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Aptitude Test 2017: Question SET NO. : C

3924

Name in BLOCK letters	Application Number
SUDHIR GHOLAP	112071

Instructions to the Candidate

- Duration of this test is 180 minutes. There are 60 multiple choice questions in the test paper, 15 each from Biology, Chemistry, Mathematics and Physics. The questions are printed on 18 pages. Please check and report if any page is missing.
- Evaluation of the OMR sheet will be based on responses to all 60 questions.
- There is only one correct answer to each question. There will be negative marking: marks for each question are:
  3 marks for a correct answer
  -1 mark for a wrong answer
  0 marks for not attempting a question.
- Please write your name (in BLOCK LETTERS) and application number as in the Hall Ticket at the appropriate places on the question paper and on the OMR sheet. You must sign the OMR sheet at the appropriate place.
- Please enter the Question Set number in your OMR sheet.
- Please carefully read the instructions given on the OMR sheet and fill the required information.
- Please write your application number (6 digits) in the boxes provided and also mark the appropriate bubbles on the OMR sheet carefully. Else your OMR sheet cannot be evaluated.
- For marking answers on the OMR sheet, use only black/blue ball point pen. Do not use pencil, white fluid, or any other device to mark the sheet. Darkening more than one option in the OMR sheet will be treated as a wrong answer.
- Electronic gadgets such as mobile phones and calculating devices are strictly prohibited inside the examination hall. Candidates are not allowed to keep books, notes, log tables, or loose papers inside the examination hall.
- Exchange of items amongst the candidates is not permitted during the Aptitude Test.
- A candidate adopting unfair means during the Aptitude Test or violating any of the instructions shall be expelled from the examination hall and his/her candidature will be cancelled.
- You must return the OMR sheet after removing the student's copy.
- You are not allowed to leave the examination hall during the Aptitude Test.

BIOLOGY

1. Match the following features to the animals. Which is the correct combination?

1. Open circulatory system
2. Closed circulatory system
3. Earthworm
4. Malpighian tubules
5. Nephridia
6. Cockroach

[A] 1,3,4 and 2,5,6 [B] 1,4,6 and 2,3,5 [C] 1,5,6 and 2,3,4 [D] 1,3,5 and 2,4,6

2. Take two plants, keep plant A in very dry conditions and plant B in high humidity. Simultaneously, immerse the roots of both plants in water with a red dye. What would you observe?

[A] Plant B turns redder than Plant A.
[B] Plant A turns redder than Plant B.
[C] Neither plant turns red.
[D] Both plants turn equally red.

3. A population of finch birds with medium sized beaks colonizes an island with plants producing medium and large sized seeds. After a disease wipes out all the plants with medium sized seeds, what is most likely to happen to the finches?

[A] They will become extinct.
[B] Their beaks will not change at all.
[C] Their beaks will become larger.
[D] Their beaks become smaller.

4. If the population of a city of 100 people increases at an intrinsic rate of 0.1, but the city only has access to food and housing for 200 people, what will the current growth rate of the population be?

[A] 9/year [B] 5/year [C] 2/year [D] Zero

5. Pick the INCORRECT statement regarding a mitochondrion,

[A] The mitochondrial matrix contains single circular DNA molecule.
[B] The mitochondrial matrix possesses 70S ribosomes.
[C] The inner and outer membranes have identical sets of enzymes.
[D] The inner membrane forms many infoldings called cristae.

$\frac{dN}{dt} = 0.1 \times 100$

$= 10$

$N = N_0$

6. Which of the following statements best describes the G0 stage of the cell cycle?

[A] Cells in this stage are proliferative but metabolically inactive.
[B] Cells in this stage are highly proliferative.
[C] Cells in this stage are metabolically active but not dividing.
[D] Cells in this stage are dying.

7. *Erythroblastosis foetalis* can be avoided by

[A] Administering anti–Rh antibodies to a Rh +ve woman before her first pregnancy.
[B] Administering anti–Rh antibodies to a Rh −ve woman before her first pregnancy.
[C] Administering anti–Rh antibodies to a Rh +ve mother after her first Rh +ve child birth.
[D] Administering anti–Rh antibodies to a Rh −ve mother after her first Rh +ve child birth.

8. During an oxidative phosphorylation the terminal electron acceptor is ——(fill up the blank)

[A] Cytochrome C [B] NAD^+ [C] Oxygen [D] FAD

9. Immature lymphocytes are primarily found in which one of the following organs?

[A] Peyer's Patches of small intestine [B] Spleen [C] Thymus [D] Liver

10. If an enzyme reaction follows the Michaelis Menten kinetics represented by the equation:

$$V_0 = V_{max} \cdot \frac{[S]}{K_M + [S]}$$

where, V_0 is the initial reaction velocity, V_{max} is the maximal reaction velocity, K_M is the Michaelis constant and $[S]$ is the substrate concentration. Which of the following statements is correct?

[A] K_M is the concentration of substrate when the velocity of the reaction is half that of the maximal velocity.
[B] K_M is the concentration of the enzyme at the optimal pH.
[C] K_M is the concentration of the enzyme at the optimal temperature.
[D] K_M is the reaction velocity at half the optimal substrate concentration.

11. Common cold is mostly caused by Rhinoviruses. Which of the following treatments will provide the best cure from this infectious agent?

[A] One tablet of amoxycillin plus one tablet of a pain killer four times a day for at least three days.
[B] Adequate rest and a balanced diet for at least three days.
[C] A glass of Oral Rehydration Suspension (ORS) plus two tablets of streptomycin twice a day for three days.
[D] Two tablets of amoxycillin twice a day for at least three days.

12. In human females, when does oogenesis begin?

[A] At the time of puberty
[B] During embryonic development
[C] During ovulation
[D] At the time of birth

13. Which one of the following statements best defines properties of a compound epithelium?

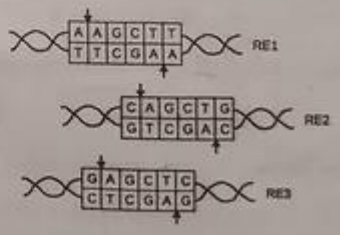
[A] It is multilayered and help binding tissues together and their eventual organization.
[B] It is multilayered and mainly protects from chemical and mechanical stresses.
[C] It is multilayered and actively participates in secretion and absorption.
[D] It is multilayered and covers the outer lining of secretory glandular epithelium.

14. Which one of the following pairs of genotype and phenotype ratios will be obtained in F2 generation for Snapdragon plants exhibiting incomplete dominance for red and white flower color traits?

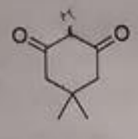
[A] 3:1 and 1:2:1 [B] 3:1 and 3:1 [C] 1:2:1 and 1:2:1 [D] 1:2:1 and 3:1

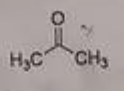
15. Provided below are recognition sequences for restriction enzymes 1 (RE1), 2 (RE2) and 3 (RE3). Arrows indicate the positions where the enzymes digest on the two strands. Which of the following can the RE1 digested DNA ligate to?

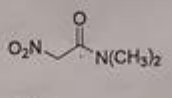
[A] Only to RE1 digested DNA.
[B] Only to RE1 and RE2 digested DNA.
[C] Only to RE1 and RE3 digested DNA.
[D] All three RE1, RE2 and RE3 digested DNA.

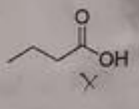


16. In which one of the following cases will the α–hydrogen NOT be abstracted on treatment with one equivalent of base?

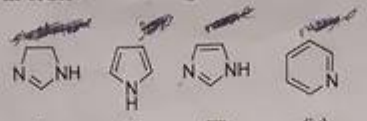
[A] 

[B] 

[C] 

[D] 

17. Arrange the following compounds in order of decreasing basicity.



(i) (ii) (iii) (iv)

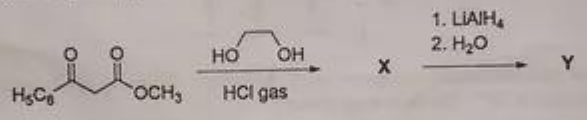
[A] (iii) > (i) > (iv) > (ii)

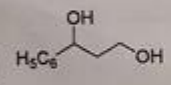
[B] (i) > (iv) > (iii) > (ii)

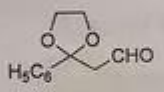
[C] (ii) > (i) > (iii) > (iv)

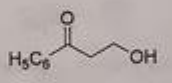
[D] (i) > (iii) > (iv) > (ii)

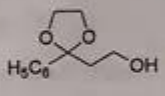
18. In the following reaction sequence, predict the structure of the final product **Y**.



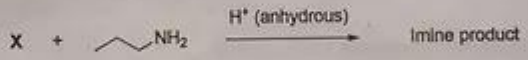
[A] 

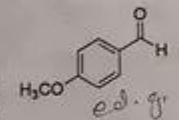
[B] 

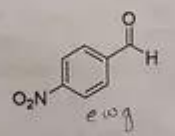
[C] 

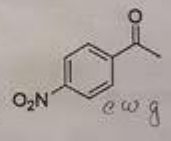
[D] 

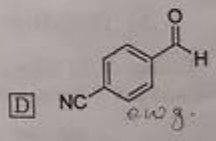
19. For the following reaction, identify the carbonyl compound **X** that shows the highest reactivity.



[A] 

[B] 

[C] 

[D] 

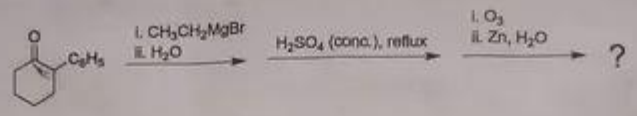
20. $SnCl_2$ dissolves in a solution containing Cl^- ions to form $[SnCl_3]^-$. What would be the geometry of $[SnCl_3]^-$?

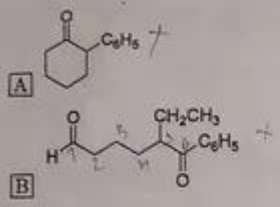
[A] Tetrahedral [B] Trigonal pyramidal [C] Trigonal planar [D] T-shaped

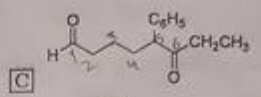
21. How many nodes are there in the antibonding molecular orbital formed by two 2s atomic orbitals?

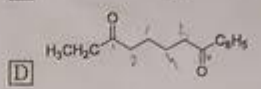
[A] 2 [B] 3 [C] 1 [D] 0

22. Identify the major product in the following reaction









23. A complex of metal M^{n+} has the following electronic distribution in d orbitals,

The neutral M has a ground state electronic configuration of $[Ar]4s^23d^6$. Which of the following complexes is consistent with the electronic distribution of M^{n+} (as described above)?

A $[MF_6]^{4-}$ B $[MF_6]^{3-}$ C $[M(CN)_6]^{4-}$ D $[M(CN)_6]^{3-}$

24. Identify the complex that can exist as a pair of enantiomers.

A *trans*–$[Co(H_2NCH_2CH_2NH_2)_2Cl_2]^+$
B $[Co(H_2NCH_2CH_2NH_2)_3]^{3+}$
C $[Co(NH_3)_4Cl_2]^+$
D $[Co\{P(C_2H_5)_3\}_2ClBr]$

25. Which of the following complexes is expected to be colored?

A $[Ni(H_2O)_6]^{2+}$ B $[Al(H_2O)_6]^{3+}$ C $[Zn(H_2O)_6]^{2+}$ D $[Mg(H_2O)_6]^{2+}$

26. Density of 3M solution of NaCl is 1.25 g/mL. Calculate the volume of water required to make 1000 mL of this NaCl solution. [Consider the density of water as 1 g/mL].

A 1074.5 mL B 1250 mL C 824.5 mL D 1000 mL

27. Electric current was passed through an aqueous solution of $CuSO_4$ using two Pt electrodes. After some time, the blue color of the solution disappeared along with evolution of O_2 gas. Which of the following statements is correct regarding the resultant solution?

A $[Cu^{2+}] > [SO_4^{2-}]$ B pH > 7 C pH < 7 D $[Cu^{2+}] = [SO_4^{2-}]$

28. Reactant R gives n different products ($P_r : r = 1, 2, 3, \cdots, n$) in n parallel first order reactions. Rate constant for the formation of any product P_r is rk where $r = 1, 2, 3, \cdots, n$. For the decay of R, what is the overall rate constant in terms of k?

A e^{-nk} B nk C k D $\frac{n(n+1)k}{2}$

$P_1\ P_2\ P_3$

$\frac{dR}{dt} = -nk[R]$

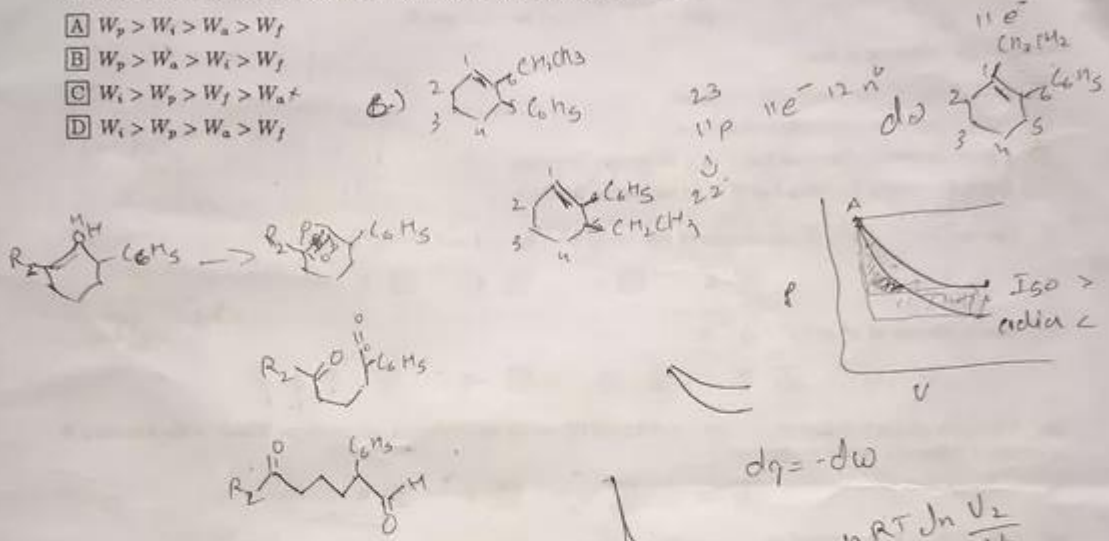
$[R] = R_0 e^{-nkt}$

29. Consider a hypothetical case in which the charge of a proton is twice as that of an electron. Using this hypothetical case, how many protons (P), neutrons (N) and electrons (E) would a neutral ^{23}Na atom contain?

[A] P = 12, N = 11, E = 23
[B] P = 11, N = 12, E = 22
[C] P = 11, N = 12, E = 11
[D] P = 11, N = 12, E = 23

30. The magnitude of reversible work done by an ideal gas in four different processes: isothermal expansion, adiabatic expansion, constant pressure expansion, and free expansion are W_i, W_a, W_p, and W_f respectively. Choose the right order of sequence for the magnitude of the work done. (Change in the volume is same for all the processes.)

[A] $W_p > W_i > W_a > W_f$
[B] $W_p > W_a > W_i > W_f$
[C] $W_i > W_p > W_f > W_a$
[D] $W_i > W_p > W_a > W_f$



MATHEMATICS

31. The number of solutions of the equation $2\sin^2 x + 1 = 3\sin x$ in the interval $(0, \pi)$ is

[A] 0. [B] 2. [C] 3. [D] 1.

32. For $n \geq 2$, the number of onto functions from the set $\{1, 2, \ldots, n\}$ to the set $\{1, 2\}$ is

[A] $n!$. [B] 2^n. [C] $2^n - 1$. [D] $2^n - 2$.

33. Let $f : \mathbf{R} \to \mathbf{R}$ be a differentiable function such that $f'(0) = 1$ and

$$f(x+y) = f(x)f(y) \text{ for all } x, y \in \mathbf{R}.$$

Which of the following is true?

[A] Both f and f' are decreasing functions.
[B] Both f and f' are increasing functions.
[C] f is an increasing function but f' is a decreasing function.
[D] f is a decreasing function but f' is an increasing function.

34. The number of points of intersection of the curves $x^2 + 8y^2 = 4$ and $x^2 + y^2 = 1$ is

[A] 2. [B] 1. [C] 4. [D] 0.

35. The coefficient of x^9 in $\left(x^2 - \frac{1}{3x}\right)^9$ is

[A] $\frac{28}{9}$. [B] $-\frac{56}{9}$. [C] -3. [D] $-\frac{28}{9}$.

36. The roots of the polynomial $x^3 - 39x^2 + 471x - 1729$ are in an arithmetic progression. Which of the following is a common difference of the progression?

[A] 13 [B] 19 [C] 7 [D] 6

37. Let $f : \mathbf{R} \to \mathbf{R}$ be defined as

$$f(x) = \begin{cases} \frac{e^{3x} - e^x - e^{2x} + 1}{x^3} & \text{if } x > 0, \\ a & \text{if } x = 0, \\ \frac{1 - \cos(2x)}{x^2} & \text{if } x < 0. \end{cases}$$

The value of a for which f is continuous at 0 is

[A] 0. [B] 2. [C] 3. [D] 1.

38. Let S be a set with 3 elements. What is the probability of choosing an ordered pair (A, B) of subsets of S such that A and B are disjoint?

[A] $\frac{1}{2}$ [B] $\frac{27}{64}$ [C] $\frac{26}{64}$ [D] $\frac{1}{8}$

39. Consider the functions y_1 and y_2 satisfying

$$\frac{dy_1}{dx} = -y_2, \ \frac{dy_2}{dx} = y_1, \ y_1(0) = 1, \ y_2(0) = 0.$$

The set $S = \{(y_1(x), y_2(x)) : x \in \mathbf{R}\}$ lies on a

[A] hyperbola. [B] parabola. [C] straight line. [D] circle.

40. A function f satisfying $f \circ f \circ f(x) = x$ for all $x \in \mathbf{R}$ is

[A] one–one but not onto.
[B] onto but not one–one.
[C] one–one and onto.
[D] neither one–one nor onto.

41. The function $f(x) = \sin x + \frac{1}{\sin x}$ in the interval $(0, \pi)$ has a

[A] local minima at $\pi/6$.
[B] local maxima at $\pi/3$.
[C] local minima at $\pi/2$.
[D] local maxima at $\pi/4$.

42. Let p be a polynomial with real coefficients such that $\int_0^1 p(t)dt = 0$. Which of the following statements is always true?

[A] p has a root in the interval $[0, 1]$.
[B] All roots of p lie in the interval $[0, 1]$.
[C] p has no roots in the interval $[0, 1]$.
[D] p has exactly one root in the interval $[0, 1]$.

43. For a complex number z, let $(1 + z)^{15} = a_0 + a_1 z + \cdots + a_{15} z^{15}$. The value of

$$(a_0 - 4a_2 + 16a_4 + \cdots - 2^{14} a_{14})^2 + (2a_1 - 8a_3 + 32a_5 \cdots - 2^{15} a_{15})^2$$

is

[A] 2^{30}. [B] 2^{15}. [C] 1. [D] 5^{15}.

44. Let A be a 3×3 matrix which has determinant 3 and satisfies the equation $A^2 - 7A + 4I = 0$. The value of $|\det(A - 2I)|$ is

[A] 1. [B] 9. [C] 5. [D] 3.

45. Consider the functions

$$g(x) = \begin{cases} 1 & \text{if } x \in [-1, 1], \\ 0 & \text{otherwise} \end{cases}$$

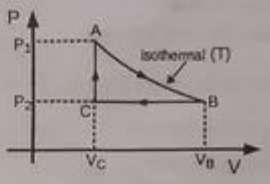
and

$$f(x) = \lim_{h \to 0} \frac{1}{2h} \int_{x-h}^{x+h} g(y)dy.$$

The value of $f(1)$ is

[A] 1. [B] 1/2. [C] −1. [D] 0.

46. One mole of an ideal gas is taken around the complete cycle as shown in the PV-diagram. Considering the universal gas constant R, the work done by the gas in one complete cycle is

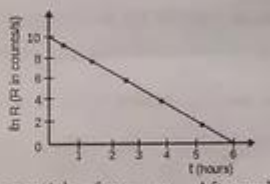


[A] $RT\ln\frac{V_B}{V_C} - P_2(V_B - V_C)$.
[B] $(P_1 - P_2)V_C + P_2(V_B - V_C)$.
[C] $RT\ln\frac{V_B - V_C}{V_C}$.
[D] 0.

47. A Copper wire of length L_{Cu}, Young's modulus Y_{Cu}, and diameter d is hung from the ceiling. An Aluminium wire of length L_{Al}, Young's modulus Y_{Al}, and of same diameter d is joined end–to–end at the free end of the Copper wire. If under the action of a load applied at the free end of the Aluminium wire the net elongation is ΔL, the applied load is

[A] $\frac{\pi d^2 \Delta L(Y_{Cu}L_{Al}+Y_{Al}L_{Cu})}{4L_{Cu}L_{Al}}$.
[B] $\frac{\pi d^2 \Delta L(Y_{Cu}L_{Al}-Y_{Al}L_{Cu})}{4L_{Cu}L_{Al}}$.
[C] $\frac{\pi d^2 Y_{Cu}Y_{Al}\Delta L}{4(Y_{Cu}L_{Al}+Y_{Al}L_{Cu})}$.
[D] $\frac{\pi d^2 Y_{Cu}Y_{Al}\Delta L}{4(Y_{Cu}L_{Al}-Y_{Al}L_{Cu})}$.

48. From the given plot of the decay rate R versus time t of some radioactive nuclei, the half life of the nuclei in hours can be estimated to be



[A] 2.5. [B] $\frac{3}{5}\ln 2$. [C] $\frac{5}{3}\ln 2$. [D] 3.

49. A particle of mass m_1 and velocity $\vec{v_i}$ collides head-on with a stationary particle of mass m_2. After collision the velocity of both particles is $\vec{v_f}$. The energy lost in the collision is

[A] $\frac{1}{2}m_2 v_i^2[1 - \frac{m_1}{m_1+m_2}]$.
[B] $\frac{1}{2}m_1 v_i^2[1 - \frac{m_2}{m_1+m_2}]$.
[C] $\frac{1}{2}m_1 v_i^2[1 - \frac{m_2}{m_1+m_2}]$.
[D] $\frac{1}{2}(m_1+m_2)(v_i - v_f)^2$.

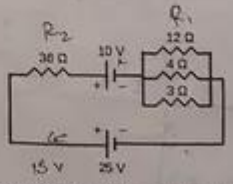
50. Particles of mass m_1 and m_2 initially sitting at the same position, start moving simultaneously at $t = 0$ with velocities $\vec{v_1}$ and $\vec{v_2}$, respectively. After a time $t = t_0$ the angular momentum of the particle of mass m_2 with respect to the particle of mass m_1 is

[A] $|\vec{v_1} - \vec{v_2}|^2 m_2 t_0$. [B] $|\vec{v_1} - \vec{v_2}|^2 \frac{m_1 m_2}{m_1+m_2} t_0$. [C] $|\vec{v_1} - \vec{v_2}|^2 \frac{m_2^2}{m_1} t_0$. [D] 0.

51. If the refractive index of the material of a prism is μ and its angle of minimum deviation is $\pi/3$ then the angle of the prism is

[A] $2\cot^{-1}(\frac{2\mu-1}{\sqrt{3}})$. [B] $2\cot^{-1}(\frac{1-2\mu}{\sqrt{3}})$. [C] $2\cot^{-1}(\sqrt{3}-2\mu)$. [D] $2\cot^{-1}(2\mu-\sqrt{3})$.

52. The current through the 36 Ω resistor in the given circuit is

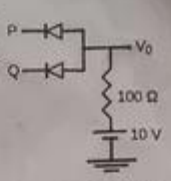


[A] 1/3 A [B] 2/5 A [C] 2/3 A [D] 70/75 A

53. The dimension of $1/RC$, where R is the resistance and C is the capacitance, is the same as that of

[A] Current. [B] Charge. [C] Time. [D] Frequency.

54. In the given circuit, the input voltages at P and Q could be either 0 V or 10 V. Use the fact that a diode under forward bias is a short circuit, and under reverse bias is an open circuit. The truth table of the circuit will be that of

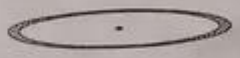


[A] an AND Gate.
[B] an OR Gate.
[C] a NAND Gate.
[D] a NOR Gate.

55. What should be the closest approximate radius of a celestial body twice as massive as the sun so that the escape speed from the celestial body is equal to the speed of light? (The mass of sun is 2×10^{30} Kg, speed of light is 3×10^8 m/s, and universal gravitational constant $G = 7 \times 10^{-11}$ N m^2/Kg^2.)

[A] 300 km [B] 1 km [C] 90 km [D] 6 km

56. Two bar magnets A and B, and a non-magnetic bar C, all of same mass and dimensions, are dropped in an identical manner one by one through the center of a copper loop held horizontally (as shown in the figure). The times taken by the bars A, B, and C to reach the ground are t_A, t_B, and t_C, respectively. Which of the following relations is correct?

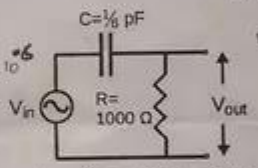


[A] $t_A > t_B > t_C$
[B] $t_A = t_B > t_C$
[C] $t_A = t_B < t_C$
[D] $t_A < t_B < t_C$

57. A metal, whose temperature coefficient of resistivity is $5 \times 10^{-4}\ ^\circ C^{-1}$, is heated from 100 °C to 1100 °C. By what factor does the mobility of electrons in the metal change due to this change in temperature?

[A] 2/3 [B] $\sqrt{2}$ [C] $\sqrt{3}/2$ [D] 3/2

58. In the given circuit, what is the closest approximate frequency at which the ratio V_{out}/V_{in} is $1/\sqrt{2}$?



[A] 0.16×10^6 Hz
[B] 1.6×10^6 Hz
[C] 10^6 Hz
[D] 10^9 Hz

59. The transverse displacement at position x and time t in a string due to a travelling wave is given by $y(x,t) = 3.0\cos(\pi x - 4\pi t)$ cm, where x is in centimeters and t is in seconds. Which of the following statements is wrong?

[A] Maximum value of transverse velocity of any point is 12π cm/s and wavelength is 0.2 m.
[B] Maximum value of transverse acceleration of any point is $48\pi^2$ cm/s^2.
[C] Speed of wave propagation in the +ve x-direction is 4π cm/s.
[D] Transverse velocity at $t = 0$ and $x = 0.25$ cm is $6\sqrt{2}\pi$ cm/s.

60. An electron of mass m_e and charge e is projected with a speed v making an angle θ with respect to the top electrode of a parallel plate capacitor as shown in the figure. Considering only the effect of the downward constant electric field E on the electron's motion, which of the following statements is correct.

[A] Electron moves along trajectory B with a final velocity $v\cos\theta$ parallel to the electrodes.
[B] Electron moves along trajectory A with a horizontal displacement given by $v\cos\theta\sqrt{2dm_e/eE}$.
[C] Electron moves along trajectory C with a maximum horizontal displacement given by $(m_e v^2 \sin 2\theta)/eE$.
[D] Electron moves along trajectory C with a time of flight given by $(m_e v/eE)\sin^2\theta$.