

Questions
120 (40 per subject)

Marks
480 (+4 each)

Time
150 minutes

Negative marking
–1 per wrong answer

Part	Section	Questions	Q. No.
Part I: Physics	Physics	40	1 to 40
Part II: Chemistry	Chemistry	40	41 to 80
Part III: Mathematics	Mathematics	40	81 to 120

Instructions

1. This paper has 120 multiple choice questions in three sections: Physics (Q1–40), Chemistry (Q41–80) and Mathematics (Q81–120).
2. Each question has four options, (A) to (D). Only ONE option is correct.
3. Each correct answer gets 4 marks. 1 mark is deducted for every wrong answer. Unanswered questions get no marks.
4. Time: 150 minutes for the whole paper. In the real test you can move between sections at will; the test closes automatically when the time is over.
5. The real KIITEE is a computer based test in English only. Calculators are not allowed.
6. The answer key and short solutions are at the end of this paper.

This is an AglaSem practice paper written on the official KIITEE B.Tech pattern (120 questions, 480 marks, 150 minutes, +4/–1, as in the KIITEE 2026 Information Brochure) and the KIITEE Physics, Chemistry and Mathematics syllabus. It is not an official KIIT paper, and its questions are original. The same Physics, Chemistry and Mathematics paper is used for B.Arch and B.Sc Computer Science; B.Tech Biotechnology candidates may take Biology in place of Mathematics.

Part I: Physics

Physics

1. If force (F), length (L) and time (T) are taken as the fundamental quantities, the dimensional formula of mass is:
 (A) $[F L^{-1} T^{-2}]$ (B) $[F L^{-1} T^2]$
 (C) $[F L T^2]$ (D) $[F L T^{-2}]$
2. The length and the radius of a cylinder are measured with maximum errors of 1% and 2% respectively. The maximum percentage error in its volume is:
 (A) 4% (B) 6%
 (C) 5% (D) 3%
3. A body starts from rest and moves with uniform acceleration. The ratio of the distances it covers in the 2nd second and in the 4th second is:
 (A) 1 : 4 (B) 3 : 5
 (C) 3 : 7 (D) 1 : 2
4. A projectile is launched so that its speed at the highest point is half its speed of projection. The angle of projection with the horizontal is:
 (A) 75° (B) 45°
 (C) 30° (D) 60°

5. A road on a curve of radius 90 m is banked at 45° . The speed at which a car can take the curve without any help from friction is ($g = 10 \text{ m/s}^2$):
 (A) $3\sqrt{10} \text{ m/s}$ (B) 45 m/s
 (C) 90 m/s (D) 30 m/s
6. A 50 kg person stands on a weighing scale in a lift that is moving upward but slowing down at 2.5 m/s^2 . The reading of the scale is ($g = 10 \text{ m/s}^2$):
 (A) 625 N (B) 500 N
 (C) 125 N (D) 375 N
7. A 4 kg block rests on a horizontal floor. The coefficients of static and kinetic friction are 0.5 and 0.3. A horizontal force of 15 N is applied to it. The friction force on the block is ($g = 10 \text{ m/s}^2$):
 (A) 15 N (B) 0 N
 (C) 20 N (D) 12 N
8. A variable force $F = 3x^2$ newton acts on a body along the x-axis. The work done by the force as the body moves from $x = 1 \text{ m}$ to $x = 2 \text{ m}$ is:
 (A) 21 J (B) 9 J
 (C) 7 J (D) 8 J
9. A body of mass m moving with speed v makes a head-on elastic collision with a body of mass $2m$ at rest. The fraction of its kinetic energy transferred to the second body is:
 (A) $8/9$ (B) $1/9$
 (C) $1/3$ (D) $2/3$
10. A ring and a solid disc of the same mass and radius roll without slipping with the same linear speed. The ratio of their total kinetic energies (ring : disc) is:
 (A) 2 : 1 (B) 3 : 4
 (C) 4 : 3 (D) 1 : 1
11. A force $F = (2\hat{i} + 3\hat{j}) \text{ N}$ acts at a point whose position vector is $r = (\hat{i} + \hat{j}) \text{ m}$. The torque of the force about the origin is:
 (A) 5 N m along +z (B) 1 N m along +z
 (C) 5 N m along -z (D) 1 N m along -z
12. Taking the Earth's radius as 6400 km, the depth below the surface at which the acceleration due to gravity is 25% less than at the surface is:
 (A) 1600 km (B) 3200 km
 (C) 4800 km (D) 800 km
13. A wire is stretched so that the stress in it is S . If Young's modulus of the material is Y , the elastic potential energy stored per unit volume of the wire is:
 (A) S^2/Y (B) $S^2/(2Y)$
 (C) $S/(2Y)$ (D) $2S^2/Y$
14. Eight identical rain drops, each falling with terminal velocity v , combine to form a single bigger drop. The terminal velocity of the bigger drop is:
 (A) $4v$ (B) $8v$
 (C) $16v$ (D) $2v$
15. The displacement of a particle in simple harmonic motion is $x = 4 \sin(2\pi t + \pi/6) \text{ cm}$, where t is in seconds. The maximum speed of the particle is:
 (A) $2\pi \text{ cm/s}$ (B) $16\pi \text{ cm/s}$
 (C) $4\pi \text{ cm/s}$ (D) $8\pi \text{ cm/s}$

16. A string fixed at both ends has fundamental frequency f . If the tension is made four times and the length is doubled (same string material and thickness), the new fundamental frequency is:
- (A) f (B) $2f$
(C) $4f$ (D) $f/2$
17. A monatomic ideal gas is heated at constant pressure. The fraction of the heat supplied that goes into raising its internal energy is:
- (A) $2/5$ (B) $5/3$
(C) $3/5$ (D) $2/3$
18. A monatomic ideal gas ($\gamma = 5/3$) is compressed adiabatically to one-eighth of its volume. Its pressure becomes:
- (A) 16 times (B) 32 times
(C) 64 times (D) 8 times
19. A black body at 2000 K emits most strongly at a wavelength of $1.45 \mu\text{m}$. When its temperature is raised to 2900 K, the wavelength of maximum emission becomes:
- (A) $1.0 \mu\text{m}$ (B) $1.45 \mu\text{m}$
(C) $2.1 \mu\text{m}$ (D) $0.5 \mu\text{m}$
20. Two rods of the same length and cross-section, with thermal conductivities K_1 and K_2 , are joined end to end. The equivalent thermal conductivity of the combination is:
- (A) $K_1 + K_2$ (B) $(K_1 + K_2)/2$
(C) $2K_1K_2/(K_1 + K_2)$ (D) $\sqrt{K_1K_2}$
21. A parallel plate capacitor has capacitance C in air. A dielectric slab of dielectric constant K and thickness equal to half the plate separation is placed between the plates. The new capacitance is:
- (A) $2KC/(K + 1)$ (B) $2C/(K + 1)$
(C) KC (D) $(K + 1)C/2$
22. A point charge q is placed at one corner of a cube. The total electric flux through the whole surface of the cube is:
- (A) $q/(6\epsilon_0)$ (B) $q/(24\epsilon_0)$
(C) q/ϵ_0 (D) $q/(8\epsilon_0)$
23. A battery of emf 12 V and internal resistance 2Ω is connected to a variable external resistor. The maximum power that can be delivered to the external resistor is:
- (A) 9 W (B) 36 W
(C) 18 W (D) 72 W
24. A uniform wire of resistance 12Ω is bent into a circle. The resistance between two points on the circle that are a quarter of the circumference apart is:
- (A) 3Ω (B) 2.25Ω
(C) 4.5Ω (D) 9Ω
25. Two heating coils, used one at a time on the same supply, boil a given quantity of water in 10 minutes and 15 minutes. If both are connected in parallel to the same supply, the same water will boil in:
- (A) 6 minutes (B) 7.5 minutes
(C) 25 minutes (D) 12.5 minutes
26. A particle of mass m and charge q , starting from rest, is accelerated through a potential difference V and then enters a uniform magnetic field B at right angles to it. The radius of its circular path is:
- (A) $(1/B)\sqrt{2mV/q}$ (B) $(1/B)\sqrt{2qV/m}$
(C) $(1/B)\sqrt{mV/q}$ (D) $B\sqrt{2mV/q}$

27. A galvanometer of resistance $50\ \Omega$ gives full-scale deflection for a current of 2 mA. To use it as an ammeter of range 0 to 2 A, one should connect:
- (A) about $0.05\ \Omega$ in series (B) about $0.05\ \Omega$ in parallel
(C) about $50\ \text{k}\Omega$ in series (D) about $5\ \Omega$ in parallel
28. A current of 3 A flows through an inductor of self-inductance 0.2 H. The energy stored in its magnetic field is:
- (A) 1.8 J (B) 0.9 J
(C) 0.3 J (D) 0.6 J
29. In a series LCR circuit at resonance, the rms voltages across the inductor, the capacitor and the resistor are 120 V, 120 V and 50 V respectively. The rms supply voltage is:
- (A) 170 V (B) 290 V
(C) 240 V (D) 50 V
30. A thin convex glass lens (refractive index 1.5) has a focal length of 20 cm in air. When it is immersed in water (refractive index $4/3$), its focal length becomes:
- (A) 20 cm (B) 80 cm
(C) 26.7 cm (D) 40 cm
31. An object 2 cm tall is placed 10 cm in front of a convex mirror of focal length 15 cm. The image is:
- (A) 30 cm in front of the mirror, 6 cm tall and inverted
(B) 30 cm behind the mirror, 6 cm tall and erect
(C) 6 cm behind the mirror, 1.2 cm tall and erect
(D) 6 cm in front of the mirror, 1.2 cm tall and inverted
32. In Young's double-slit experiment the slits are 0.5 mm apart and the screen is 1 m away. For light of wavelength 500 nm the fringe width is:
- (A) 10 mm (B) 0.5 mm
(C) 1 mm (D) 0.1 mm
33. The polarising (Brewster) angle for a transparent medium is 60° . The critical angle for this medium is:
- (A) $\sin^{-1}(1/2)$ (B) $\sin^{-1}(\sqrt{3}/2)$
(C) $\sin^{-1}(2/3)$ (D) $\sin^{-1}(1/\sqrt{3})$
34. The speed of electromagnetic waves in a non-magnetic medium of relative permittivity 4 is:
- (A) $3 \times 10^8\ \text{m/s}$ (B) $0.75 \times 10^8\ \text{m/s}$
(C) $6 \times 10^8\ \text{m/s}$ (D) $1.5 \times 10^8\ \text{m/s}$
35. Light of wavelength 310 nm falls on a metal whose work function is 2.5 eV. The stopping potential for the emitted photoelectrons is (take $hc = 1240\ \text{eV nm}$):
- (A) 4.0 V (B) 2.5 V
(C) 6.5 V (D) 1.5 V
36. According to Bohr's model, the ratio of the radius of the third orbit of Li^{2+} ($Z = 3$) to the radius of the first orbit of hydrogen is:
- (A) $1/3$ (B) 3
(C) 9 (D) 1
37. A radioactive substance has a half-life of 20 minutes. The time taken for 75% of a sample to decay is:
- (A) 60 minutes (B) 20 minutes
(C) 40 minutes (D) 30 minutes

38. The energy gap of silicon is about 1.1 eV. The longest wavelength of light that can create electron-hole pairs in silicon is about ($hc = 1240 \text{ eV nm}$):
(A) 560 nm (B) 2250 nm
(C) 1130 nm (D) 113 nm
39. A NAND gate with both its inputs joined together works as:
(A) a NOR gate (B) an OR gate
(C) a NOT gate (D) an AND gate
40. In a common-emitter transistor circuit, a change of 0.02 mA in the base current causes a change of 1 mA in the collector current. The current gain β is:
(A) 20 (B) 50
(C) 49 (D) 51

Part II: Chemistry

Chemistry

41. The number of moles of oxygen atoms present in 49 g of H_2SO_4 is:
(A) 4 (B) 1
(C) 2 (D) 0.5
42. The mass of anhydrous Na_2CO_3 (molar mass 106 g/mol) needed to prepare 250 mL of a 0.2 M solution is:
(A) 2.65 g (B) 5.3 g
(C) 21.2 g (D) 10.6 g
43. Under identical conditions, the ratio of the rates of diffusion of H_2 and O_2 is:
(A) 1 : 16 (B) 16 : 1
(C) 1 : 4 (D) 4 : 1
44. The total number of orbitals in the shell with principal quantum number $n = 4$ is:
(A) 8 (B) 4
(C) 16 (D) 32
45. A solution is made by mixing 46 g of ethanol ($\text{C}_2\text{H}_5\text{OH}$) with 36 g of water. The mole fraction of ethanol in the solution is:
(A) $1/2$ (B) $1/3$
(C) 0.56 (D) $2/3$
46. A non-volatile solute is dissolved in a solvent whose vapour pressure is 100 mm Hg. If the mole fraction of the solute is 0.2, the vapour pressure of the solution is:
(A) 100 mm Hg (B) 80 mm Hg
(C) 120 mm Hg (D) 20 mm Hg
47. The standard enthalpies of formation of $\text{CO}_2(\text{g})$, $\text{H}_2\text{O}(\text{l})$ and $\text{CH}_4(\text{g})$ are -393.5 , -285.8 and -74.8 kJ/mol respectively. The standard enthalpy of combustion of methane is:
(A) $+890.3 \text{ kJ/mol}$ (B) -604.5 kJ/mol
(C) -890.3 kJ/mol (D) -1039.9 kJ/mol
48. For the reaction $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$, the relation between K_p and K_c is:
(A) $K_p = K_c(\text{RT})^{-1}$ (B) $K_p = K_c(\text{RT})$
(C) $K_p = K_c$ (D) $K_p = K_c(\text{RT})^{-2}$

49. The pH of a 1×10^{-3} M solution of $\text{Ba}(\text{OH})_2$ (fully ionised) is about ($\log 2 = 0.30$):
(A) 2.7 (B) 3.0
(C) 11.0 (D) 11.3
50. The oxidation state of chromium in CrO_5 (which has two peroxide groups) is:
(A) +10 (B) +5
(C) +6 (D) +8
51. The quantity of electricity needed to reduce 1 mol of MnO_4^- ions to Mn^{2+} ions is:
(A) 5 F (B) 2 F
(C) 7 F (D) 3 F
52. For a zero-order reaction, the half-life is:
(A) directly proportional to the initial concentration
(B) proportional to the square of the initial concentration
(C) inversely proportional to the initial concentration
(D) independent of the initial concentration
53. For coagulating a negatively charged arsenious sulphide (As_2S_3) sol, the most effective ion is:
(A) Na^+ (B) Ba^{2+}
(C) PO_4^{3-} (D) Al^{3+}
54. Among F, Cl, Br and I, the element with the most negative electron gain enthalpy is:
(A) I (B) Br
(C) F (D) Cl
55. The hybridisation of sulphur and the shape of the SF_4 molecule are:
(A) sp^3d^2 , square planar (B) sp^3d , see-saw
(C) dsp^2 , square planar (D) sp^3 , tetrahedral
56. Which one of the following molecules is polar (has a non-zero dipole moment)?
(A) CCl_4 (B) SO_2
(C) CO_2 (D) BeF_2
57. In the structure of diborane (B_2H_6) there are:
(A) four $3\text{c}-2\text{e}$ bonds and one B–B double bond
(B) two $2\text{c}-2\text{e}$ B–H bonds and four $3\text{c}-2\text{e}$ bonds
(C) six $2\text{c}-2\text{e}$ B–H bonds and one B–B bond
(D) four $2\text{c}-2\text{e}$ B–H bonds and two $3\text{c}-2\text{e}$ B–H–B bonds
58. Which of the following oxides of nitrogen is paramagnetic?
(A) N_2O_3 (B) N_2O
(C) N_2O_5 (D) NO
59. The basicity of phosphorous acid, H_3PO_3 , is:
(A) 1 (B) 0
(C) 2 (D) 3
60. Among the alkali metal ions in water, the one with the lowest ionic mobility is:
(A) Na^+ (B) Li^+
(C) Cs^+ (D) K^+

61. Zone refining is used to obtain very high purity:
(A) nickel (B) copper
(C) zirconium (D) germanium
62. Because of the inert pair effect, the most stable oxidation state of lead in its compounds is:
(A) +1 (B) +4
(C) +2 (D) +3
63. The spin-only magnetic moment of the Cr^{3+} ion (Z of Cr = 24) is about:
(A) 4.90 BM (B) 2.83 BM
(C) 3.87 BM (D) 5.92 BM
64. The IUPAC name of $\text{K}_3[\text{Fe}(\text{C}_2\text{O}_4)_3]$ is:
(A) tripotassium oxalatoiron(II)
(B) potassium trioxalatoiron(III)
(C) potassium trioxalatoferrate(II)
(D) potassium trioxalatoferrate(III)
65. The total number of stereoisomers of the octahedral ion $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ (en = ethane-1,2-diamine) is:
(A) 2 (B) 1
(C) 4 (D) 3
66. The hybridisation, shape and magnetic nature of $[\text{Ni}(\text{CO})_4]$ are:
(A) sp^3 , tetrahedral, diamagnetic
(B) dsp^2 , square planar, paramagnetic
(C) sp^3 , tetrahedral, paramagnetic
(D) dsp^2 , square planar, diamagnetic
67. The Ziegler-Natta catalyst, used for polymerising ethene, is a combination of:
(A) Pd and BaSO_4 (B) TiCl_4 and $\text{Al}(\text{C}_2\text{H}_5)_3$
(C) V_2O_5 and SO_2 (D) Ni and H_2
68. A nucleus of uranium-238 ($Z = 92$) emits one alpha particle and then two beta (β^-) particles. The final nucleus is:
(A) Th-234 ($Z = 90$) (B) Pa-234 ($Z = 91$)
(C) U-234 ($Z = 92$) (D) Th-230 ($Z = 90$)
69. A mixture of o-nitrophenol and p-nitrophenol is best separated by:
(A) simple filtration
(B) sublimation
(C) fractional crystallisation from benzene
(D) steam distillation
70. A hydrocarbon contains 80% carbon by mass. Its empirical formula is:
(A) C_2H_5 (B) CH_4
(C) CH_2 (D) CH_3
71. Which of the following carboxylic acids is the weakest?
(A) CH_3COOH (B) $\text{C}_6\text{H}_5\text{COOH}$
(C) HCOOH (D) FCH_2COOH

72. Propene is treated with B_2H_6 and the product is oxidised with H_2O_2 in aqueous NaOH. The final product is:
- (A) propanal (B) propane-1,2-diol
(C) propan-2-ol (D) propan-1-ol
73. Chlorobenzene reacts with chlorine in the presence of anhydrous $FeCl_3$. The main products are:
- (A) hexachlorocyclohexane (B) 1,3-dichlorobenzene
(C) benzyl chloride (D) 1,2- and 1,4-dichlorobenzene
74. Which of the following is the most acidic?
- (A) 2,4,6-trinitrophenol (B) 4-methylphenol
(C) phenol (D) 2-nitrophenol
75. Which of the following does NOT undergo aldol condensation?
- (A) ethanal (B) 2,2-dimethylpropanal
(C) propanal (D) propanone
76. Benzenediazonium chloride reacts with hypophosphorous acid (H_3PO_2) to give:
- (A) phenol (B) aniline
(C) chlorobenzene (D) benzene
77. The monomer of neoprene is:
- (A) isoprene (2-methylbuta-1,3-diene)
(B) chloroprene (2-chlorobuta-1,3-diene)
(C) acrylonitrile (propenenitrile)
(D) vinyl chloride (chloroethene)
78. On hydrolysis, lactose gives:
- (A) glucose only (B) galactose and fructose
(C) glucose and fructose (D) glucose and galactose
79. Which artificial sweetener is used only in cold foods and soft drinks because it is unstable at cooking temperature?
- (A) aspartame (B) alitame
(C) sucralose (D) saccharin
80. Which of the following is a typical component of photochemical smog but not of classical (London) smog?
- (A) sulphur dioxide (B) peroxyacetyl nitrate (PAN)
(C) sulphuric acid droplets (D) soot particles

Part III: Mathematics

Mathematics

81. If $n(A) = 40$, $n(B) = 26$ and $n(A \cup B) = 60$, then $n(A \cap B)$ is:
- (A) 14 (B) 20
(C) 6 (D) 34
82. The domain of the function $f(x) = 1/\sqrt{x^2 - 9}$ is:
- (A) $(-\infty, -3) \cup (3, \infty)$ (B) $R - \{3\}$
(C) $(-3, 3)$ (D) $[-3, 3]$

83. If $f(x) = 2x + 3$ and $g(x) = x^2 - 1$, then $(g \circ f)(1)$ equals:
 (A) 3 (B) 26
 (C) 24 (D) 8
84. The value of $(1 + i)^{10}/(1 - i)^8$ is:
 (A) $-2i$ (B) 2
 (C) $32i$ (D) $2i$
85. The principal argument of $(1 + i\sqrt{3})/(1 - i)$ is:
 (A) $7\pi/12$ (B) $5\pi/12$
 (C) $-\pi/12$ (D) $\pi/12$
86. A is a square matrix of order 3 with $|A| = 4$. The value of $|\text{adj}(2A)|$ is:
 (A) 256 (B) 128
 (C) 1024 (D) 64
87. The solution of the system $x + y + z = 4$, $2x - y + z = 8$ and $x + 2y - z = -3$ is $(x, y, z) =$
 (A) $(-1, 2, 3)$ (B) $(2, 1, 1)$
 (C) $(3, -1, 2)$ (D) $(2, -1, 3)$
88. The system $kx + y + z = 0$, $x + ky + z = 0$, $x + y + kz = 0$ has a non-trivial solution when k equals:
 (A) 0 or 3 (B) 1 or -2
 (C) -1 or 2 (D) 1 only
89. If α and β are the roots of $2x^2 - 6x + 3 = 0$, then $1/\alpha^2 + 1/\beta^2$ is:
 (A) $3/8$ (B) $2/3$
 (C) $8/3$ (D) 4
90. The number of different arrangements of the letters of the word COLLEGE is:
 (A) 1260 (B) 5040
 (C) 630 (D) 2520
91. The number of ways in which 5 boys and 3 girls can sit in a row so that no two girls sit next to each other is:
 (A) 40320 (B) 14400
 (C) 4320 (D) 2880
92. The term independent of x in the expansion of $(2x - 1/x^2)^6$ is:
 (A) 240 (B) -240
 (C) -160 (D) 60
93. If the coefficients of x^2 and x^3 in the expansion of $(2 + x/3)^n$ are equal, then n is:
 (A) 18 (B) 20
 (C) 12 (D) 15
94. The sum of the first n terms of an AP is $3n^2 + 2n$. Its 10th term is:
 (A) 56 (B) 62
 (C) 59 (D) 320
95. The third term of a GP is 4. The product of its first five terms is:
 (A) 1024 (B) 4096
 (C) 256 (D) 64

96. The value of $\lim_{x \rightarrow 0} (1 - \cos 4x)/x^2$ is:
 (A) 8 (B) 4
 (C) 2 (D) 16
97. The value of $\lim_{x \rightarrow 0} (\tan 2x - \sin 2x)/x^3$ is:
 (A) 4 (B) 0
 (C) 8 (D) 2
98. For $x > 0$, the derivative of x^x with respect to x is:
 (A) $x^x(1 - \ln x)$ (B) $x^x(1 + \ln x)$
 (C) $x \cdot x^x(x - 1)$ (D) $x^x \ln x$
99. The maximum value of $f(x) = x e^{-x}$ for real x is:
 (A) e (B) $2/e^2$
 (C) $1/e$ (D) 1
100. The points on the curve $y = x^3 - 12x + 1$ at which the tangent is parallel to the x -axis are:
 (A) (2, -15) and (-2, 17) (B) (2, -15) only
 (C) (0, 1) only (D) (2, 17) and (-2, -15)
101. $\int dx/(x^2 - 4)$ equals:
 (A) $(1/4) \ln|(x + 2)/(x - 2)| + C$ (B) $(1/4) \ln|(x - 2)/(x + 2)| + C$
 (C) $(1/2) \ln|(x - 2)/(x + 2)| + C$ (D) $(1/2) \tan^{-1}(x/2) + C$
102. $\int e^x (1/x - 1/x^2) dx$ equals:
 (A) $e^x/x + C$ (B) $e^x \ln x + C$
 (C) $-e^x/x + C$ (D) $e^x/x^2 + C$
103. The value of $\int_0^{\pi/4} \tan^2 x dx$ is:
 (A) $\pi/4$ (B) $1 + \pi/4$
 (C) $\pi/4 - 1/2$ (D) $1 - \pi/4$
104. The area of the region bounded by the parabola $y = x^2$ and the line $y = 4$ is:
 (A) $8/3$ sq. units (B) $64/3$ sq. units
 (C) $32/3$ sq. units (D) $16/3$ sq. units
105. The order and degree of the differential equation $y = x(dy/dx) + \sqrt{1 + (dy/dx)^2}$ are:
 (A) order 1, degree 1 (B) order 1, degree 2
 (C) order 2, degree 2 (D) order 2, degree 1
106. The general solution of the differential equation $dy/dx + y = e^{-x}$ is:
 (A) $y = (x + C)e^x$ (B) $y = x e^{-x} + Ce^x$
 (C) $y = Ce^{-x} - x$ (D) $y = (x + C)e^{-x}$
107. The distance between the parallel lines $5x - 12y + 4 = 0$ and $10x - 24y - 18 = 0$ is:
 (A) 13 (B) 1
 (C) $1/2$ (D) 2
108. The equation of the circle with centre (2, -3) that passes through the point (5, 1) is:
 (A) $x^2 + y^2 - 4x + 6y + 12 = 0$ (B) $x^2 + y^2 - 4x + 6y - 25 = 0$
 (C) $x^2 + y^2 + 4x - 6y - 12 = 0$ (D) $x^2 + y^2 - 4x + 6y - 12 = 0$
109. The equation of the parabola with focus (0, 2) and directrix $y = -2$ is:
 (A) $x^2 = -8y$ (B) $x^2 = 8y$
 (C) $y^2 = 8x$ (D) $x^2 = 4y$

- 110.** The eccentricity of the ellipse $9x^2 + 25y^2 = 225$ is:
 (A) $3/4$ (B) $4/5$
 (C) $3/5$ (D) $5/4$
- 111.** The distance of the point $(2, 3, 4)$ from the plane $3x - 6y + 2z + 11 = 0$ is:
 (A) 1 (B) $1/7$
 (C) 7 (D) 2
- 112.** The angle between the planes $x + y + 2z = 3$ and $2x - y + z = 5$ is:
 (A) 60° (B) 30°
 (C) 90° (D) 45°
- 113.** The area of the parallelogram whose adjacent sides are $a = \hat{i} + 2\hat{j} + 3\hat{k}$ and $b = -3\hat{i} - 2\hat{j} + \hat{k}$ is:
 (A) $12\sqrt{5}$ sq. units (B) 180 sq. units
 (C) $6\sqrt{5}$ sq. units (D) $3\sqrt{5}$ sq. units
- 114.** The vectors $\hat{i} - \hat{j} + \hat{k}$, $2\hat{i} + \hat{j} - \hat{k}$ and $\lambda\hat{i} - \hat{j} + \lambda\hat{k}$ are coplanar when λ equals:
 (A) 0 (B) 3
 (C) 1 (D) -1
- 115.** Two cards are drawn one after the other, without replacement, from a well-shuffled pack of 52 cards. The probability that both are aces is:
 (A) $1/221$ (B) $2/221$
 (C) $1/169$ (D) $1/13$
- 116.** A fair coin is tossed 5 times. The probability of getting exactly 3 heads is:
 (A) $5/16$ (B) $3/16$
 (C) $1/2$ (D) $5/32$
- 117.** The mean and variance of a binomial distribution are 6 and 2 respectively. Then:
 (A) $n = 9$, $p = 2/3$ (B) $n = 18$, $p = 1/3$
 (C) $n = 12$, $p = 1/2$ (D) $n = 9$, $p = 1/3$
- 118.** The value of $\cos(\pi/5) \cos(2\pi/5)$ is:
 (A) $1/8$ (B) $1/2$
 (C) $\sqrt{5}/4$ (D) $1/4$
- 119.** The general solution of $2\cos^2 x - 3\cos x + 1 = 0$ is (n is any integer):
 (A) $x = n\pi + (-1)^n \pi/6$ (B) $x = 2n\pi$ or $x = 2n\pi \pm \pi/3$
 (C) $x = n\pi$ or $x = n\pi \pm \pi/3$ (D) $x = 2n\pi \pm \pi/6$ only
- 120.** The value of $\sin^{-1}(3/5) + \cos^{-1}(12/13)$ is:
 (A) $\cos^{-1}(56/65)$ (B) $\sin^{-1}(16/65)$
 (C) $\sin^{-1}(56/65)$ (D) $\sin^{-1}(63/65)$

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

Physics

- (B) $F = MLT^{-2}$, so $M = F L^{-1} T^2$.
- (C) $V = \pi r^2 l$, so $\Delta V/V = 2(\Delta r/r) + \Delta l/l = 2(2\%) + 1\% = 5\%$.
- (C) With $u = 0$, the distance in the n th second is $a(2n - 1)/2$, which is proportional to $(2n - 1)$. For $n = 2$ and 4 this gives $3 : 7$.
- (D) At the top only the horizontal component $u \cos \theta$ remains. $u \cos \theta = u/2$ gives $\cos \theta = 1/2$, so $\theta = 60^\circ$.
- (D) For no friction, $\tan \theta = v^2/(rg)$, so $v = \sqrt{(rg \tan \theta)} = \sqrt{(90 \times 10 \times 1)} = 30 \text{ m/s}$.
- (D) The acceleration is downward (2.5 m/s^2), so $N = m(g - a) = 50 \times 7.5 = 375 \text{ N}$.
- (A) Limiting friction $= 0.5 \times 40 = 20 \text{ N}$, which is more than 15 N , so the block does not move. Static friction just balances the applied force: 15 N .
- (C) $W = \int F dx = \int_1^2 3x^2 dx = [x^3]_1^2 = 8 - 1 = 7 \text{ J}$.
- (A) For a head-on elastic collision with the target at rest, fraction transferred $= 4m_1 m_2 / (m_1 + m_2)^2 = 4(m)(2m)/(3m)^2 = 8/9$.
- (C) Ring: $\frac{1}{2}mv^2 + \frac{1}{2}(mr^2)(v/r)^2 = mv^2$. Disc: $\frac{1}{2}mv^2 + \frac{1}{2}(\frac{1}{2}mr^2)(v/r)^2 = \frac{3}{4}mv^2$. Ratio $= 1 : \frac{3}{4} = 4 : 3$.
- (B) $\tau = r \times F = (1 \times 3 - 1 \times 2) \hat{k} = +1 \hat{k} \text{ N m}$.
- (A) $g(d) = g(1 - d/R)$. $0.75g = g(1 - d/R)$ gives $d = R/4 = 1600 \text{ km}$.
- (B) Energy per unit volume $= \frac{1}{2} \times \text{stress} \times \text{strain} = \frac{1}{2} \times S \times (S/Y) = S^2/(2Y)$.
- (A) Volume is conserved: $8 \times (4/3)\pi r^3 = (4/3)\pi R^3$, so $R = 2r$. Terminal velocity $\propto r^2$, so it becomes $4v$.
- (D) $v(\text{max}) = A\omega = 4 \times 2\pi = 8\pi \text{ cm/s}$.
- (A) $f = (1/2L)\sqrt{T/\mu}$. Four times the tension doubles $\sqrt{T}$; twice the length halves $1/L$. The frequency stays f .
- (C) $\Delta U/Q = nC_v \Delta T / (nC_p \Delta T) = C_v/C_p = (3R/2)/(5R/2) = 3/5$.
- (B) $PV^\gamma = \text{constant}$, so $P_2/P_1 = (V_1/V_2)^\gamma = 8^{5/3} = 2^5 = 32$.
- (A) By Wien's law $\lambda(m)T$ is constant: $\lambda = 1.45 \times 2000/2900 = 1.0 \mu\text{m}$.
- (C) In series the thermal resistances add: $2L/(KA) = L/(K_1 A) + L/(K_2 A)$, so $K = 2K_1 K_2 / (K_1 + K_2)$.
- (A) $C' = \epsilon_0 A / [(d/2) + (d/2K)] = (\epsilon_0 A/d) \times 2K/(K + 1) = 2KC/(K + 1)$.
- (D) Eight such cubes around the corner would enclose the charge completely, so one cube receives $1/8$ of the flux q/ϵ_0 .

23. (C) Power to the load is maximum when $R = r = 2\ \Omega$: $I = 12/4 = 3\text{ A}$ and $P = I^2R = 9 \times 2 = 18\text{ W}$ ($= E^2/4r$).
24. (B) The two arcs are $3\ \Omega$ and $9\ \Omega$ in parallel: $(3 \times 9)/(3 + 9) = 27/12 = 2.25\ \Omega$.
25. (A) Heat needed $H = V^2t/R$, so $t \propto R$. In parallel $R = R_1R_2/(R_1 + R_2)$, so $t = t_1t_2/(t_1 + t_2) = 150/25 = 6\text{ minutes}$.
26. (A) $qV = \frac{1}{2}mv^2$ gives $mv = \sqrt{(2mqV)}$. $r = mv/(qB) = \sqrt{(2mqV)}/(qB) = (1/B)\sqrt{(2mV/q)}$.
27. (B) Shunt $S = I(g)G/(I - I(g)) = (0.002 \times 50)/1.998 \approx 0.05\ \Omega$, connected in parallel with the galvanometer.
28. (B) $U = \frac{1}{2}LI^2 = \frac{1}{2} \times 0.2 \times 9 = 0.9\text{ J}$.
29. (D) $V = \sqrt{[V(R)]^2 + (V(L) - V(C))^2} = \sqrt{(50^2 + 0^2)} = 50\text{ V}$. At resonance $V(L)$ and $V(C)$ cancel.
30. (B) $1/f \propto (\mu(\text{lens})/\mu(\text{medium}) - 1)$. In air this is 0.5; in water it is $1.5/(4/3) - 1 = 0.125$. So $f(\text{water}) = 20 \times 0.5/0.125 = 80\text{ cm}$.
31. (C) With $f = +15\text{ cm}$ and $u = -10\text{ cm}$: $1/v = 1/15 + 1/10 = 1/6$, so $v = +6\text{ cm}$ (behind, virtual). $m = -v/u = 0.6$, so the image is erect and 1.2 cm tall.
32. (C) $\beta = \lambda D/d = (500 \times 10^{-9} \times 1)/(0.5 \times 10^{-3}) = 10^{-3}\text{ m} = 1\text{ mm}$.
33. (D) By Brewster's law $\mu = \tan 60^\circ = \sqrt{3}$. The critical angle C satisfies $\sin C = 1/\mu = 1/\sqrt{3}$.
34. (D) $v = c/\sqrt{(\mu_r\epsilon_r)} = (3 \times 10^8)/\sqrt{(1 \times 4)} = 1.5 \times 10^8\text{ m/s}$.
35. (D) Photon energy $= 1240/310 = 4.0\text{ eV}$. $K(\text{max}) = 4.0 - 2.5 = 1.5\text{ eV}$, so the stopping potential is 1.5 V .
36. (B) $r_n \propto n^2/Z$. For Li^{2+} , $n = 3$: $9/3 = 3$ times the first Bohr radius of hydrogen.
37. (C) When 75% has decayed, 25% $= 1/4$ remains, which takes two half-lives $= 40\text{ minutes}$.
38. (C) $\lambda(\text{max}) = hc/E(g) = 1240/1.1 \approx 1127\text{ nm}$, in the near infrared.
39. (C) With $A = B$, $Y = (A \cdot A)' = A'$, which is the NOT operation.
40. (B) $\beta = \Delta I(C)/\Delta I(B) = 1/0.02 = 50$.

Chemistry

41. (C) Molar mass of $\text{H}_2\text{SO}_4 = 98\text{ g/mol}$, so $49\text{ g} = 0.5\text{ mol}$. Each molecule has 4 O atoms: $0.5 \times 4 = 2\text{ mol}$ of O atoms.
42. (B) Moles needed $= 0.2 \times 0.250 = 0.05\text{ mol}$. Mass $= 0.05 \times 106 = 5.3\text{ g}$.
43. (D) By Graham's law $r \propto 1/\sqrt{M}$: $r(\text{H}_2)/r(\text{O}_2) = \sqrt{(32/2)} = \sqrt{16} = 4$.
44. (C) The number of orbitals in a shell is $n^2 = 16$ (one 4s, three 4p, five 4d and seven 4f).
45. (B) $46\text{ g ethanol} = 1\text{ mol}$ and $36\text{ g water} = 2\text{ mol}$. Mole fraction of ethanol $= 1/(1 + 2) = 1/3$. (0.56 is its mass fraction.)
46. (B) By Raoult's law $p = p^\circ \times x(\text{solvent}) = 100 \times 0.8 = 80\text{ mm Hg}$.
47. (C) $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$. $\Delta H = [-393.5 + 2(-285.8)] - (-74.8) = -965.1 + 74.8 = -890.3\text{ kJ/mol}$.
48. (A) $K_p = K_c(RT)^{\Delta n}$, with $\Delta n = 2 - 3 = -1$.
49. (D) $[\text{OH}^-] = 2 \times 10^{-3}\text{ M}$, so $\text{pOH} = 3 - 0.30 = 2.70$ and $\text{pH} = 14 - 2.70 = 11.3$.
50. (C) CrO_5 has one O^{2-} and two O_2^{2-} groups: $x - 2 - 2(2) = 0$, so $x = +6$. (Taking all O as -2 would wrongly give $+10$.)
51. (A) Mn changes from $+7$ to $+2$, a gain of 5 electrons per ion, so 5 faradays are needed per mole.
52. (A) For zero order, $[A] = [A]_0 - kt$, so $t_{1/2} = [A]_0/(2k)$, which is directly proportional to $[A]_0$.
53. (D) By the Hardy-Schulze rule a negative sol is coagulated by cations, and the higher the charge, the greater the power: $\text{Al}^{3+} > \text{Ba}^{2+} > \text{Na}^+$.
54. (D) Fluorine is very small, so the added electron feels strong repulsion in the compact 2p shell. Chlorine therefore has the most negative electron gain enthalpy.
55. (B) S has 4 bond pairs and 1 lone pair (5 electron pairs): sp^3d , with the lone pair in an equatorial position, giving a see-saw shape.
56. (B) SO_2 is bent (S has a lone pair), so the bond moments do not cancel. CO_2 and BeF_2 are linear and CCl_4 is tetrahedral, so their bond moments cancel.
57. (D) Diborane has four terminal B-H bonds (two-centre two-electron) and two bridging B-H-B 'banana' bonds (three-centre two-electron). There is no B-B bond.

- 58. (D)** NO has an odd number of electrons (15), so one electron is unpaired. The other oxides listed have all electrons paired.
- 59. (C)** H_3PO_3 is $\text{HPO}(\text{OH})_2$: one H is bonded directly to P and is not ionisable. Only the two O–H hydrogens are acidic.
- 60. (B)** Li^+ is the smallest ion and is the most heavily hydrated, so its hydrated ion is the largest and moves the slowest.
- 61. (D)** Zone refining suits semiconductors such as Ge and Si. Copper is refined electrolytically, zirconium by the van Arkel method and nickel by the Mond process.
- 62. (C)** Down group 14 the ns^2 pair is reluctant to take part in bonding, so Pb(II) is more stable than Pb(IV) ; this is why PbO_2 is a strong oxidising agent.
- 63. (C)** Cr^{3+} is $3d^3$ with 3 unpaired electrons: $\mu = \sqrt{3(3 + 2)} = \sqrt{15} \approx 3.87 \text{ BM}$.
- 64. (D)** The complex ion is an anion, so iron is named 'ferrate'. Three $\text{C}_2\text{O}_4^{2-}$ ligands give -6 , and the charge is -3 , so Fe is $+3$.
- 65. (D)** The trans isomer has a mirror plane (1 isomer). The cis isomer is chiral and exists as a pair of enantiomers (2). Total = 3.
- 66. (A)** Ni is in the 0 state ($3d^8 4s^2$). CO is a strong-field ligand: the 4s electrons pair into 3d, giving $3d^{10}$, and $4s 4p^3$ (sp^3) orbitals form a tetrahedral, diamagnetic complex.
- 67. (B)** Ziegler–Natta catalyst is triethylaluminium with titanium tetrachloride. Pd/BaSO_4 is Lindlar's catalyst (partly poisoned).
- 68. (C)** α emission lowers A by 4 and Z by 2: Th-234 (Z = 90). Each β^- raises Z by 1 with no change in A: U-234 (Z = 92), an isotope of the parent.
- 69. (D)** o-Nitrophenol has intramolecular hydrogen bonding, so it is steam volatile. p-Nitrophenol is held by intermolecular hydrogen bonds and stays behind.
- 70. (D)** $\text{C} : \text{H} = 80/12 : 20/1 = 6.67 : 20 = 1 : 3$, so the empirical formula is CH_3 (the molecule could be C_2H_6).
- 71. (A)** The +I effect of the methyl group destabilises the carboxylate ion. pK_a values: acetic 4.76, benzoic 4.20, formic 3.75, fluoroacetic about 2.6.
- 72. (D)** Hydroboration–oxidation adds H and OH across the double bond in an anti-Markovnikov way, so OH ends up on the terminal carbon.
- 73. (D)** Cl deactivates the ring ($-I$) but directs the incoming group to the ortho and para positions ($+R$), so 1,2- and 1,4-dichlorobenzene are formed, the para isomer in larger amount.
- 74. (A)** Three nitro groups ($-M$ and $-I$) strongly stabilise the phenoxide ion, so picric acid is by far the most acidic. A methyl group lowers acidity.
- 75. (B)** Aldol condensation needs an α -hydrogen. In $(\text{CH}_3)_3\text{C}-\text{CHO}$ the α -carbon carries no hydrogen.
- 76. (D)** H_3PO_2 (or ethanol) reduces the diazonium group and replaces $-\text{N}_2^+$ by H, giving benzene. Warming with water would give phenol.
- 77. (B)** Neoprene, a synthetic rubber, is polychloroprene. Natural rubber is a polymer of isoprene; PVC is from vinyl chloride.
- 78. (D)** Lactose (milk sugar) is made of β -D-galactose and β -D-glucose linked by a glycosidic bond. Sucrose gives glucose and fructose, maltose gives glucose only.
- 79. (A)** Aspartame (a dipeptide methyl ester) breaks down on heating. Saccharin and sucralose are stable at cooking temperature.
- 80. (B)** Photochemical smog forms from NO_x and hydrocarbons in sunlight and contains O_3 , PAN and aldehydes. Classical smog is smoke plus SO_2 and its acid products.

Mathematics

- 81. (C)** $n(A \cap B) = n(A) + n(B) - n(A \cup B) = 40 + 26 - 60 = 6$.
- 82. (A)** We need $x^2 - 9 > 0$ (strictly, as it is under a root in the denominator), so $|x| > 3$.
- 83. (C)** $(g \cdot f)(1) = g(f(1)) = g(5) = 25 - 1 = 24$. $(f \cdot g)(1)$ would be $f(0) = 3$.
- 84. (D)** $(1 + i)/(1 - i) = i$, so the expression is $i^8 \times (1 + i)^2 = 1 \times 2i = 2i$.
- 85. (A)** $\arg(1 + i\sqrt{3}) = \pi/3$ and $\arg(1 - i) = -\pi/4$. The argument of the quotient is $\pi/3 + \pi/4 = 7\pi/12$, which lies in $(-\pi, \pi]$.

86. (C) $|2A| = 2^3 \times 4 = 32$. For order 3, $|\text{adj } B| = |B|^2$, so $|\text{adj}(2A)| = 32^2 = 1024$.
87. (D) Third minus first: $y - 2z = -7$. Second minus twice the first: $-3y - z = 0$, so $z = -3y$. Then $7y = -7$: $y = -1$, $z = 3$ and $x = 2$.
88. (B) The coefficient determinant must be zero: $k^3 - 3k + 2 = (k - 1)^2(k + 2) = 0$, so $k = 1$ or $k = -2$.
89. (C) $\alpha + \beta = 3$, $\alpha\beta = 3/2$. $\alpha^2 + \beta^2 = 9 - 3 = 6$, so $1/\alpha^2 + 1/\beta^2 = 6/(9/4) = 8/3$.
90. (A) 7 letters with L twice and E twice: $7!/(2! \times 2!) = 5040/4 = 1260$.
91. (B) Arrange the boys in $5! = 120$ ways. That leaves 6 gaps; choose and fill 3 of them with the girls in ${}^6P_3 = 120$ ways. Total $= 120 \times 120 = 14400$.
92. (A) $T(r+1) = C(6,r)(2x)^{6-r}(-1/x^2)^r = C(6,r)2^{6-r}(-1)^r x^{6-3r}$. $r = 2$ gives $15 \times 16 = 240$.
93. (B) Coefficient of x^r is $C(n,r)2^{n-r}3^r(-r)$. Equating $r = 2$ and $r = 3$: $6C(n,2) = C(n,3)$, so $3 = (n - 2)/6$ and $n = 20$.
94. (C) $a(10) = S(10) - S(9) = (300 + 20) - (243 + 18) = 320 - 261 = 59$.
95. (A) The terms are a/r^2 , a/r , a , ar , ar^2 with $a = 4$ the middle term. Their product is $a^5 = 4^5 = 1024$.
96. (A) $1 - \cos 4x = 2 \sin^2 2x$, so the limit $= 2 \times (2)^2 \times \lim (\sin 2x/2x)^2 = 8$.
97. (A) $\tan y - \sin y = y^3/2 + \text{higher terms}$. With $y = 2x$ this is $8x^3/2 = 4x^3$, so the limit is 4.
98. (B) Let $y = x^x$, so $\ln y = x \ln x$. Then $y'/y = \ln x + 1$, so $y' = x^x(1 + \ln x)$.
99. (C) $f'(x) = e^{-x}(1 - x) = 0$ at $x = 1$, where f changes from increasing to decreasing. $f(1) = 1/e$.
100. (A) $dy/dx = 3x^2 - 12 = 0$ gives $x = \pm 2$; $y(2) = 8 - 24 + 1 = -15$ and $y(-2) = -8 + 24 + 1 = 17$.
101. (B) $\int dx/(x^2 - a^2) = (1/2a) \ln|(x - a)/(x + a)| + C$ with $a = 2$.
102. (A) This is $\int e^x [f(x) + f'(x)] dx$ with $f(x) = 1/x$, $f'(x) = -1/x^2$, so the answer is $e^x f(x) + C = e^x/x + C$.
103. (D) $\tan^2 x = \sec^2 x - 1$, so the integral is $[\tan x - x]_0^{\pi/4} = 1 - \pi/4$.
104. (C) They meet at $x = \pm 2$. Area $= \int_{-2}^2 (4 - x^2) dx = 16 - 16/3 = 32/3$.
105. (B) Write $p = dy/dx$. Removing the root: $(y - xp)^2 = 1 + p^2$, which is of degree 2 in p . The highest derivative is the first, so order 1, degree 2.
106. (D) Integrating factor e^x : $d(y e^x)/dx = 1$, so $y e^x = x + C$ and $y = (x + C)e^{-x}$.
107. (B) The second line is $5x - 12y - 9 = 0$. Distance $= |4 - (-9)|/\sqrt{25 + 144} = 13/13 = 1$.
108. (D) $r^2 = 3^2 + 4^2 = 25$. $(x - 2)^2 + (y + 3)^2 = 25$ expands to $x^2 + y^2 - 4x + 6y + 13 - 25 = 0$, i.e. $x^2 + y^2 - 4x + 6y - 12 = 0$.
109. (B) $x^2 + (y - 2)^2 = (y + 2)^2$ simplifies to $x^2 = 8y$.
110. (B) $x^2/25 + y^2/9 = 1$, so $a^2 = 25$, $b^2 = 9$ and $e = \sqrt{1 - 9/25} = 4/5$.
111. (A) $|3(2) - 6(3) + 2(4) + 11|/\sqrt{9 + 36 + 4} = |6 - 18 + 8 + 11|/7 = 7/7 = 1$.
112. (A) $\cos \theta = |(1)(2) + (1)(-1) + (2)(1)|/(\sqrt{6} \times \sqrt{6}) = 3/6 = 1/2$, so $\theta = 60^\circ$.
113. (C) $a \times b = 8\hat{i} - 10\hat{j} + 4\hat{k}$, so $|a \times b| = \sqrt{64 + 100 + 16} = \sqrt{180} = 6\sqrt{5}$.
114. (C) Their scalar triple product must be zero: $(\lambda - 1) + 3\lambda + (-2 - \lambda) = 3\lambda - 3 = 0$, so $\lambda = 1$.
115. (A) $(4/52) \times (3/51) = 12/2652 = 1/221$.
116. (A) $C(5,3)(1/2)^5 = 10/32 = 5/16$.
117. (A) $np = 6$ and $npq = 2$ give $q = 1/3$, so $p = 2/3$ and $n = 6/(2/3) = 9$.
118. (D) $\cos 36^\circ = (\sqrt{5} + 1)/4$ and $\cos 72^\circ = (\sqrt{5} - 1)/4$. Their product is $(5 - 1)/16 = 1/4$.
119. (B) $(2\cos x - 1)(\cos x - 1) = 0$ gives $\cos x = 1$ ($x = 2n\pi$) or $\cos x = 1/2$ ($x = 2n\pi \pm \pi/3$).
120. (C) $\cos^{-1}(12/13) = \sin^{-1}(5/13)$. $\sin(A + B) = (3/5)(12/13) + (4/5)(5/13) = 36/65 + 20/65 = 56/65$; both angles are acute and the sum is below $\pi/2$, so it equals $\sin^{-1}(56/65)$.