

Questions
120 MCQs

Marks
120 (1 each)

Time
2 hours 30 minutes

Negative marking
None

Part	Section	Questions	Q. No.
Section I	Mathematics	30	1 to 30
Section II	Physics	30	31 to 60
Section III	Chemistry	30	61 to 90
Section IV	English / Aptitude	30	91 to 120

Instructions

1. This is the MPC paper taken by B.Tech applicants: 120 multiple-choice questions in four sections of 30 each, as in the latest official V-SAT question booklet (V-SAT 2021, Paper-1).
2. Section I Mathematics (Q1 to 30), Section II Physics (Q31 to 60), Section III Chemistry (Q61 to 90) and Section IV English / Aptitude (Q91 to 120). BiPC candidates answer Biology in place of Mathematics.
3. Each question has four options and only one is correct. Each correct answer carries 1 mark. There is no negative marking, so attempt every question.
4. Time allowed is 2 hours 30 minutes. Vignan now conducts V-SAT as an online test; calculators and other electronic devices are not allowed.
5. The answer key and solutions are at the end. Check them only after you finish.

This is an AglaSem practice paper written on the latest official V-SAT pattern (V-SAT 2021 booklet: 4 sections x 30 questions, 1 mark each, no negative marking, 2 hours 30 minutes) and the Intermediate (Class 11-12) syllabus. Vignan has not published a separate 2027 pattern. It is not an official Vignan's University paper and its questions are not taken from any V-SAT paper.

Section I

Mathematics

1. If $f(x) = (x - 1)/(x + 1)$, $x \neq -1, 0$, then $f(f(x))$ equals:
 (A) $1/x$ (B) $-1/x$
 (C) $-x$ (D) x
2. The domain of the real function $f(x) = \sqrt{4 - x^2}$ is:
 (A) $[0, 2]$ (B) all real numbers
 (C) $[-2, 2]$ (D) $(-2, 2)$
3. If A is a 3×3 matrix with $|A| = 4$, then $|\text{adj } A|$ is:
 (A) 64 (B) 12
 (C) 16 (D) 4
4. The rank of the matrix $[[1, 2, 3], [2, 4, 6], [1, 1, 1]]$ is:
 (A) 0 (B) 3
 (C) 1 (D) 2
5. If the vectors $i + \lambda j + 2k$ and $2i - j + 3k$ are perpendicular, then λ equals:
 (A) -8 (B) 4
 (C) 6 (D) 8

6. The area of the parallelogram with adjacent sides $a = i + j$ and $b = j + k$ is:
 (A) $\sqrt{2}$ (B) 3
 (C) 2 (D) $\sqrt{3}$
7. The value of $\sin 15^\circ$ is:
 (A) $(\sqrt{6} - \sqrt{2})/4$ (B) $(\sqrt{2} - 1)/2$
 (C) $(\sqrt{6} + \sqrt{2})/4$ (D) $(\sqrt{3} - 1)/2$
8. The maximum value of $3 \sin x + 4 \cos x$ is:
 (A) 1 (B) 4
 (C) 5 (D) 7
9. The coefficient of x^2 in the expansion of $(1 + x)^8$ is:
 (A) 28 (B) 56
 (C) 16 (D) 8
10. In triangle ABC, $a = 3$, $b = 4$ and $c = 5$. The circumradius R of the triangle is:
 (A) 2 (B) 5
 (C) $5/2$ (D) 3
11. The distance between the parallel lines $3x + 4y = 5$ and $3x + 4y = 15$ is:
 (A) 10 (B) 2
 (C) 1 (D) 5
12. Two fair dice are thrown together. The probability that the sum of the numbers shown is 7 is:
 (A) $1/6$ (B) $1/12$
 (C) $5/36$ (D) $7/36$
13. The centre and radius of the circle $x^2 + y^2 - 4x + 6y - 3 = 0$ are:
 (A) $(-2, 3)$ and 4 (B) $(2, -3)$ and 4
 (C) $(-2, 3)$ and $\sqrt{10}$ (D) $(2, -3)$ and 16
14. The focus of the parabola $y^2 = 8x$ is:
 (A) $(2, 0)$ (B) $(8, 0)$
 (C) $(4, 0)$ (D) $(0, 2)$
15. The eccentricity of the ellipse $x^2/25 + y^2/16 = 1$ is:
 (A) $5/4$ (B) $3/4$
 (C) $4/5$ (D) $3/5$
16. The value of $\lim_{x \rightarrow 0} (\sin 3x)/x$ is:
 (A) 3 (B) 1
 (C) 0 (D) $1/3$
17. The value of $\lim_{x \rightarrow \infty} (1 + 2/x)^x$ is:
 (A) e (B) 2
 (C) e^2 (D) 1
18. If $y = x^x$ ($x > 0$), then dy/dx equals:
 (A) $x^x \log x$ (B) $x^x(1 + \log x)$
 (C) $x^x(1 - \log x)$ (D) $x \cdot x^{x-1}$
19. If $y = \sin^2 x$, then dy/dx equals:
 (A) $\sin 2x$ (B) $\cos 2x$
 (C) $2 \sin x$ (D) $2 \cos x$

20. The local maximum value of $f(x) = x^3 - 3x$ is:
 (A) 0 (B) -2
 (C) 2 (D) 1
21. The slope of the tangent to the curve $y = x^2 + 3x$ at $x = 1$ is:
 (A) 5 (B) 3
 (C) 2 (D) 4
22. $\int dx / (1 + x^2)$ equals:
 (A) $\sin^{-1}x + C$ (B) $1/(1 + x^2) + C$
 (C) $\log(1 + x^2) + C$ (D) $\tan^{-1}x + C$
23. The value of $\int \sin x \, dx$ from 0 to $\pi/2$ is:
 (A) -1 (B) 0
 (C) 1 (D) $\pi/2$
24. The value of $\int x e^x \, dx$ from 0 to 1 is:
 (A) e (B) 1
 (C) $e - 1$ (D) $e + 1$
25. The area of the region enclosed by the curves $y = x^2$ and $y = x$ is:
 (A) $1/6$ sq. unit (B) $5/6$ sq. unit
 (C) $1/3$ sq. unit (D) $1/2$ sq. unit
26. The order and degree of the differential equation $(d^2y/dx^2)^3 + (dy/dx)^4 + y = 0$ are:
 (A) order 2, degree 3 (B) order 2, degree 4
 (C) order 3, degree 2 (D) order 4, degree 3
27. The general solution of the differential equation $dy/dx = y$ is:
 (A) $y = Cx$ (B) $y = Ce^x$
 (C) $y = x + C$ (D) $y = Ce^{-x}$
28. If $i = \sqrt{-1}$, then i^{2027} equals:
 (A) 1 (B) -i
 (C) -1 (D) i
29. If α and β are the roots of $x^2 - 5x + 6 = 0$, then $\alpha^2 + \beta^2$ equals:
 (A) 11 (B) 25
 (C) 37 (D) 13
30. The number of different arrangements of the letters of the word VIGNAN is:
 (A) 720 (B) 360
 (C) 120 (D) 180

Section II

Physics

31. The dimensional formula of the coefficient of viscosity is:
 (A) $[ML^2T^{-1}]$ (B) $[ML^{-2}T^{-2}]$
 (C) $[ML^{-1}T^{-1}]$ (D) $[MLT^{-1}]$

32. Two forces of 3 N and 4 N act on a body at right angles to each other. The magnitude of their resultant is:
 (A) 1 N (B) 12 N
 (C) 5 N (D) 7 N
33. A body is projected at 30° to the horizontal with a speed of 20 m/s. Its maximum height is ($g = 10 \text{ m/s}^2$):
 (A) 20 m (B) 10 m
 (C) 15 m (D) 5 m
34. A 5 kg block on a rough horizontal floor (coefficient of friction 0.2) is pulled by a horizontal force of 20 N. Its acceleration is ($g = 10 \text{ m/s}^2$):
 (A) 4 m/s^2 (B) 1 m/s^2
 (C) 3 m/s^2 (D) 2 m/s^2
35. A man of mass 60 kg stands in a lift moving upward with an acceleration of 2 m/s^2 . The reading of a weighing machine under him is ($g = 10 \text{ m/s}^2$):
 (A) 600 N (B) 480 N
 (C) 120 N (D) 720 N
36. A spring of force constant 200 N/m is compressed by 10 cm. The energy stored in it is:
 (A) 0.5 J (B) 1 J
 (C) 2 J (D) 10 J
37. A 2 kg ball moving at 3 m/s strikes a 1 kg ball at rest and the two stick together. Their common velocity is:
 (A) 1 m/s (B) 3 m/s
 (C) 2 m/s (D) 1.5 m/s
38. For a solid sphere rolling without slipping, the fraction of its total kinetic energy that is rotational is:
 (A) $\frac{2}{5}$ (B) $\frac{5}{7}$
 (C) $\frac{2}{7}$ (D) $\frac{1}{2}$
39. The radius of gyration of a uniform disc of radius R about its own axis (perpendicular to its plane) is:
 (A) $\sqrt{2} R$ (B) $R/2$
 (C) $R/\sqrt{2}$ (D) R
40. The radius of a satellite's circular orbit is made four times. Its period of revolution becomes:
 (A) 2 times (B) 8 times
 (C) 4 times (D) 16 times
41. Light of photon energy 5 eV falls on a metal of work function 2 eV. The stopping potential is:
 (A) 7 V (B) 5 V
 (C) 3 V (D) 2.5 V
42. A wire 2 m long with cross-sectional area 1 mm^2 is stretched by a load of 100 N. If $Y = 2 \times 10^{11} \text{ N/m}^2$, the extension is:
 (A) 10 mm (B) 1 mm
 (C) 0.1 mm (D) 2 mm
43. Water flows at 2 m/s through a pipe of cross-section 10 cm^2 . Its speed where the cross-section narrows to 5 cm^2 is:
 (A) 8 m/s (B) 2 m/s
 (C) 1 m/s (D) 4 m/s

44. The excess pressure inside a soap bubble of radius r (surface tension T) is:
 (A) $8T/r$ (B) $2T/r$
 (C) $4T/r$ (D) T/r
45. If α is the coefficient of linear expansion of a solid, its coefficient of volume expansion is:
 (A) 2α (B) 3α
 (C) $\alpha/3$ (D) α
46. The ratio of specific heats C_p/C_v for a monoatomic ideal gas is:
 (A) $9/7$ (B) $5/3$
 (C) $4/3$ (D) $7/5$
47. The average translational kinetic energy of a gas molecule at absolute temperature T is (k = Boltzmann constant):
 (A) $3kT$ (B) $(1/2)kT$
 (C) $(3/2)kT$ (D) kT
48. The displacement of a particle in SHM is $x = 5 \sin(\pi t + \pi/3)$ cm, t in seconds. Its time period is:
 (A) 2 s (B) 1 s
 (C) π s (D) 5 s
49. The tension in a stretched string is made four times. The speed of transverse waves on it becomes:
 (A) unchanged (B) half
 (C) four times (D) twice
50. A pipe 0.85 m long is closed at one end. If the speed of sound is 340 m/s, its fundamental frequency is:
 (A) 200 Hz (B) 400 Hz
 (C) 100 Hz (D) 50 Hz
51. An object is placed 30 cm in front of a convex lens of focal length 20 cm. The image is formed at:
 (A) 60 cm behind the lens (B) 60 cm in front of the lens
 (C) 30 cm behind the lens (D) 12 cm behind the lens
52. The critical angle for light going from a medium of refractive index $\sqrt{2}$ to air is:
 (A) 45° (B) 90°
 (C) 30° (D) 60°
53. The electric potential at a distance of 9 cm from a point charge of $1 \mu\text{C}$ is ($1/4\pi\epsilon_0 = 9 \times 10^9 \text{ N m}^2/\text{C}^2$):
 (A) $9 \times 10^5 \text{ V}$ (B) 10^4 V
 (C) 10^3 V (D) 10^5 V
54. A $2 \mu\text{F}$ capacitor is charged to 100 V. The energy stored in it is:
 (A) 0.1 J (B) 1 J
 (C) 0.02 J (D) 0.01 J
55. A cell of emf 2 V and internal resistance 0.5Ω is connected to an external resistance of 3.5Ω . The terminal voltage of the cell is:
 (A) 0.25 V (B) 1.75 V
 (C) 1.5 V (D) 2 V
56. A galvanometer is converted into an ammeter by connecting:
 (A) a low resistance in series (B) a low resistance in parallel
 (C) a high resistance in series (D) a high resistance in parallel

57. A proton and an alpha particle enter the same uniform magnetic field with the same velocity, perpendicular to the field. The ratio of the radius of the alpha particle's path to that of the proton is:
(A) $1/2$ (B) 4
(C) 1 (D) 2
58. The current in a coil of self-inductance 0.5 H changes from 0 to 2 A in 0.1 s. The emf induced is:
(A) 0.1 V (B) 1 V
(C) 20 V (D) 10 V
59. The output of a NAND gate when both its inputs are 1 is:
(A) either 0 or 1 (B) undefined
(C) 0 (D) 1
60. Nuclear radius varies as $A^{1/3}$. The ratio of the nuclear radius of ^{64}Cu to that of ^{27}Al is:
(A) 64 : 27 (B) 4 : 3
(C) 16 : 9 (D) 3 : 4

Section III

Chemistry

61. The number of radial nodes in a 3s orbital is:
(A) 0 (B) 1
(C) 3 (D) 2
62. Which of the following sets of quantum numbers is NOT possible?
(A) $n = 3, l = 2, m = +2, s = -1/2$ (B) $n = 2, l = 1, m = -1, s = +1/2$
(C) $n = 2, l = 2, m = 0, s = +1/2$ (D) $n = 1, l = 0, m = 0, s = -1/2$
63. Among Na, Mg, Al and Si, the element with the highest first ionisation enthalpy is:
(A) Mg (B) Na
(C) Si (D) Al
64. The bond order of the O_2^+ ion is:
(A) 3 (B) 2
(C) 1.5 (D) 2.5
65. Which of the following molecules has zero dipole moment?
(A) NH_3 (B) HCl
(C) H_2O (D) BF_3
66. The shape of the XeF_4 molecule is:
(A) square planar (B) see-saw
(C) octahedral (D) tetrahedral
67. The volume occupied by 2 moles of an ideal gas at STP (taking 22.4 L per mole) is:
(A) 11.2 L (B) 44.8 L
(C) 89.6 L (D) 22.4 L
68. The volume of 0.1 M NaOH needed to neutralise 20 mL of 0.2 M H_2SO_4 is:
(A) 40 mL (B) 20 mL
(C) 80 mL (D) 160 mL

69. Entropy of the system increases in the:
 (A) condensation of steam (B) freezing of water
 (C) reaction $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$ (D) melting of ice
70. The solubility product of a sparingly soluble salt AB_2 with solubility s (mol/L) is:
 (A) s^3 (B) $2s^3$
 (C) s^2 (D) $4s^3$
71. A buffer contains equal concentrations of acetic acid ($\text{pK}_a = 4.74$) and sodium acetate. Its pH is:
 (A) 4.74 (B) 2.37
 (C) 7.00 (D) 9.26
72. 'Perhydrol' is the commercial name of:
 (A) sodium peroxide (B) 3% hydrogen peroxide
 (C) heavy water (D) 30% hydrogen peroxide
73. Lithium shows a diagonal relationship with:
 (A) aluminium (B) sodium
 (C) beryllium (D) magnesium
74. The inert pair effect is most marked in:
 (A) thallium (B) aluminium
 (C) boron (D) gallium
75. Silicones are polymers whose repeating unit is:
 (A) $-\text{SiO}_4-$ (B) $-\text{R}_2\text{SiO}-$
 (C) $-\text{SiH}_2\text{O}-$ (D) $-\text{R}_2\text{Si}-$
76. Among the hydrides NH_3 , PH_3 , AsH_3 and BiH_3 , the strongest reducing agent is:
 (A) NH_3 (B) AsH_3
 (C) PH_3 (D) BiH_3
77. The first true compound of a noble gas, prepared by Neil Bartlett, was:
 (A) XeF_6 (B) $\text{Xe}^+[\text{PtF}_6]^-$
 (C) XeO_3 (D) KrF_2
78. A Schottky defect in an ionic crystal:
 (A) does not change the density
 (B) makes the crystal coloured
 (C) raises the density of the crystal
 (D) lowers the density of the crystal
79. 18 g of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) is dissolved in 178.2 g of water. The mole fraction of glucose is:
 (A) 0.01 (B) 0.09
 (C) 0.001 (D) 0.1
80. For the Daniell cell $\text{Zn} | \text{Zn}^{2+} || \text{Cu}^{2+} | \text{Cu}$, $E^\circ(\text{Zn}^{2+}/\text{Zn}) = -0.76 \text{ V}$ and $E^\circ(\text{Cu}^{2+}/\text{Cu}) = +0.34 \text{ V}$. The standard emf is:
 (A) 0.42 V (B) 1.10 V
 (C) 0.76 V (D) -1.10 V
81. An aldehyde with no α -hydrogen, on heating with concentrated NaOH , undergoes:
 (A) aldol condensation (B) Wurtz reaction
 (C) Cannizzaro reaction (D) Hofmann bromamide reaction

82. The rate of a reaction doubles for every 10°C rise in temperature. If the temperature is raised from 20°C to 50°C , the rate becomes:
- (A) 8 times (B) 9 times
(C) 3 times (D) 6 times
83. Froth flotation is used to concentrate:
- (A) oxide ores (B) halide ores
(C) sulphide ores (D) carbonate ores
84. The spin-only magnetic moment of Fe^{3+} (Z of Fe = 26) is about:
- (A) 4.90 BM (B) 3.87 BM
(C) 1.73 BM (D) 5.92 BM
85. The IUPAC name of $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$ is:
- (A) hexaamminecobalt(III) chloride
(B) cobalt hexaammine trichloride
(C) hexaamminecobaltate(III) chloride
(D) hexaamminecobalt(II) chloride
86. The number of σ and π bonds in acrylonitrile, $\text{CH}_2=\text{CH}-\text{C}\equiv\text{N}$, is:
- (A) 7σ and 2π (B) 6σ and 2π
(C) 6σ and 3π (D) 5σ and 3π
87. Ozonolysis of 2-butene ($\text{CH}_3\text{CH}=\text{CHCH}_3$) followed by treatment with $\text{Zn}/\text{H}_2\text{O}$ gives:
- (A) propanone only (B) ethanal and propanone
(C) methanal and propanal (D) ethanal only
88. When methyl bromide is heated with sodium in dry ether, the main product is:
- (A) butane (B) ethane
(C) methane (D) propane
89. The carbylamine (isocyanide) test is given by:
- (A) all amines (B) tertiary amines
(C) primary amines (D) secondary amines
90. Which of the following is a biodegradable polymer?
- (A) PHBV (B) PVC
(C) nylon-6,6 (D) polythene

Section IV

English / Aptitude

91. A boat goes at 10 km/h in still water and the stream flows at 2 km/h. How long will the boat take to go 24 km downstream and come back?
- (A) 4.8 hours (B) 5 hours
(C) 6 hours (D) 4 hours
92. A man rows 18 km downstream in 2 hours and 10 km upstream in 2 hours. The speed of the stream is:
- (A) 2 km/h (B) 4 km/h
(C) 3 km/h (D) 7 km/h

93. Pipe A can fill a tank in 12 hours and pipe B can empty it in 18 hours. If both are opened together, the empty tank fills in:
(A) 30 hours (B) 36 hours
(C) 6 hours (D) 7.2 hours
94. Two pipes can fill a tank in 20 minutes and 30 minutes respectively. Together they fill it in:
(A) 10 minutes (B) 25 minutes
(C) 12 minutes (D) 15 minutes
95. The sum of three numbers is 140. The ratio of the first to the second is 2 : 3 and of the second to the third is 4 : 5. The second number is:
(A) 48 (B) 60
(C) 32 (D) 45
96. If $\log 2 = 0.3010$ and $\log 3 = 0.4771$, then $\log 12$ equals:
(A) 1.0791 (B) 0.7781
(C) 1.1761 (D) 1.0811
97. A number is first increased by 20% and then decreased by 20%. The net change is:
(A) 4% decrease (B) 2% decrease
(C) 4% increase (D) no change
98. In a 100 m race, A beats B by 10 m and B beats C by 10 m. By how much does A beat C?
(A) 21 m (B) 19 m
(C) 20 m (D) 18 m
99. In a 200 m race, A beats B by 20 m or by 4 seconds. A's time over the course is:
(A) 40 s (B) 32 s
(C) 36 s (D) 44 s
100. The fourth proportional to 4, 6 and 10 is:
(A) 15 (B) 24
(C) 20 (D) 12
101. The mean proportional between 9 and 16 is:
(A) 25 (B) 12
(C) 12.5 (D) 144
102. A car goes from P to Q at 40 km/h and returns at 60 km/h. Its average speed for the whole journey is:
(A) 48 km/h (B) 52 km/h
(C) 45 km/h (D) 50 km/h
103. The compound interest on Rs 10,000 at 10% per annum for 2 years, compounded annually, is:
(A) Rs 2,000 (B) Rs 2,200
(C) Rs 1,100 (D) Rs 2,100
104. A father is four times as old as his son. After 5 years he will be three times as old as his son. The father's present age is:
(A) 45 years (B) 36 years
(C) 40 years (D) 30 years
105. A train 120 m long crosses a platform 180 m long in 15 seconds. The speed of the train is:
(A) 60 km/h (B) 72 km/h
(C) 54 km/h (D) 80 km/h

- 106.** Fill in the blank with a suitable preposition: He has been ill ____ Sunday.
(A) for (B) from
(C) by (D) since
- 107.** Fill in the blank with a suitable preposition: She is very fond ____ music.
(A) about (B) of
(C) for (D) with
- 108.** Fill in the blank with a suitable preposition: He travelled to Chennai ____ train.
(A) in (B) with
(C) on (D) by
- 109.** Fill in the blank: By the time we reached the station, the train ____.
(A) was leaving (B) had left
(C) has left (D) left
- 110.** Fill in the blank: If I ____ you, I would accept the offer.
(A) have been (B) were
(C) am (D) was being
- 111.** Fill in the blank with a suitable collective noun: a ____ of wolves
(A) pack (B) swarm
(C) flock (D) herd
- 112.** Fill in the blank with a suitable collective noun: a ____ of ships
(A) fleet (B) bunch
(C) team (D) galaxy
- 113.** Choose the correct form of the part in capitals: He did not know WHERE WAS THE HOSPITAL.
(A) where hospital is there (B) where was hospital
(C) where the hospital was (D) where is the hospital
- 114.** Choose the correct verb: The quality of these mangoes ____ not good.
(A) were (B) have
(C) is (D) are
- 115.** Choose the meaning of the idiom: to burn the midnight oil
(A) to work or study late into the night
(B) to get angry quickly
(C) to waste money
(D) to start a fire
- 116.** Choose the meaning of the expression: a blessing in disguise
(A) something good that at first seemed bad
(B) a hidden enemy
(C) a costly gift
(D) an unexpected punishment
- 117.** Choose the correct question tag: Let's go for a walk, ____?
(A) shall we (B) don't we
(C) shan't you (D) will you

118. Fill in the blank with a suitable relative pronoun: This is the boy ____ father is a pilot.

(A) whom

(B) who

(C) which

(D) whose

119. Choose the correct active voice form: The letter was written by Ravi.

(A) Ravi had been writing the letter.

(B) Ravi wrote the letter.

(C) Ravi has written the letter.

(D) Ravi writes the letter.

120. Choose the correct indirect speech: He said, "I am tired."

(A) He said that he is being tired.

(B) He said that I am tired.

(C) He said that he was tired.

(D) He told that he had tired.

Answer Key

1	B	2	C	3	C	4	D	5	D	6	D	7	A	8	C	9	A	10	C
11	B	12	A	13	B	14	A	15	D	16	A	17	C	18	B	19	A	20	C
21	A	22	D	23	C	24	B	25	A	26	A	27	B	28	B	29	D	30	B
31	C	32	C	33	D	34	D	35	D	36	B	37	C	38	C	39	C	40	B
41	C	42	B	43	D	44	C	45	B	46	B	47	C	48	A	49	D	50	C
51	A	52	A	53	D	54	D	55	B	56	B	57	D	58	D	59	C	60	B
61	D	62	C	63	C	64	D	65	D	66	A	67	B	68	C	69	D	70	D
71	A	72	D	73	D	74	A	75	B	76	D	77	B	78	D	79	A	80	B
81	C	82	A	83	C	84	D	85	A	86	C	87	D	88	B	89	C	90	A
91	B	92	A	93	B	94	C	95	A	96	A	97	A	98	B	99	C	100	A
101	B	102	A	103	D	104	C	105	B	106	D	107	B	108	D	109	B	110	B
111	A	112	A	113	C	114	C	115	A	116	A	117	A	118	D	119	B	120	C

Solutions

Mathematics

- (B) $f(f(x)) = [(x-1)/(x+1) - 1] / [(x-1)/(x+1) + 1] = (-2)/(2x) = -1/x$.
- (C) We need $4 - x^2 \geq 0$, that is, $-2 \leq x \leq 2$.
- (C) For an $n \times n$ matrix, $|\text{adj } A| = |A|^{n-1} = 4^2 = 16$.
- (D) Row 2 = $2 \times$ Row 1, but Row 3 is not a multiple of Row 1, so exactly two rows are independent.
- (D) Dot product = $2 - \lambda + 6 = 0$, so $\lambda = 8$.
- (D) $a \times b = i - j + k$, whose magnitude is $\sqrt{3}$.
- (A) $\sin(45^\circ - 30^\circ) = \sin 45 \cos 30 - \cos 45 \sin 30 = (\sqrt{3} - 1)/(2\sqrt{2}) = (\sqrt{6} - \sqrt{2})/4$.
- (C) $a \sin x + b \cos x$ has maximum $\sqrt{a^2 + b^2} = \sqrt{9 + 16} = 5$.
- (A) Coefficient = ${}^8C_2 = 8 \times 7 / 2 = 28$.
- (C) Since $3^2 + 4^2 = 5^2$, $C = 90^\circ$; $R = c/(2 \sin C) = 5/2$.
- (B) Distance = $|15 - 5| / \sqrt{3^2 + 4^2} = 10/5 = 2$.
- (A) Favourable pairs: (1,6), (2,5), (3,4), (4,3), (5,2), (6,1) = 6 out of 36 = $1/6$.
- (B) Centre $(-g, -f) = (2, -3)$; radius = $\sqrt{4 + 9 + 3} = 4$.
- (A) $y^2 = 4ax$ with $4a = 8$ gives $a = 2$; focus $(a, 0) = (2, 0)$.
- (D) $e = \sqrt{1 - b^2/a^2} = \sqrt{1 - 16/25} = 3/5$.
- (A) $(\sin 3x)/x = 3 \times (\sin 3x)/(3x) \rightarrow 3 \times 1 = 3$.
- (C) $\lim (1 + a/x)^x = e^a$ with $a = 2$.
- (B) $\log y = x \log x$; $(1/y) dy/dx = \log x + 1$, so $dy/dx = x^x(1 + \log x)$.
- (A) $dy/dx = 2 \sin x \cos x = \sin 2x$.
- (C) $f'(x) = 3x^2 - 3 = 0$ at $x = \pm 1$; $f''(-1) = -6 < 0$, so the maximum is at $x = -1$: $f(-1) = -1 + 3 = 2$.
- (A) $dy/dx = 2x + 3 = 5$ at $x = 1$.
- (D) The derivative of $\tan^{-1}x$ is $1/(1 + x^2)$.
- (C) $[-\cos x]$ from 0 to $\pi/2 = -0 + 1 = 1$.
- (B) $\int x e^x dx = (x - 1)e^x$; from 0 to 1: $0 - (-1) = 1$.
- (A) The curves meet at $x = 0$ and 1; area = $\int (x - x^2) dx$ from 0 to 1 = $1/2 - 1/3 = 1/6$.

26. (A) Highest derivative is d^2y/dx^2 (order 2), raised to power 3 (degree 3).

27. (B) $dy/y = dx$ gives $\log y = x + c$, so $y = Ce^x$.

28. (B) $2027 = 4 \times 506 + 3$, so $i^{2027} = i^3 = -i$.

29. (D) $\alpha + \beta = 5$, $\alpha\beta = 6$; $\alpha^2 + \beta^2 = 25 - 12 = 13$.

30. (B) Six letters with N repeated twice: $6!/2! = 360$.

Physics

31. (C) $\eta = F/(A \cdot dv/dx) = [MLT^{-2}]/([L^2][T^{-1}]) = [ML^{-1}T^{-1}]$.

32. (C) $R = \sqrt{(3^2 + 4^2)} = 5 \text{ N}$.

33. (D) $H = u^2 \sin^2\theta / 2g = 400 \times 0.25 / 20 = 5 \text{ m}$.

34. (D) Friction $= 0.2 \times 50 = 10 \text{ N}$; net force $= 10 \text{ N}$; $a = 10/5 = 2 \text{ m/s}^2$.

35. (D) Apparent weight $= m(g + a) = 60 \times 12 = 720 \text{ N}$.

36. (B) $U = \frac{1}{2}kx^2 = \frac{1}{2} \times 200 \times (0.1)^2 = 1 \text{ J}$.

37. (C) Momentum conservation: $2 \times 3 = 3 \times v$, so $v = 2 \text{ m/s}$.

38. (C) Rotational KE $= (1/2)(2/5 mr^2)\omega^2 = mv^2/5$; total $= 7mv^2/10$; fraction $= (1/5)/(7/10) = 2/7$.

39. (C) $I = MR^2/2 = MK^2$, so $K = R/\sqrt{2}$.

40. (B) Kepler's third law $T^2 \propto r^3$: $T \propto r^{3/2} = 4^{3/2} = 8$.

41. (C) $K_{\text{max}} = 5 - 2 = 3 \text{ eV}$, so the stopping potential is 3 V .

42. (B) $\Delta L = FL/(AY) = 100 \times 2 / (10^{-6} \times 2 \times 10^{11}) = 10^{-3} \text{ m} = 1 \text{ mm}$.

43. (D) Continuity: $A_1v_1 = A_2v_2$, so $v_2 = 10 \times 2 / 5 = 4 \text{ m/s}$.

44. (C) A soap bubble has two surfaces, so $\Delta P = 2 \times 2T/r = 4T/r$.

45. (B) For an isotropic solid, $\gamma = 3\alpha$.

46. (B) $C_v = 3R/2$ and $C_p = 5R/2$, so $\gamma = 5/3$.

47. (C) Each of the three translational degrees of freedom has $kT/2$.

48. (A) $\omega = \pi \text{ rad/s}$, so $T = 2\pi/\omega = 2 \text{ s}$.

49. (D) $v = \sqrt{(T/\mu)}$, so $v \propto \sqrt{T}$.

50. (C) For a closed pipe $f = v/4L = 340/3.4 = 100 \text{ Hz}$.

51. (A) $1/v - 1/u = 1/f$ with $u = -30$: $1/v = 1/20 - 1/30 = 1/60$, so $v = +60 \text{ cm}$ (real, on the other side).

52. (A) $\sin C = 1/n = 1/\sqrt{2}$, so $C = 45^\circ$.

53. (D) $V = kq/r = 9 \times 10^9 \times 10^{-6} / 0.09 = 10^5 \text{ V}$.

54. (D) $U = \frac{1}{2}CV^2 = \frac{1}{2} \times 2 \times 10^{-6} \times 10^4 = 0.01 \text{ J}$.

55. (B) $I = 2/(3.5 + 0.5) = 0.5 \text{ A}$; $V = IR = 0.5 \times 3.5 = 1.75 \text{ V}$.

56. (B) The shunt (low resistance in parallel) carries most of the current.

57. (D) $r = mv/qB$; alpha has 4 times the mass and 2 times the charge, so r is 2 times.

58. (D) $\epsilon = L di/dt = 0.5 \times 2/0.1 = 10 \text{ V}$.

59. (C) AND of 1 and 1 is 1; NAND inverts it to 0.

60. (B) $R \propto A^{1/3}$: $64^{1/3} : 27^{1/3} = 4 : 3$.

Chemistry

61. (D) Radial nodes $= n - l - 1 = 3 - 0 - 1 = 2$.

62. (C) l can take values only from 0 to $n - 1$, so $l = 2$ is not allowed for $n = 2$.

63. (C) Ionisation enthalpy rises across the period (Al is lower than Mg); Si has the highest of these four.

64. (D) O_2 has bond order 2; removing an antibonding electron gives $(10 - 5)/2 = 2.5$.

65. (D) BF_3 is trigonal planar and symmetric, so the bond dipoles cancel.

66. (A) Xe has four bond pairs and two lone pairs (sp^3d^2); the lone pairs sit opposite each other, giving a square planar shape.
67. (B) $2 \times 22.4 = 44.8$ L.
68. (C) Moles of $H^+ = 0.020 \times 0.2 \times 2 = 0.008$; volume of NaOH = $0.008/0.1 = 0.08$ L = 80 mL.
69. (D) Solid $\rightarrow$ liquid increases disorder; the others decrease it.
70. (D) $AB_2 \rightleftharpoons A^{2+} + 2B^-$; $K_{sp} = s \times (2s)^2 = 4s^3$.
71. (A) Henderson equation: $pH = pK_a + \log([salt]/[acid]) = 4.74 + \log 1 = 4.74$.
72. (D) A 30% (100 volume) solution of H_2O_2 is sold as perhydrol.
73. (D) Li (group 1, period 2) resembles Mg (group 2, period 3) because of similar size and polarising power.
74. (A) Down group 13, the ns^2 pair becomes reluctant to bond; Tl shows a stable +1 state.
75. (B) Silicones are organosilicon polymers with $-(R_2SiO)-$ units.
76. (D) The E–H bond weakens down group 15, so reducing power increases to BiH_3 .
77. (B) In 1962 Bartlett made $Xe^+[PtF_6]^-$ by reacting xenon with PtF_6 .
78. (D) Equal numbers of cations and anions are missing from the lattice, so mass per unit volume falls.
79. (A) Glucose $18/180 = 0.1$ mol; water $178.2/18 = 9.9$ mol; $x = 0.1/10 = 0.01$.
80. (B) $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode} = 0.34 - (-0.76) = 1.10$ V.
81. (C) Aldehydes like HCHO and C_6H_5CHO disproportionate into an alcohol and a carboxylate salt.
82. (A) A $30^\circ C$ rise is three $10^\circ C$ steps: $2^3 = 8$.
83. (C) Sulphide ore particles are wetted by pine oil and rise with the froth.
84. (D) Fe^{3+} is $3d^5$ with 5 unpaired electrons: $\mu = \sqrt{(5 \times 7)} = \sqrt{35} \approx 5.92$ BM.
85. (A) Six ammine ligands, Co in +3 state in a cationic complex, chloride as counter ion.
86. (C) σ : 3 C–H, C=C, C–C, $C \equiv N = 6$; π : one in C=C and two in $C \equiv N = 3$.
87. (D) Cleaving the C=C at the middle gives two molecules of CH_3CHO .
88. (B) Wurtz reaction: $2CH_3Br + 2Na \rightarrow CH_3-CH_3 + 2NaBr$.
89. (C) Only primary amines give the foul-smelling isocyanide with $CHCl_3$ and alcoholic KOH.
90. (A) PHBV (poly- β -hydroxybutyrate-co- β -hydroxyvalerate) is broken down by bacteria.

English / Aptitude

91. (B) Downstream $24/12 = 2$ h; upstream $24/8 = 3$ h; total 5 h.
92. (A) Downstream 9 km/h, upstream 5 km/h; stream = $(9 - 5)/2 = 2$ km/h.
93. (B) Net rate = $1/12 - 1/18 = 1/36$ per hour.
94. (C) $1/20 + 1/30 = 5/60 = 1/12$ per minute.
95. (A) Combined ratio 8 : 12 : 15 (35 parts); one part = 4; second = $12 \times 4 = 48$.
96. (A) $\log 12 = 2 \log 2 + \log 3 = 0.6020 + 0.4771 = 1.0791$.
97. (A) $1.2 \times 0.8 = 0.96$, a 4% decrease.
98. (B) When A runs 100, B runs 90; C runs 90% of B's distance = 81. A beats C by 19 m.
99. (C) B covers 20 m in 4 s, so B's speed is 5 m/s and B takes 40 s; A takes 4 s less = 36 s.
100. (A) $4 : 6 = 10 : x$, so $x = 60/4 = 15$.
101. (B) Mean proportional = $\sqrt{(9 \times 16)} = 12$.
102. (A) Average speed = $2 \times 40 \times 60 / (40 + 60) = 48$ km/h.
103. (D) Amount = $10000 \times 1.1^2 = 12,100$; CI = 2,100.
104. (C) $4x + 5 = 3(x + 5)$ gives $x = 10$; father = 40 years.
105. (B) Distance 300 m in 15 s = 20 m/s = 72 km/h.
106. (D) 'Since' is used with a point of time in the perfect tense.

107. (B) The phrase is 'fond of'.
108. (D) We say 'by train', 'by bus', 'by air'.
109. (B) The earlier of two past actions takes the past perfect.
110. (B) An imaginary condition uses the subjunctive 'were' for all persons.
111. (A) Wolves move in a pack; cattle in a herd; sheep in a flock; bees in a swarm.
112. (A) A group of ships is a fleet.
113. (C) In an indirect question the subject comes before the verb.
114. (C) The subject is 'quality' (singular); 'of these mangoes' does not change it.
115. (A) It means staying up late to work or study.
116. (A) It is a misfortune that turns out to be useful.
117. (A) Sentences beginning with 'Let's' take the tag 'shall we'.
118. (D) 'Whose' shows possession: the boy's father.
119. (B) Simple past passive (was written) becomes simple past active (wrote).
120. (C) Present tense changes to past and 'I' changes to 'he' in reported speech.