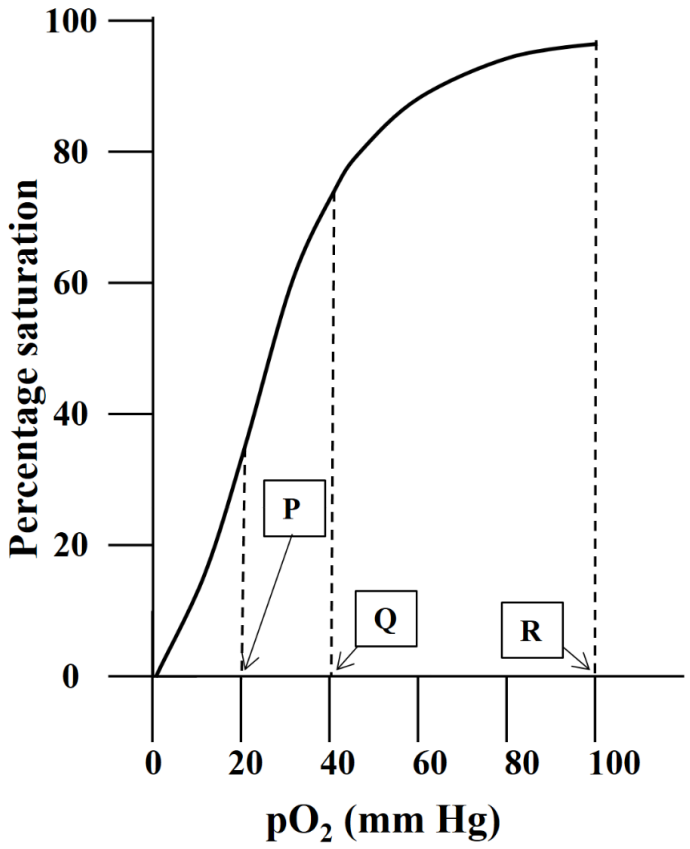
    A. sporozoite and haemozoin.

    B. trophozoite and haemozoin.

    C. merozoite and hemagglutinin.

    D. sporozoite and hemagglutinin.

4. The oxygen dissociation curve (as percentage saturation versus pO_2 of blood) of haemoglobin for a healthy adult individual is shown in the graph.



P, **Q** and **R** in the graph, respectively, represent pO_2 of blood in:

A. veins (post-exercise); veins (at rest); arteries

B. arteries; veins (at rest); veins (post-exercise)

C. arteries; veins (post-exercise); veins (at rest)

D. veins (at rest); veins (post-exercise); arteries

5. When a human somatic cell undergoes mitotic division, the ploidy level in metaphase and telophase, respectively, would be:

    A. 2n and 2n

    B. n and n

    C. 4n and 2n

    D. n and 2n

6. In an enzymatic reaction, the initial velocity at a substrate concentration of 0.03 mmol/L was 1.5×10^{-3} mmol/L/min. The substrate concentration required to reach half of the maximum velocity was 0.06 mmol/L. The maximum velocity (mmol/L/min) of this enzymatic reaction is:

   A. 4.5×10^{-3}

   B. 3×10^{-3}

   C. 0.5×10^{-3}

   D. 0.135×10^{-3}

7. In an experiment, 250 bacterial cells were inoculated into a flask containing fresh growth medium. After a period of acclimatization, the growth pattern was monitored. The bacteria showed a rapid rate of multiplication until 3 hours. At this point, the experimenter pipetted out 0.01 mL of the bacterial culture and added it to 9.99 mL diluent. When 0.1 mL of this diluted culture was plated on a solidified growth medium and incubated under optimum conditions, 102 colonies were observed. If each colony originated from one bacterium, then the doubling time of these bacteria is approximately:

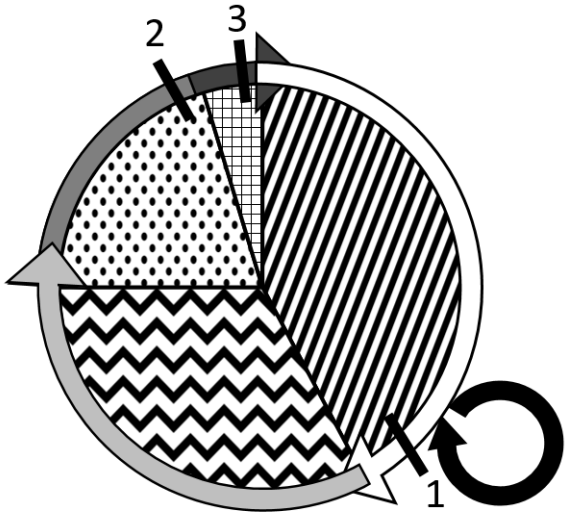
    A. 15 minutes

    B. 10 minutes

    C. 20 minutes

    D. 40 minutes

8. In the eukaryotic cell cycle shown in the figure, the black solid bars (**1**, **2** and **3**) represent important checkpoints that determine whether the cell will continue to proceed through the cycle. This progression of cell cycle depends on the signals received from both internal and external environment of the cell. The cell can exit from the cycle and enter a non-dividing state at the point indicated by a black circular arrow.



Factors influencing checkpoints **1**, **2** and **3**, respectively, are:

A. growth factors; DNA replication; chromosome attachment to spindles.

B. chromosome attachment to spindles; DNA replication; growth factors.

C. DNA replication; growth factors; chromosome attachment to spindles.

D. growth factors; chromosome attachment to spindles; DNA replication.

9. Shotgun method was used for sequencing a stretch of DNA wherein the molecule was broken into small fragments and each fragment was sequenced. The DNA sequence was then assembled by identifying the overlaps. The 5'- 3' sequence of the fragments (**I-V**) are given below:

   (I) GGCTCAAGGAGAGGG

   (II) CCGTCAAAAAAATTTAACCCTT

   (III) CCCTTAAGGAGAGAGGATTAGGA

   (IV) GGGAATTATACCGT

   (V) GGATACCTTTT

   Identify the alignment of the fragments to determine the correct DNA sequence.

   A. I-IV-II-III-V

   B. III-I-II-IV-V

   C. I-IV-V-II-III

   D. IV-III-V-I-II

10. In the *lac*-operon system, lactose acts as an inducer that binds to the repressor protein attached to the operator region (*lacO*) and allows the expression of β-galactosidase. When X-gal (a synthetic substrate) is added to the medium, β-galactosidase converts it into a blue-coloured compound.

    In an experiment, the β-galactosidase coding sequence was replaced with a T7-RNA polymerase coding sequence downstream to the *lac* operator region (*lacO*). The β-galactosidase coding sequence was inserted into a plasmid under the control of T7 promoter (that allows binding of only T7-RNA polymerase). When another factor **Y** is produced in this cell, it binds and blocks the activity of T7-RNA polymerase. Based on this information, choose the correct statement.

    A. In the presence of both X-gal and lactose, but in the absence of factor **Y**, colonies will appear blue.

    B. In the presence of X-gal, lactose and factor **Y**, colonies will appear blue.

    C. In the absence of lactose, but in the presence of X-gal and factor **Y**, colonies will appear blue.

    D. In the absence of both lactose and factor **Y**, but in the presence of X-gal, colonies will appear blue.

11. Two plants of the same type were potted in separate pots **X** and **Y**. After a few days, it was observed that the leaves of the plant in pot **X** were completely wilted, whereas those of the plant in pot **Y** were upright and firm. The pressure potential (Ψ_p), solute potential (Ψ_s) and water potential (Ψ_w) of the leaf cells of the plants in **X** and **Y** would, respectively, be:

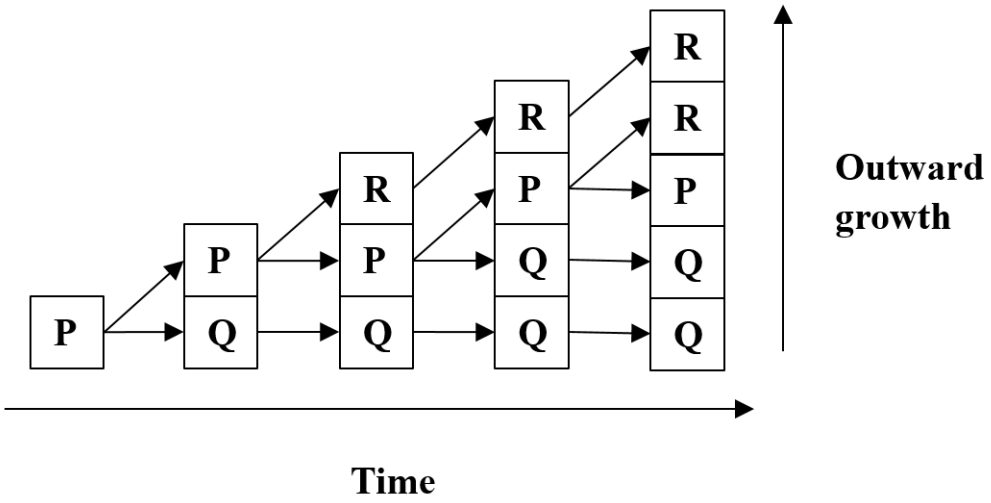
    A. **X**: 0, -0.7, -0.7 and **Y**: 0.7, -0.7, 0

    B. **X**: 0.7, -0.7, 0 and **Y**: 0, -0.7, -0.7

    C. **X**: 0, -0.7, 0.7 and **Y**: 0.7, 0, -0.7

    D. **X**: -0.7, 0.7, 0 and **Y**: 0, 0.7, 0.7

12. The pattern formation of certain tissues (**P**, **Q** and **R**) in a thickening dicot stem is depicted in the figure.



If a transverse section of such a stem was stained with phloroglucinol (that specifically stains lignified tissue), then the tissue/s that would be stained is/are:

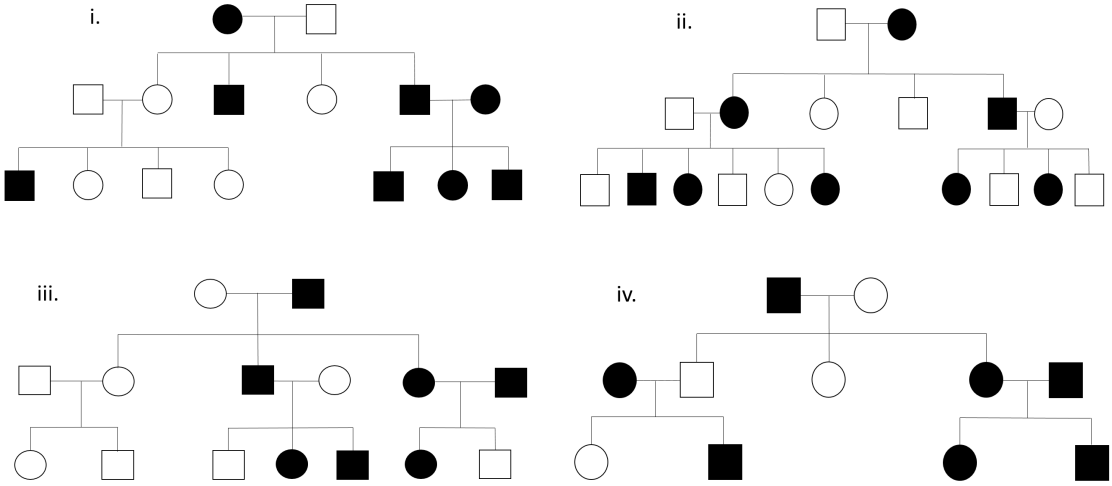
A. **Q** only

B. **P** and **Q** only

C. **P** only

D. **Q** and **R** only

13. Four pedigrees are shown, where square represents male and circle represents female. Affected individuals are represented as filled squares and circles. Note that carriers are not indicated and the penetrance of the trait is 100%.



Among the given options, choose the option that correctly represents pedigrees indicating inheritance of autosomal recessive and sex-linked recessive traits, respectively.

A. iv and i

B. iv and ii

C. iii and i

D. iii and ii

14. When a true-breeding purple-fruit-bearing brinjal plant is crossed with a true-breeding white-fruit-bearing brinjal plant, all the F1 plants produced violet brinjals. Choose the expected outcome observed in F2 plants resulting from selfing the F1 plants.

    A. Twice the number of progeny plants would bear violet fruits as compared to purple fruits.

    B. 75% of the progeny plants would produce purple fruits.

    C. 25% of the progeny would bear white fruits while the remaining would bear violet fruits.

    D. Equal proportion of progeny would bear purple and violet fruits.

15. Experiments carried out by the ethologist Nikolaas Tinbergen supported the hypothesis that 'a wasp learns the location of her nest by visual cues only'. The method he followed was as follows: the entrance of the wasp's nest on the ground was surrounded by cones of a pine tree in a circular manner. These cones served as movable visual cues. When the wasp left her nest for foraging, the pine cones were moved to a different location and placed in the same circular manner. In this context, choose the correct option that depicts the expected behaviour of the wasp on her return.

    A. The wasp looks for the nest entrance at the centre of the pine cones.

    B. The wasp efficiently locates her original nest.

    C. The wasp hovers around the pine cones before reaching her original nest entrance.

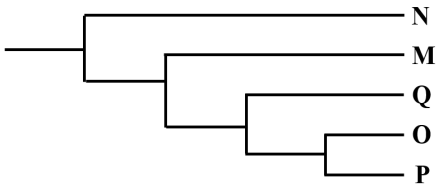
    D. The wasp reaches her original nest entrance but realizes that the pine cones are missing and goes to find them.

16. The table depicts list of characters (**I**-**V**) in five species (**M**-**Q**) where 1 represents presence and 0 represents absence of the character.

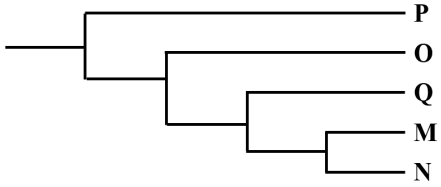
	Species **M**	Species **N**	Species **O**	Species **P**	Species **Q**
Character **I**	0	0	0	1	0
Character **II**	1	0	1	1	1
Character **III**	1	1	1	1	1
Character **IV**	0	0	1	1	1
Character **V**	0	0	1	1	0

The tree that correctly represents the evolutionary relationship between the species **M**, **N**, **O**, **P** and **Q** is:

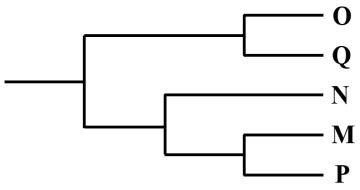
A.



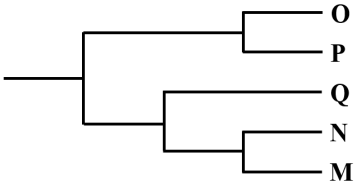
B.



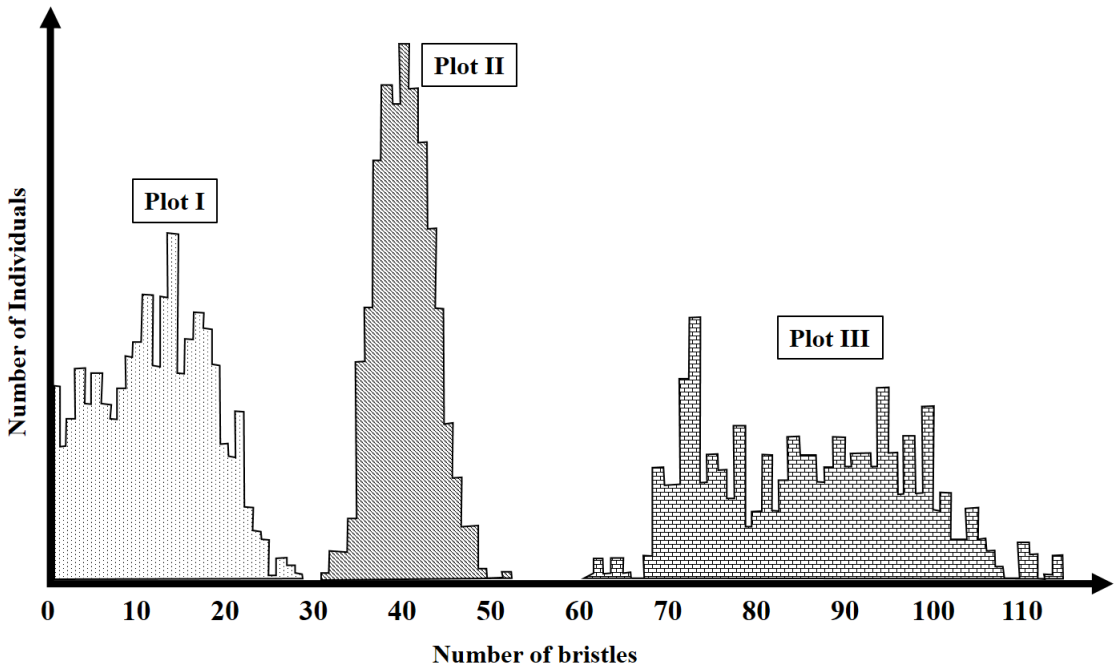
C.



D.



17. Studies have shown that considerable genetic variation exist in the number of abdominal bristles found in fruit fly populations. An experiment on artificial selection on a population of *Drosophila melanogaster* was carried out for 35 generations. Three respresentative plots **I**, **II** and **III** are shown.



If the observed population is undergoing stabilizing selection, then the correct option is:

A. At the end of the experiment, majority of the flies had an average of 40 abdominal bristles.

B. Plot **II** represents the highest proportion of population at the start of the experiment.

C. Populations in plots **I** and **III** represent characters selected for during the course of the experiment.

D. Plots **II** and **III** had the highest proportions of flies at the start of the experiment.

18. The process of opening and closing of stomata (called stomatal movement) is controlled by turgor pressure changes in the guard cells. A list of events is given below.

(i) Water potential becomes less negative

(ii) Guard cells shrink

(iii) Water potential becomes more negative

(iv) Guard cells swell

(v) K^+ and Cl^- diffuse passively out of the cell

(vi) Water is taken up by the cells

(vii) Water diffuses out of the cell by osmosis

(viii) Stomata close

(ix) Stomata open

(x) K^+ and Cl^- actively move into the cell

The correct sequence of events occurring in the guard cells leading to stomatal movement during a period of darkness in most plants would be:

A. (v) → (i) → (vii) → (ii) → (viii)

B. (x) → (iii) → (vi) → (iv) → (ix)

C. (v) → (iii) → (vi) → (iv) → (ix)

D. (x) → (i) → (vii) → (ii) → (viii)

19. A researcher wants to study the effect of habitat fragmentation on bird species richness in a tropical rainforest. The species richness of the same rainforest before fragmentation is known. The best study design to ensure valid and reliable results would be to:

    A. compare bird species richness in multiple patches of varying sizes of the entire tropical rainforest.

    B. count the number of bird species in a single large patch of the tropical rainforest.

    C. compare bird species richness of the fragmented tropical rainforest with that of a fragmented temperate forest.

    D. compare the total number of individuals of any bird species in the fragmented and unfragmented tropical rainforest.

20. A particular herbivore species **X** was being studied. There are two populations of this species, one found in Sri Lanka and the other in Indian mainland. Five thousand years ago, species **X** had a variety of colours - blue, green, red and yellow. Species **X** of all the four colours were equally prevalent in both the locations. In the present-day Sri Lankan Island, while species **X** of all these colours are still found, the majority of the population is green in colour. If this change in population distribution is solely due to founder effect, the statement most likely to be true is:

    A. A severe earthquake killed a large number of species **X** of all colours, after which the individuals that came in from Indian mainland were predominantly green in colour.

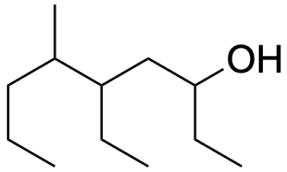
    B. The green-coloured species **X** could perfectly camouflage with the vegetation of the forest and were thus less predated upon by carnivores.

    C. A severe earthquake killed a large number of species **X** of all colours, and survivors were green in colour merely by chance.

    D. The number of species **X** that were green-coloured, decreased in Indian mainland due to predation.

1. Maltose, a disaccharide, contains glycosidic linkage between
    A. two units of α-D-glucose
    B. β-D-glucose and α-D-fructose
    C. two units of β-D-glucose
    D. α-D-glucose and β-D-fructose

2. Consider the following compound.



The IUPAC name of the compound is

A. 5-ethyl-6-methylnonan-3-ol

B. 1,3-diethyl-4-methylheptan-1-ol

C. 5-ethyl-6-propylheptan-3-ol

D. 5-ethyl-4-methylnonan-7-ol

3. According to the VSEPR theory, the shapes of PCl_5, PCl_4^+, and PCl_3, respectively, are

    A. Trigonal bipyramidal, Tetrahedral, and Trigonal pyramidal

    B. Trigonal bipyramidal, Square planar, and Trigonal planar

    C. Square pyramid, Tetrahedral, and Trigonal pyramidal

    D. Square pyramid, Tetrahedral, and Trigonal planar

4. If the density of a liquid is 1.81 g/cm^3, then the mass of 1.2 mL of the liquid in correct significant figures is

    A. 2.2 g

    B. 2.172 g

    C. 2.17 g

    D. 2.1 g

5. The oxidation number and valence number of Ga in Ga_2Cl_4 having a metal−metal bond, respectively, are

    A. 2 and 3

    B. 3 and 3

    C. 1 and 3

    D. 3 and 2

6. Cyclopentene is transformed into 1,2,3-tribromocyclopentane in two steps. The correct order of reagents required to carry out this transformation is

   A. Step 1: 1 equiv. Br_2, hν
      Step 2: 1 equiv. Br_2/CCl_4

   B. Step 1: HBr
      Step 2: 1 equiv. Br_2/CCl_4

   C. Step 1: 1 equiv. Br_2/CCl_4
      Step 2: 1 equiv. Br_2, hν

   D. Step 1: 1 equiv. Br_2, hν
      Step 2: HBr/peroxide

7. The compound **P** on reaction with KCN gives **Q** which on catalytic hydrogenation with H_2/Ni produces **R**. Compound **R** on reaction with $CHCl_3$/KOH gives n-propylisocyanide. The compound **P** is

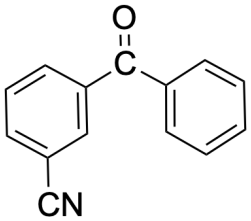
    A. chloroethane

    B. 1-chloroethene

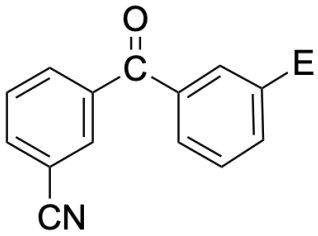
    C. chloropropane

    D. 1-chloropropene

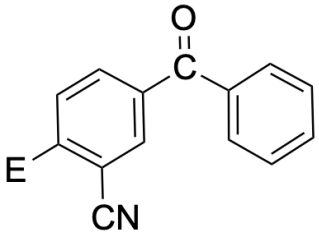
8. Consider the following compound.



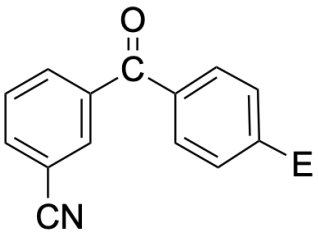
The major product in an aromatic electrophilic substitution reaction (E = electrophile) on the given compound would be



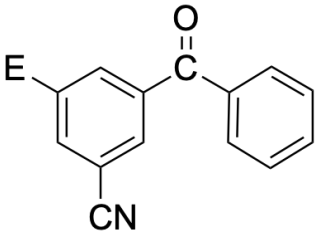
(a)



(b)

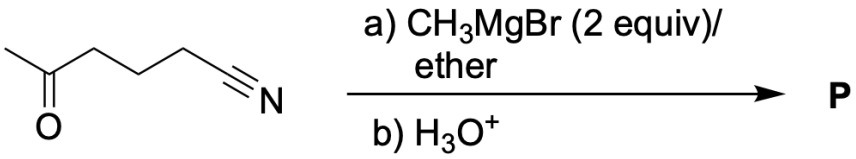


(c)

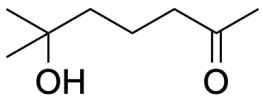


(d)

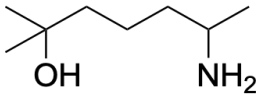
9. Consider the following reaction:



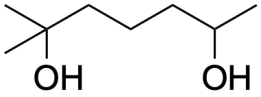
The compound **P** is



(a)



(b)



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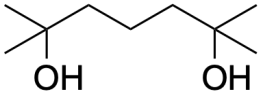
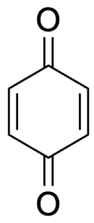
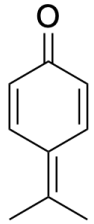


(d)

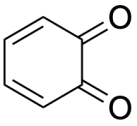
10. Isopropyl benzene when oxidized in the presence of air followed by treatment with dil. HCl produces compounds **P** and **Q**. **P** turns a blue litmus paper red. **P** produces **R** upon reaction with chromic acid. The structure of **R** is



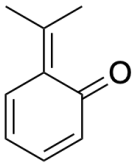
(a)



(b)



(c)



(d)

11. A first-row transition metal dipositive ion forms an octahedral aqua complex **P**, which is paramagnetic. The addition of excess ammonia to **P** gives **Q**, which also is paramagnetic. Adding excess NaCN to **P** gives a diamagnetic complex **R**. The complexes **P**, **Q**, and **R**, respectively, are

    A. $[Ni(H_2O)_6]^{2+}$, $[Ni(NH_3)_6]^{2+}$, and $[Ni(CN)_4]^{2-}$

    B. $[Ti(H_2O)_6]^{2+}$, $[Ti(NH_3)_6]^{2+}$, and $[Ti(CN)_6]^{4-}$

    C. $[V(H_2O)_6]^{2+}$, $[V(NH_3)_6]^{2+}$, and $[V(CN)_6]^{4-}$

    D. $[Cu(H_2O)_6]^{2+}$, $[Cu(NH_3)_6]^{2+}$, and $[Cu(CN)_4]^{2-}$

12. The correct sequence of the given manganese oxides with respect to melting point is

    A. $Mn_2O_7 < MnO_2 < Mn_2O_3 < MnO$

    B. $MnO < Mn_2O_3 < MnO_2 < Mn_2O_7$

    C. $MnO \cong Mn_2O_3 < MnO_2 < Mn_2O_7$

    D. $Mn_2O_7 < MnO_2 \cong Mn_2O_3 < MnO$

13. The metal ion that does not form a stable metal carbonyl complex is

A. Ti^{4+}

B. V^{3+}

C. Cr^{3+}

D. Mn^{4+}

14. Consider two radioactive substances **P** and **Q** that decay following a first order kinetics. It takes nine years for **P** for decay of $2/3^{rd}$ of its initial amount. In the same nine years **Q** decays by half. If the ratio of the initial (t = 0) amounts of **P** and **Q**, that is $\mathbf{P}_0$:$\mathbf{Q}_0$ is 81:16, the number of years after which the quantities of **P** and **Q** would be same is

    A. 36

    B. 9

    C. 54

    D. 72

15. Consider the reaction $\mathbf{X} + \mathbf{Y} \rightleftharpoons 2\mathbf{Z}$ performed in a 1 L container. The equilibrium constant is equal to 0.5. If the reaction begins with 1 mole of $\mathbf{X}$, 2 moles of $\mathbf{Y}$, and n moles of $\mathbf{Z}$, and at equilibrium the quantity of $\mathbf{Z}$ is 1 mole, then n is equal to

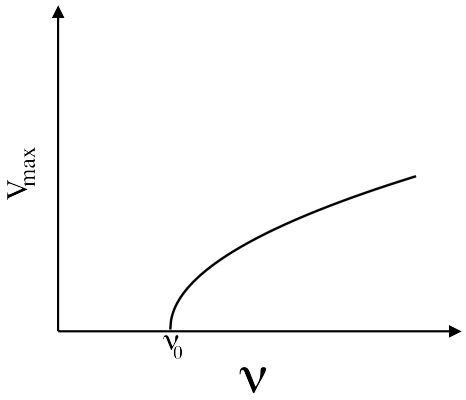
    A. 1

    B. 0.5

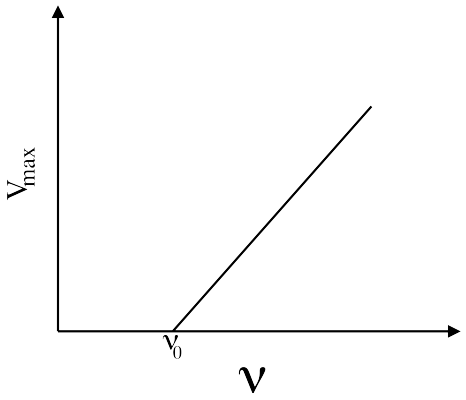
    C. 0.33

    D. 1.2

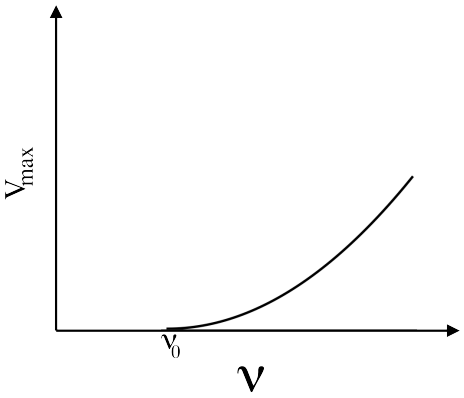
16. For a photoelectric setup, the relationship between the maximum velocity (V_{max}) of the photoelectrons and the incident radiation frequency ν (ν_0 being the threshold frequency) is best represented as



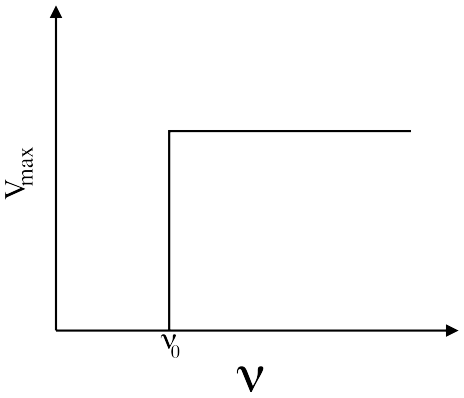
(a)



(b)

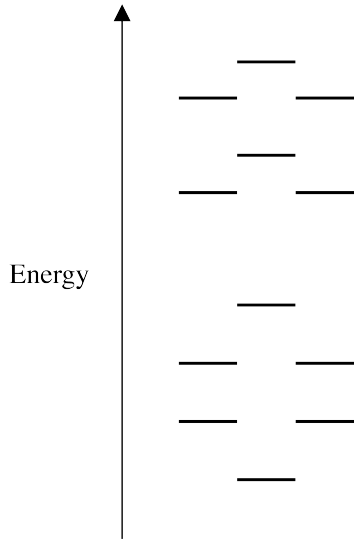


(c)



(d)

17. Consider a hypothetical order of molecular orbitals (MO) as shown below.



Assuming this MO ordering is valid for all the given diatomic molecules listed here, the diatomic molecule that would be paramagnetic is

A. N_2

B. C_2

C. F_2

D. O_2

18. Let the vapour pressure of a liquid be P_1 and P_2 at two different temperatures T_1 and T_2, respectively. They are related by an equation given by

$$ln\left(\frac{P_2}{P_1}\right) = \left(\frac{\Delta H}{R}\right)\left[\left(\frac{1}{T_1}\right) - \left(\frac{1}{T_2}\right)\right]$$

where, ΔH represents the heat of vaporisation, R is the ideal gas constant. Assume, $R = 2$ cal/mol/K, ΔH for water is equal to 540 cal/g, and P denotes the vapour pressure of water at 450 K. The value of ln(P) is close to

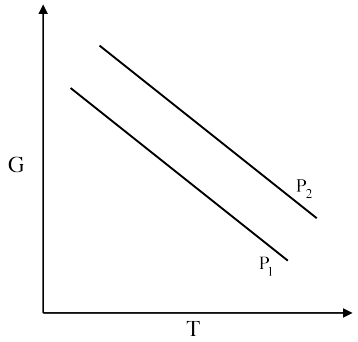
A. 2.23

B. 0.12

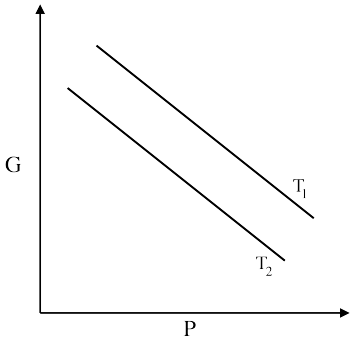
C. 10.8

D. 0.6

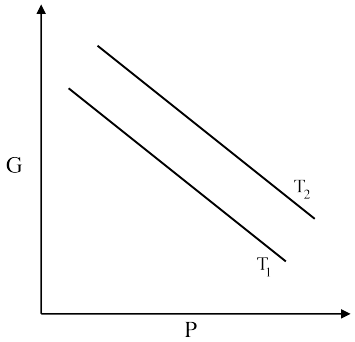
19. The Gibbs free energy G for a liquid is considered as a function of temperature (T) and pressure (P). G is plotted either as a function of temperature at different constant pressures P_1 and P_2 ($P_2 > P_1$) or as a function of pressure at different constant temperatures T_1 and T_2 ($T_2 > T_1$). The correct variation of G is best represented as



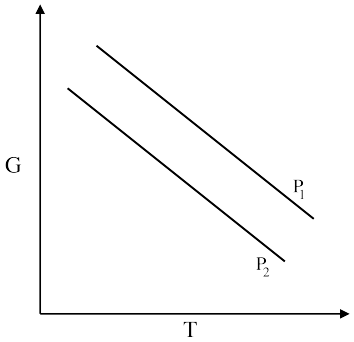
(a)



(b)



(c)



(d)

20. Consider the electrochemical cell with two metal/metal ion electrodes, represented as $M(s)|M^{2+}(aq)||N^{2+}(aq)|N(s)$, where, M and N represent two different metals. The plot of the EMF of the cell (E) against the quantity $\ln(C_1/C_2)$, where C_1 and C_2 are the concentrations of the ions $M^{2+}(aq)$ and $N^{2+}(aq)$ respectively, is linear with intercept x and slope y. Let the equilibrium constant of the cell reaction $M(s)+N^{2+}(aq) \rightleftharpoons M^{2+}(aq)+N(s)$ be denoted by K. The correct relationship involving K is

    A. $\ln K = -x/y$

    B. $\ln K = y/x$

    C. $K = -x/y$

    D. $K = y/x$

1. Let $\theta \neq (2n+1)\dfrac{\pi}{2}$, for $n \in \mathbb{Z}$. Consider the following system of two equations in the variables x and y:

$$\begin{aligned} x\cos\theta + y\sec\theta &= 0 \\ x\sin\theta + y\tan\theta &= 0. \end{aligned}$$

This system does **not** have a unique solution if and only if θ is in the set

A. $\{n\pi : n \in \mathbb{Z}\}$

B. $\{(2n+1)\pi : n \in \mathbb{Z}\}$

C. $\{2n\pi : n \in \mathbb{Z}\}$

D. $\{(4n+1)\pi : n \in \mathbb{Z}\}$

2. Let S be the set of all rational numbers r such that if $r = \frac{p}{q}$ with $p, q \in \mathbb{Z}, q \neq 0$, then the two solutions of the quadratic equation $x^2 + 2px + q^2 = 0$ are equal. Then the number of elements in S is

   A. 2

   B. 4

   C. 1

   D. infinite

3. The value of the integral $\int_0^{\sqrt{\pi}} x \sin^2(x^2)\, dx$ is

A. $\frac{\pi}{4}$

B. π

C. $\frac{\sqrt{\pi}}{4}$

D. $\sqrt{\pi}$

4. For $x \in \mathbb{R}$, define $\langle x \rangle = x - [x]$. Then for any arbitrary pair of real numbers $x, y \in \mathbb{R}^+$,

   A. $\langle x + y \rangle \leq \langle x \rangle + \langle y \rangle$

   B. $\langle x + y \rangle \geq \langle x \rangle + \langle y \rangle$

   C. $\langle x + y \rangle = \langle x \rangle + \langle y \rangle$

   D. $\langle x + y \rangle \neq \langle x \rangle + \langle y \rangle$

5. Let L_1 and L_2 be two lines in the 3-dimensional space. The line L_1 is defined by the equations

$$\frac{x-1}{3} = \frac{y-2}{2} = \frac{z-3}{\alpha}$$

and the line L_2 is defined by the equations

$$\frac{x+2}{-2} = \frac{y-3}{4\alpha} = \frac{z+7}{3},$$

where α is a nonzero real number. If the lines L_1 and L_2 are mutually perpendicular, then the value of α is

A. $\frac{6}{11}$

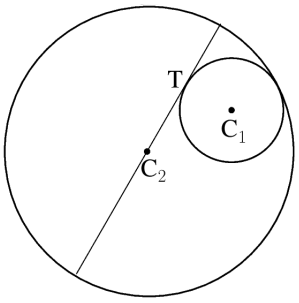
B. $\frac{4}{3}$

C. $\frac{8}{13}$

D. $\frac{3}{7}$

6.

A circle S_1 with centre at C_1 and radius r_1 touches another circle S_2 with centre at C_2 and radius r_2 internally as shown in the figure. If $r_2 > 2r_1$ and a diameter of the bigger circle touches the smaller circle at T, then the length of the segment C_2T is



A. $\sqrt{r_2^2 - 2r_1r_2}$

B. $\sqrt{r_2^2 - r_1r_2}$

C. $\sqrt{r_1^2 + r_1r_2}$

D. $\sqrt{r_1^2 + 2r_1r_2}$

7. Let $f : \mathbb{R} \to \mathbb{R}$ be defined by $f(x) = \min\{|x|, x^2\}$. Then f is

   A. differentiable everywhere except at $x = 1$ and $x = -1$

   B. differentiable everywhere

   C. differentiable everywhere except at $x = 0$

   D. differentiable everywhere except at $x = 0$ and $x = 1$

8. Let w be a complex number such that $w^5 = 1$ but $w \neq -1$. Then $(1 + w)^{-1}$ is equal to

   A. $\frac{1}{2}(1 - w + w^2 - w^3 + w^4)$

   B. $1 - w + w^2 - w^3 + w^4$

   C. $1 + w + w^2 + w^3 + w^4$

   D. $\frac{1}{2}(1 + w - w^2 + w^3 - w^4)$

9. Let k, l and m be three 3-digit numbers chosen randomly. Then the probability that $k + l + m$ is divisible by number 3 is

   A. $\frac{1}{3}$

   B. $\frac{1}{2}$

   C. $\frac{1}{4}$

   D. $\frac{1}{9}$

10. Let $f(x) = x^3 - ax^2 + bx + c$, where a, b, c are nonzero integers. Suppose that $f(a) = 0$. Then, all the roots of f are integers if and only if

    A. $\dfrac{c}{a}$ is the square of an integer.

    B. $-\dfrac{c}{a}$ is the square of an integer.

    C. c is the square of an integer.

    D. $b = 3n^2$, for some integer n.

11. If A and B are two real numbers such that

$$\lim_{x \to 0} \frac{B - \cos x + A \cos 2x}{x} \text{ exists,}$$

then the value of $A + B$ is

A. 1

B. 2

C. 0

D. 3

12. Let $g : [0, \infty) \to \mathbb{R}$ be a continuous function such that

$$g(x) + (\log 2) \int_0^x g(t) \cos t \; dt = 1.$$

Then the value of $g\left(\frac{\pi}{6}\right)$ is

A. $\frac{1}{\sqrt{2}}$

B. $\sqrt{2}$

C. $\frac{\sqrt{3}}{2}$

D. $\frac{1}{2}$

13. The value of

$$\sum_{k=1}^{2025} \int_{2k\pi}^{2k\pi+\frac{\pi}{2}} \frac{\cos^k(x)}{\cos^k(x)+\sin^k(x)}\, dx$$

is

A. $\frac{2025\pi}{4}$

B. $\frac{2025\pi}{2}$

C. 2025π

D. 0

14. An ellipse has the points $(3, 2)$ and $(7, 2)$ as foci. If the ellipse touches the x-axis then its eccentricity is

A. $\dfrac{1}{\sqrt{2}}$

B. $\dfrac{1}{2}$

C. $\dfrac{1}{2\sqrt{2}}$

D. $\sqrt{2} - 1$

15. Let X and Y be two students who have appeared NEST. Given that

    i. the probability that X qualifies NEST is $\frac{1}{10}$;

    ii. the probability that X qualifies NEST given that Y qualifies NEST is $\frac{1}{2}$;

    iii. the probability that Y qualifies NEST given that X qualifies NEST is $\frac{1}{4}$.

    Then the probability that X does not qualify NEST given that Y does not qualify NEST is

    A. $\frac{35}{38}$

    B. $\frac{1}{2}$

    C. $\frac{9}{10}$

    D. $\frac{3}{4}$

16. Let A and B be two sets. Let A_1, A_2 and A_3 be subsets of A such that $A_1 \cup A_2 \cup A_3 = A$ and $A_i \cap A_j = \phi$ for $i \neq j$. Let $f : A \to B$ be a function. For each $i = 1, 2, 3$, let $f_i : A_i \to B$ be defined by $f_i(x) = f(x)$ for $x \in A_i$. Then

    A. f is surjective whenever f_i is surjective for each $i = 1, 2, 3$.

    B. f is injective whenever f_i is injective for each $i = 1, 2, 3$.

    C. f is bijective whenever f_i is bijective for each $i = 1, 2, 3$.

    D. f_i is surjective for each $i = 1, 2, 3$ whenever f is surjective.

17. Let R be the equivalence relation on $\mathbb{N} \setminus \{1\} = \{n \in \mathbb{N} : n \geq 2\}$ defined by

$$\text{for } m, n \in \mathbb{N} \setminus \{1\}, \quad m \, R \, n \text{ if } \frac{\log m}{\log n} \text{ is a rational number.}$$

Then

A. m and n have the same number of distinct prime divisors whenever $m \, R \, n$

B. the number of equivalence classes is finite

C. all prime numbers are in the same equivalence class

D. there exists an equivalence class with finitely many elements

18. Let S be the set of integers n such that $1 \leq n \leq 1000$ and can be written as $n = 3x+5y$, with $x, y \in \mathbb{N} \cup \{0\}$. Then the number of elements in S is

    A. 996

    B. 500

    C. 992

    D. 498

19. The limit

$$\lim_{a\to 0} \frac{1}{a} \int_{2-a}^{2+a} \cos^2(\pi t)\ e^{\left|\frac{2-t}{a}\right|}\ dt$$

A. equals $2\,(e-1)$

B. equals $2\,(1-e)$

C. equals $(e-1)$

D. does not exist

20. Let A $= (1, 1, -6)$, B $= (11, -1, 2)$, C $= (3, 1, 2)$ and O $= (0, 0, 0)$ be points in $\mathbb{R}^3$. Then the distance between the lines AB and OC is

A. $\dfrac{27}{\sqrt{26}}$

B. 27

C. $\dfrac{10}{\sqrt{5}}$

D. 10

1. In 2024 Olympics two runners, Noah Lyles and Kishane Thompson, finished the 100.00 m race in 9.784 s and 9.789 s respectively. Assuming that they move with constant speed, the distance between the two runners when Noah Lyles touched the finishing line would have been close to

    A. 5 cm

    B. 10 cm

    C. 20 cm

    D. 50 cm

    Mechanics-I

2. Three positive and two negative charges each of magnitude q are placed at five of the six vertices of a regular hexagon of side R. The work done to bring a negative charge $-q$ from infinity to the center of the hexagon is

   A. $\frac{1}{4\pi\epsilon_0}\left(\frac{-q^2}{R}\right)$

   B. $\frac{1}{4\pi\epsilon_0}\left(\frac{q^2}{R}\right)$

   C. $\frac{1}{4\pi\epsilon_0}\left(\frac{-5q^2}{R}\right)$

   D. $\frac{1}{4\pi\epsilon_0}\left(\frac{q^2}{2R}\right)$

   Electricity and Magnetism-I

3. Consider a metal cylinder of heat capacity C, thermal conductivity K, mass m and radius r. The combination that will have the dimension of time is

   A. $\frac{C}{Kr}$

   B. $\frac{mC}{Kr}$

   C. $\frac{mC}{K}$

   D. $\frac{C}{K}$

   Heat and Thermodynamics-I

4. If all the Helium-4 nuclei, each of mass 4.0026034 u, in the core of a star is converted to Carbon-12 (12 u) nuclei, then the energy released in MeV per carbon nucleus is

   A. 7.28

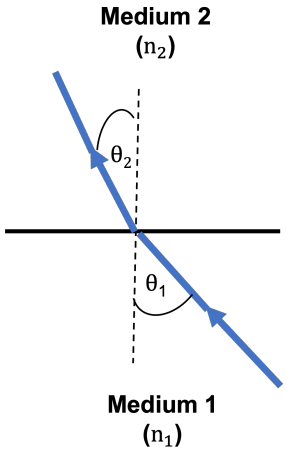
   B. 9.70

   C. 2.43

   D. 12.37

   Modern Physics-I

5. The figure shows a ray of light going from a medium of refractive index n_1 to a medium of refractive index n_2 such that $\theta_1 > \theta_2$. Select the correct option.



A. Wavelength $\lambda_1 > \lambda_2$

B. Refractive index $n_1 > n_2$

C. Angular frequency $\omega_2 > \omega_1$

D. Speed of light $v_2 > v_1$

Optics and Waves-I

6. A simple pendulum, suspended from the roof of a lift, is set to small oscillations. The lift starts moving downwards such that the distance convered in time t is given by $3t^2$. Compared to the stationary lift, the pendulum will

   A. oscillate with increasing time period.

   B. oscillate with decreasing time period.

   C. oscillate with the same time period.

   D. stop oscillating.

   Mechanics-II

7. A periodic dimming of light coming from a distant star is observed. This is attributed to the eclipses caused by the presence of a planet orbiting around the star. The time between successive eclipses is measured to be 30 Earth days. The mass of the star is estimated to be 1.15 times the mass of the Sun. The distance in AU (1 AU = 1.50 $\times$ 10^{11} m) between the star and planet is close to

   A. 0.2

   B. 0.4

   C. 0.8

   D. 0.6

   Mechanics-III

8. A bead is constrained to move on a frictionless wire, placed in the x-y plane and under the influence of gravity. The shape of this wire is described by the equation $y = ax^n$, where x and y represent the horizontal and vertical coordinates respectively. The bead is released at a small distance away from the origin. The bead will oscillate around origin provided

   A. $a = 2.5$ and $n = 4$

   B. $a = 2.5$ and $n = 3$

   C. $a = -2.5$ and $n = 2$

   D. $a = 2.5$ and $n = 0.5$

   Mechanics-IV

9. The engine in a sports car provides constant power to all the four wheels over a range 0 to 120 kilometers per hour (kmph). The car accelerates from 0 to 45 kmph in 1.50 s. The time the car takes to accelerate from 0 to 90 kmph is

    A. 6.0 s

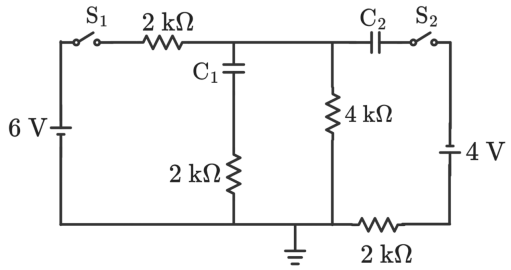
    B. 3.0 s

    C. 7.5 s

    D. 4.5 s

    Mechanics-V

10. Consider the following circuit with capacitors C_1 and C_2 having equal capacitance of $2\mu F$. Two switches S_1 and S_2 are closed simultaneosuly at $t = 0$. After a long time, the charges on the capacitors C_1 and C_2 respectively are



A. $8\,\mu C$ and $16\,\mu C$

B. $2\,\mu C$ and $2\,\mu C$

C. $8\,\mu C$ and $8\,\mu C$

D. $4\,\mu C$ and $8\,\mu C$

EM-II

11. The transverse electric field of an electromagnetic wave in free space is expressed as $\vec{E} = E_0 \cos(\vec{k} \cdot \vec{r} - \omega t)[2\hat{x} + \alpha\hat{y}]$, where $\vec{k} = 3\hat{x} - 2\hat{y} + \hat{z}$ is the propagation vector and α is a constant. All quantities are in S.I. units. The amplitude of magnetic field of the electromagnetic wave in S.I. units is

    A. $\sqrt{13}E_0/c$

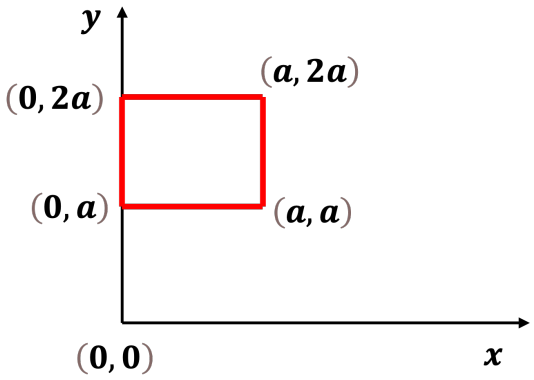
    B. $\sqrt{7}E_0/c$

    C. $\sqrt{5}E_0/c$

    D. $3\sqrt{3}E_0/c$

    Electricity and Magnetism-III

12. A square loop of side length a, carrying current I, is placed in the x-y plane as shown in the figure. The magnetic field in the region has the form $\vec{B} = \beta y \hat{z}$, where β is a positive constant. The magnitude of the net force on the loop is



A. $\beta I a^2$

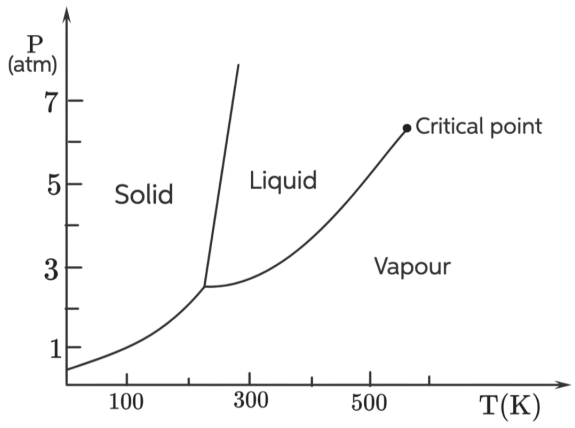
B. 0 (zero)

C. $2\beta I a^2$

D. $3\beta I a^2$

Electricity and Magnetism-IV

13. A qualitative phase diagram of a substance is shown in the figure below. Choose the correct option from the following statements.



A. The liquid to vapour phase transition of the substance is not possible at STP.

B. When two blocks of the substance are pressed together and released, they form a single solid block.

C. All the three phases of the substance cannot coexist.

D. The substance can be solidified only at high pressure.

Heat and Thermodynamics-II

14. An ideal monoatomic gas, initially at pressure P, is kept in a spherical container of volume V. The container is adiabatically compressed to half of its initial radius. Assuming the process is reversible and neglecting the thickness of the container, the magnitude of compressional work on the system is expressed as βPV, where β is

A. $\frac{9}{2}$

B. $\frac{5}{3}$

C. $\frac{7}{8}$

D. $\frac{7}{5}$

Heat and thermodynamics-III

15. The Parker solar probe, orbiting the Sun, experiences solar radiation flux of 650 $kW \cdot m^{-2}$. The heat shield (area = 1.0 m^2, emissivity = 1.0) surrounding the probe is internally cooled by a conductive heat transfer mechanism. The shield is designed to operate at 1500 K. The required heat transfer rate (in kW) to be delivered by the cooling system is approximately

    A. 360

    B. 340

    C. 380

    D. 650

    Heat and thermodynamics-IV

16. A p-n junction diode in a circuit is in reverse bias but not under breakdown condition. As compared to the p-n junction diode in a forward bias,

    A. the depletion layer width increases.

    B. the barrier potential decreases.

    C. the current enhances significantly across the junction.

    D. the electric field across the junction changes sign.

    Modern Physics-II

17. Monochromatic light from a discharge tube containing dilute gas of hydrogen atoms falls on platinum metal which has a work function of 5.65 eV. The energy of the fastest photoelectrons is 6.45 eV. This corresponds to

    A. the change in the angular momentum of the H atom is of magnitude $\frac{h}{\pi}$.

    B. the electronic transiton from the state $n = 2$ to $n = 1$.

    C. the electronic transition from the state $n = 5$ to $n = 2$.

    D. the change in the angular momentum of the H atom is of magnitude $\frac{h}{2\pi}$.

    Modern Physics-III

18. A tube of length 0.5 m open at both ends has a small hole in the middle. Air is blown through this hole. If the speed of sound in air is 330 $\mathrm{m{\cdot}s^{-1}}$, the first three harmonics in Hz are

    A. 660, 1320, 1980

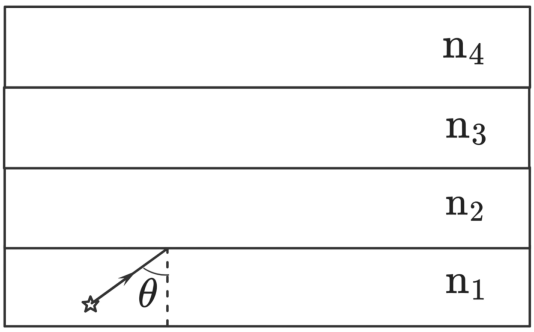
    B. 330, 660, 990

    C. 330, 990, 1650

    D. 660, 1980, 3300

    OPW-II

19. Four long glass plates with refractive indices $n_1 > n_2 > n_3 > n_4$ are stacked in parallel as shown in the figure. A light ray, traveling in the first plate, is incident on the second plate at an angle θ. This ray passes through second and third plates but does not enter the fourth plate. Then, the minimum value of θ is



A. $\sin^{-1}(\frac{n_4}{n_1})$

B. $\sin^{-1}(\frac{n_4}{n_3})$

C. $\sin^{-1}(\frac{n_1}{n_3})$

D. $\sin^{-1}(\frac{n_2}{n_3})$

OPW-III

20. The magnitude R of an earthquake is related to the energy it releases by a logarithmic scale, $R = a \log_{10}(E/E_0)$, where a and E_0 are positive constants. An earthquake of magnitude $R = 6$ has 31 times more energy than one of $R = 5$. An earthquake of magnitude $R = 7$ has β times more energy than one of $R = 5$, where β is approximately

    A. 1000

    B. 100

    C. 300

    D. 500

    General Physics-I