BITSAT 2027 Sample Paper

Full-length practice test with answer key and worked solutions · Prepared by 10YearsQuestionPaper.com

About this paper. This is an original practice paper written in the pattern of the BITSAT-2026 brochure, the latest pattern published by BITS Pilani. It is **not** an official BITS paper and does not predict the questions in BITSAT 2027. Check the BITSAT 2027 brochure at bitsadmission.com when it is released, in case the pattern changes.

Part	Subject	Questions	Question numbers	Marks
I	Physics	30	1–30	90
II	Chemistry	30	31–60	90
III (a)	English Proficiency	10	61–70	30
III (b)	Logical Reasoning	20	71–90	60
IV	Mathematics	40	91–130	120
	Total	**130**		**390**

- Time: **3 hours**. There is no separate time limit for each part.
- Every question has four options, and exactly one is correct.
- Marking: **+3** for a correct answer, **−1** for a wrong answer, 0 for a question not attempted.
- In the real test, a candidate who answers all 130 questions with time left may take 12 extra questions (3 each from Physics, Chemistry, Mathematics and Logical Reasoning). Once they are taken, the first 130 answers cannot be changed. This sample paper contains the 130 main questions only.
- The Logical Reasoning part of the real test also has figure-based questions (pattern perception, figure matrix, paper cutting). This paper uses text-based reasoning questions, so practise figure questions from the BITSAT previous year papers.
- The answer key and step-by-step solutions are at the end. Attempt the full paper in one sitting before you look at them.

Part I: Physics (Questions 1–30)

1. Planck's constant has the same dimensions as

(a) energy
(b) linear momentum
(c) angular momentum
(d) power

2. A ball is projected with a speed of 20 m/s at 30° above the horizontal. Its maximum height is ($g = 10$ m/s²)

(a) 5 m
(b) 10 m
(c) 15 m
(d) 20 m

3. A boat moves at 5 km/h in still water. It crosses a river 1 km wide, flowing at 3 km/h, along the shortest path (straight across). The time taken is

(a) 12 min
(b) 15 min
(c) 20 min
(d) 25 min

4. Blocks of 3 kg and 2 kg hang from the two ends of a light string passing over a frictionless pulley. The tension in the string is ($g = 10$ m/s²)

(a) 24 N
(b) 25 N
(c) 20 N
(d) 30 N

5. A block slides down a rough incline of angle 37° with coefficient of kinetic friction 0.5. Its acceleration is ($g = 10$ m/s², $\sin 37^\circ = 0.6$, $\cos 37^\circ = 0.8$)

(a) 2 m/s²
(b) 4 m/s²
(c) 6 m/s²
(d) 8 m/s²

6. A 2 kg ball moving at 6 m/s collides head-on with a 1 kg ball at rest, and the two stick together. The kinetic energy lost in the collision is

(a) 6 J
(b) 18 J
(c) 24 J
(d) 12 J

7. A spring of spring constant 200 N/m is compressed by 10 cm and then releases a 0.5 kg block on a smooth horizontal surface. The speed of the block after it leaves the spring is

(a) 1 m/s
(b) 20 m/s
(c) 4 m/s
(d) 2 m/s

8. A solid sphere starts from rest and rolls without slipping down an incline of vertical height h. Its speed at the bottom is

(a) $\sqrt{2gh}$
(b) $\sqrt{4gh/3}$
(c) $\sqrt{10gh/7}$
(d) $\sqrt{gh}$

9. The moment of inertia of a thin uniform rod of mass M and length L about an axis perpendicular to it, passing through a point $L/4$ from its centre, is

(a) $ML^2/12$ **(b)** $7ML^2/48$

(c) $5ML^2/48$ **(d)** $ML^2/3$

10. A radioactive sample has a half-life of 20 minutes. The time taken for 75% of it to decay is

(a) 15 min **(b)** 30 min

(c) 40 min **(d)** 60 min

11. A planet has twice the radius of the Earth and the same average density. If the escape velocity from the Earth is 11.2 km/s, the escape velocity from the planet is

(a) 11.2 km/s **(b)** 15.8 km/s

(c) 44.8 km/s **(d)** 22.4 km/s

12. A satellite close to the Earth's surface has period T_0. The period of a satellite orbiting at a height equal to the Earth's radius R is

(a) $\sqrt{2}\,T_0$ **(b)** $2T_0$

(c) $2\sqrt{2}\,T_0$ **(d)** $4T_0$

13. A wire is stretched by a force F. A second wire of the same material, with twice the length and twice the radius, is stretched by the same force. Its extension, compared with the first wire, is

(a) half **(b)** the same

(c) double **(d)** four times

14. Water flows out of a small hole in the side of a wide open tank, 5 m below the water surface. The speed of efflux is ($g = 10$ m/s²)

(a) 5 m/s **(b)** 7 m/s

(c) 14 m/s **(d)** 10 m/s

15. A mass on a spring oscillates with period T. The spring is cut into two equal halves and the same mass is attached to one half. The new period is

(a) $T/2$ **(b)** $T/\sqrt{2}$

(c) $\sqrt{2}\,T$ **(d)** $2T$

16. The fundamental frequency of an open organ pipe is 300 Hz. The fundamental frequency of a pipe of the same length closed at one end is

(a) 75 Hz **(b)** 150 Hz

(c) 300 Hz **(d)** 600 Hz

17. A source of frequency f moves towards a stationary observer at one-tenth of the speed of sound. The frequency heard by the observer is

(a) $10f/9$ **(b)** $11f/10$

(c) $9f/10$ **(d)** $10f/11$

18. The efficiency of a Carnot engine working between 527 °C and 127 °C is

(a) 50% **(b)** 25%

(c) 75% **(d)** 76%

19. The rms speed of the molecules of a gas at 27 °C is doubled when the temperature is raised to

(a) 108 °C **(b)** 327 °C

(c) 1200 °C **(d)** 927 °C

20. A point charge q is placed at the centre of a cube. The electric flux through one face of the cube is

(a) q/ε_0 **(b)** $q/(6\varepsilon_0)$

(c) $q/(4\varepsilon_0)$ **(d)** $6q/\varepsilon_0$

21. A parallel plate capacitor has capacitance C. A dielectric slab of dielectric constant 4 and thickness equal to half the plate separation is inserted between the plates. The new capacitance is

(a) $2C$ **(b)** $5C/2$

(c) $4C$ **(d)** $8C/5$

22. A wire of resistance R is stretched uniformly to three times its original length. Its new resistance is

(a) $3R$ **(b)** $9R$

(c) $6R$ **(d)** $R/3$

23. The two inputs of a NAND gate are joined together. The circuit then works as

(a) an AND gate **(b)** an OR gate

(c) a NOR gate **(d)** a NOT gate

24. A circular loop of radius 10 cm carries a current of 5 A. The magnetic field at its centre is ($\mu_0 = 4\pi \times 10^{-7}$ T m/A)

(a) $\pi \times 10^{-5}$ T **(b)** $2\pi \times 10^{-5}$ T

(c) $\pi \times 10^{-6}$ T **(d)** $2\pi \times 10^{-6}$ T

25. A galvanometer of resistance 99 Ω gives full-scale deflection at 10 mA. To convert it into an ammeter of range 0–1 A, the shunt needed is

(a) 0.1 Ω **(b)** 9.9 Ω

(c) 1 Ω **(d)** 99 Ω

26. A series LCR circuit has $L = 10$ mH and $C = 1$ μF. Its resonant angular frequency is

(a) 10^3 rad/s **(b)** 10^5 rad/s

(c) 10^6 rad/s **(d)** 10^4 rad/s

27. An object is placed 30 cm in front of a convex lens of focal length 20 cm. The image is

(a) real, inverted, 60 cm behind the lens, twice the size of the object

(b) virtual, erect, 60 cm in front of the lens, twice the size of the object

(c) real, inverted, 12 cm behind the lens, smaller than the object

(d) real, erect, 60 cm behind the lens, same size as the object

28. In Young's double-slit experiment the slits are 1 mm apart, the screen is 1 m away and the wavelength is 600 nm. The fringe width is

(a) 0.06 mm **(b)** 0.6 mm

(c) 6 mm **(d)** 0.3 mm

29. Light of wavelength 310 nm falls on a metal of work function 2.5 eV. The stopping potential is (take $hc = 1240$ eV nm)

(a) 2.5 V **(b)** 4.0 V

(c) 1.5 V **(d)** 6.5 V

30. For the hydrogen atom, the ratio of the wavelength of the first line of the Balmer series to that of the first line of the Lyman series is

(a) $5/27$ **(b)** $27/5$

(c) $4/3$ **(d)** $9/4$

Part II: Chemistry (Questions 31–60)

31. The number of molecules in 4.4 g of CO_2 is ($N_A = 6.022 \times 10^{23}$)

(a) 6.022×10^{23} **(b)** 6.022×10^{22}

(c) 1.2×10^{23} **(d)** 3.011×10^{22}

32. A compound contains 40% carbon, 6.67% hydrogen and 53.33% oxygen by mass. Its empirical formula is

(a) CH_2O **(b)** CHO

(c) CH_3O **(d)** C_2H_4O

33. Under the same conditions of temperature and pressure, the ratio of the rates of effusion of H_2 and O_2 is

(a) 1 : 4 **(b)** 16 : 1

(c) 4 : 1 **(d)** 1 : 16

34. The maximum number of electrons in an atom that can have $n = 3$ and $l = 1$ is

(a) 2 **(b)** 6

(c) 10 **(d)** 18

35. The shape of the XeF_4 molecule is

(a) tetrahedral **(b)** see-saw

(c) square planar **(d)** octahedral

36. The bond order of the superoxide ion, O_2^-, is

(a) 1 **(b)** 1.5

(c) 2 **(d)** 2.5

37. The hybridisation of sulphur in SF_4 is

(a) sp^3 **(b)** sp^3d^2

(c) dsp^2 **(d)** sp^3d

38. A reaction has $\Delta H < 0$ and $\Delta S < 0$. The reaction is spontaneous

(a) at all temperatures **(b)** only at low temperatures

(c) only at high temperatures **(d)** at no temperature

39. The standard enthalpies of formation of CO_2(g), H_2O(l) and CH_4(g) are –393.5, –285.8 and –74.8 kJ/mol. The standard enthalpy of combustion of methane is

(a) –604.5 kJ/mol **(b)** –965.1 kJ/mol

(c) –752.9 kJ/mol **(d)** –890.3 kJ/mol

40. For the reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, the relation between K_p and K_c is

(a) $K_p = K_c(RT)^2$ **(b)** $K_p = K_c$

(c) $K_p = K_c(RT)^{-2}$ **(d)** $K_p = K_c(RT)^{-1}$

41. The pH of a 0.001 M solution of H_2SO_4, assuming complete dissociation, is ($\log 2 = 0.30$)

(a) 2.00 **(b)** 3.00

(c) 3.30 **(d)** 2.70

42. A buffer contains acetic acid ($\mathrm{p}K_a = 4.74$) and sodium acetate, with [salt]/[acid] = 10. Its pH is

(a) 3.74 **(b)** 5.74

(c) 4.74 **(d)** 6.74

43. A metal crystallises in a face-centred cubic lattice with edge length 400 pm. The radius of the metal atom is

(a) 100 pm **(b)** 141.4 pm

(c) 173.2 pm **(d)** 200 pm

44. Which 0.1 molal aqueous solution has the highest freezing point?

(a) Glucose **(b)** NaCl

(c) $CaCl_2$ **(d)** $K_4[Fe(CN)_6]$

45. For the cell Zn | Zn^{2+} || Cu^{2+} | Cu, $E^\circ(\mathrm{Zn^{2+}/Zn}) = -0.76$ V and $E^\circ(\mathrm{Cu^{2+}/Cu}) = +0.34$ V. The standard Gibbs energy change of the cell reaction is ($F = 96500$ C/mol)

(a) −106.2 kJ/mol **(b)** +212.3 kJ/mol

(c) −212.3 kJ/mol **(d)** −424.6 kJ/mol

46. The mass of copper deposited from a $CuSO_4$ solution by 0.5 faraday of electricity is (Cu = 63.5)

(a) 7.9 g **(b)** 15.9 g

(c) 31.75 g **(d)** 63.5 g

47. A first-order reaction has a half-life of 10 minutes. The time required for 99.9% of the reaction to complete is approximately

(a) 100 min **(b)** 50 min

(c) 30 min **(d)** 1000 min

48. The rate of a reaction doubles for every 10 °C rise in temperature. When the temperature is raised from 25 °C to 55 °C, the rate increases by a factor of

(a) 3 **(b)** 6

(c) 9 **(d)** 8

49. Which alkali metal carbonate decomposes on heating to give carbon dioxide?

(a) Na_2CO_3 **(b)** Li_2CO_3

(c) K_2CO_3 **(d)** Rb_2CO_3

50. Which oxoacid of phosphorus is monobasic?

(a) H_3PO_2 **(b)** H_3PO_3

(c) H_3PO_4 **(d)** $H_4P_2O_7$

51. Complete hydrolysis of XeF_6 gives

(a) $XeOF_4$ **(b)** XeO_2F_2

(c) XeO_3 **(d)** XeO_4

52. In acidic medium, the number of electrons gained by one MnO_4^- ion is

(a) 1 **(b)** 3

(c) 7 **(d)** 5

53. The IUPAC name of $K_3[Fe(CN)_6]$ is

(a) potassium hexacyanidoferrate(III) **(b)** potassium hexacyanidoferrate(II)

(c) potassium hexacyanidoiron(III) **(d)** tripotassium hexacyanidoiron(II)

54. The number of unpaired electrons in the high-spin complex $[CoF_6]^{3-}$ is

(a) 0 **(b)** 2

(c) 6 **(d)** 4

55. Propene reacts with HBr in the presence of a peroxide. The main product is

(a) 2-bromopropane **(b)** 1-bromopropane

(c) 1,2-dibromopropane **(d)** propan-2-ol

56. Which of the following is the strongest acid?

(a) CH_3COOH **(b)** $ClCH_2COOH$

(c) $Cl_2CHCOOH$ **(d)** Cl_3CCOOH

57. Which of the following gives a positive iodoform test?

(a) Methanol **(b)** Propan-1-ol

(c) Ethanol **(d)** Benzaldehyde

58. Which of the following is the strongest base in aqueous solution?

(a) NH_3 **(b)** CH_3NH_2

(c) $(CH_3)_2NH$ **(d)** $(CH_3)_3N$

59. Which of the following is a non-reducing sugar?

(a) Glucose **(b)** Fructose

(c) Maltose **(d)** Sucrose

60. Nylon-6,6 is made by condensation polymerisation of

(a) caprolactam **(b)** hexamethylenediamine and adipic acid

(c) ethylene glycol and terephthalic acid **(d)** phenol and formaldehyde

Part III (a): English Proficiency (Questions 61–70)

61. Choose the word closest in meaning to **EPHEMERAL**.

(a) Eternal **(b)** Short-lived

(c) Ethereal **(d)** Essential

62. Choose the word most opposite in meaning to **BENEVOLENT**.

(a) Malevolent **(b)** Generous

(c) Kind **(d)** Charitable

63. Choose the correctly spelt word.

(a) Accomodation **(b)** Acommodation

(c) Accommadation **(d)** Accommodation

64. Fill in the blank: She has been working at this company _____ 2019.

(a) for
(b) by
(c) from
(d) since

65. Fill in the blank: Neither the teacher nor the students _____ aware of the change in the timetable.

(a) was
(b) is
(c) were
(d) has been

66. Choose the meaning of the idiom: **to burn the midnight oil**

(a) to waste money carelessly
(b) to work or study late into the night
(c) to start a quarrel
(d) to lose one's temper

67. Choose the correct passive form of: *The committee has approved the proposal.*

(a) The proposal was approved by the committee.
(b) The proposal had been approved by the committee.
(c) The proposal has been approved by the committee.
(d) The proposal is approved by the committee.

68. Choose the correct question tag: *Let's go for a walk, _____?*

(a) shall we
(b) will you
(c) don't we
(d) won't we

69. Read the passage and answer Questions 69 and 70.

For most of history, cities treated trees as decoration, planted wherever space happened to be left over. Recent research has changed that view. A mature street tree shades the pavement beneath it, soaks up rainwater that would otherwise overload drains, and traps fine dust from the air. Yet trees deliver these benefits only if they survive, and many young trees in cities die within a few years because they are planted in compacted soil and never watered after the first season. Planners are therefore shifting their attention from the number of trees planted to the number that reach maturity.

Which statement best expresses the main idea of the passage?

(a) Because trees help cities only once they grow, planners now focus on how many planted trees survive.
(b) Trees in cities matter only for their appearance.
(c) Cities have too little space to plant trees.
(d) Compacted soil is the main cause of flooding in cities.

70. According to the passage, why do many young city trees die within a few years?

(a) They are planted too close to drains.
(b) They are planted in compacted soil and not watered after the first season.
(c) Fine dust in the air damages their leaves.
(d) Planners choose decorative species that cannot survive.

Part III (b): Logical Reasoning (Questions 71–90)

71. Find the next term: 2, 6, 12, 20, 30, ?

(a) 42 **(b)** 40

(c) 44 **(d)** 48

72. Find the next term: 3, 5, 9, 17, 33, ?

(a) 65 **(b)** 49

(c) 63 **(d)** 66

73. Find the next term: AZ, BY, CX, ?

(a) DV **(b)** EW

(c) DX **(d)** DW

74. Find the wrong term in the series: 1, 4, 9, 16, 24, 36

(a) 4 **(b)** 16

(c) 36 **(d)** 24

75. Doctor : Hospital :: Teacher : ?

(a) School **(b)** Book

(c) Student **(d)** Lesson

76. 3 : 27 :: 5 : ?

(a) 25 **(b)** 100

(c) 125 **(d)** 150

77. Find the odd one out: Copper, Iron, Brass, Silver

(a) Copper **(b)** Iron

(c) Silver **(d)** Brass

78. Find the odd one out: 11, 13, 17, 21, 23

(a) 21 **(b)** 11

(c) 17 **(d)** 23

79. In a certain code, CAT is written as DBU. How is DOG written in that code?

(a) EPH **(b)** CNF

(c) EOH **(d)** FQI

80. If MANGO is coded as 13-1-14-7-15, how is APPLE coded?

(a) 1-16-16-12-5 **(b)** 1-15-15-12-5

(c) 1-16-16-11-5 **(d)** 2-16-16-12-5

81. Pointing to a boy, Riya said, “He is the son of the only son of my paternal grandfather.” How is the boy related to Riya?

(a) Cousin **(b)** Uncle

(c) Brother **(d)** Nephew

82. Ravi walks 5 km north, turns right and walks 3 km, then turns right again and walks 9 km. How far is he from his starting point?

(a) 3 km **(b)** 4 km

(c) 5 km **(d)** 7 km

83. What is the angle between the hour hand and the minute hand of a clock at 3:40?

(a) 120° **(b)** 150°

(c) 140° **(d)** 130°

84. 1 January 2027 is a Friday. What day of the week is 1 March 2027?

(a) Sunday **(b)** Monday

(c) Tuesday **(d)** Wednesday

85. Statements: All roses are flowers. Some flowers fade quickly.
Conclusions: I. Some roses fade quickly. II. All roses fade quickly.

(a) Only I follows **(b)** Only II follows

(c) Both I and II follow **(d)** Neither I nor II follows

86. P is taller than Q. R is shorter than Q. S is taller than P. Who is the shortest?

(a) P **(b)** Q

(c) R **(d)** S

87. Find the missing number in the table:

2	3	13
4	5	41
3	6	?

(a) 36 **(b)** 39

(c) 45 **(d)** 54

88. In a row of 40 students, Aman is 15th from the left end. What is his position from the right end?

(a) 25th **(b)** 26th

(c) 24th **(d)** 27th

89. If '+' means '×', '×' means '−', '−' means '÷' and '÷' means '+', find the value of $8 + 3 \times 12 - 4 \div 2$.

(a) 19 **(b)** 21

(c) 23 **(d)** 25

90. In a group of 50 students, 30 like tea, 25 like coffee and 10 like both. How many like neither?

(a) 0 **(b)** 10

(c) 5 **(d)** 15

Part IV: Mathematics (Questions 91–130)

91. If $z = \dfrac{1+i}{1-i}$, then z^{100} equals

(a) 1 **(b)** -1

(c) i **(d)** $-i$

92. If ω is a non-real cube root of unity, then $(1+\omega-\omega^2)^3$ equals

(a) 8 **(b)** 0

(c) -8 **(d)** 1

93. If α and β are the roots of $x^2 - 3x + 1 = 0$, then $\alpha^4 + \beta^4$ equals

(a) 45 **(b)** 47

(c) 49 **(d)** 51

94. The maximum value of $Z = 3x + 2y$ subject to $x + y \le 4$, $x \le 3$, $x \ge 0$, $y \ge 0$ is

(a) 8 **(b)** 9

(c) 12 **(d)** 11

95. The sum $1 + \dfrac{2}{2} + \dfrac{3}{2^2} + \dfrac{4}{2^3} + \cdots$ to infinity is

(a) 4 **(b)** 3

(c) 2 **(d)** ∞

96. The vectors $\hat{i}+\hat{j}+\hat{k}$, $\hat{i}-\hat{j}+\hat{k}$ and $\hat{i}+\hat{j}+\lambda\hat{k}$ are coplanar when λ equals

(a) 1 **(b)** -1

(c) 0 **(d)** 2

97. The term independent of x in the expansion of $\left(x^2 + \dfrac{1}{x}\right)^9$ is

(a) 36 **(b)** 84

(c) 126 **(d)** 9

98. The number of distinct arrangements of the letters of the word BANANA is

(a) 720 **(b)** 120

(c) 360 **(d)** 60

99. The number of diagonals of a decagon (10-sided polygon) is

(a) 45 **(b)** 35

(c) 70 **(d)** 90

100. If A is a 3×3 matrix with $|A| = 4$, then $|\operatorname{adj} A|$ equals

(a) 4 **(b)** 8

(c) 16 **(d)** 64

101. The system $kx + y + z = 0$, $x + ky + z = 0$, $x + y + kz = 0$ has a non-trivial solution when k equals

(a) 1 or -2 **(b)** -1 or 2

(c) 0 only **(d)** 1 only

102. The domain of $f(x) = \sqrt{\log_{10}\left(\dfrac{5x - x^2}{4}\right)}$ is

(a) $(0, 5)$ **(b)** $[0, 5]$

(c) $(1, 4)$ **(d)** $[1, 4]$

103. The number of onto (surjective) functions from a set with 3 elements to a set with 2 elements is

(a) 8 **(b)** 6

(c) 2 **(d)** 9

104. The contrapositive of "If it rains, then the ground is wet" is

(a) If the ground is wet, then it rains.

(b) If it does not rain, then the ground is not wet.

(c) If the ground is not wet, then it does not rain.

(d) It rains and the ground is not wet.

105. The value of $\cos 20^\circ \cos 40^\circ \cos 80^\circ$ is

(a) $1/8$ **(b)** $1/4$

(c) $1/16$ **(d)** $\sqrt{3}/8$

106. The general solution of $\sin x = \dfrac{1}{2}$ is

(a) $x = n\pi + \dfrac{\pi}{6}$ **(b)** $x = 2n\pi \pm \dfrac{\pi}{6}$

(c) $x = n\pi + (-1)^n \dfrac{\pi}{6}$ **(d)** $x = n\pi \pm \dfrac{\pi}{3}$

107. $\tan^{-1}\dfrac{1}{2} + \tan^{-1}\dfrac{1}{3}$ equals

(a) $\pi/6$ **(b)** $\pi/4$

(c) $\pi/3$ **(d)** $\pi/2$

108. The distance between the parallel lines $3x + 4y = 5$ and $6x + 8y = 25$ is

(a) $3/2$ **(b)** 3

(c) 4 **(d)** 2

109. The centre and radius of the circle $x^2 + y^2 - 4x + 6y - 12 = 0$ are

(a) $(-2, 3)$ and 5 **(b)** $(2, -3)$ and 5

(c) $(2, -3)$ and $\sqrt{12}$ **(d)** $(4, -6)$ and 5

110. The equation of the directrix of the parabola $x^2 = -8y$ is

(a) $y = -2$ **(b)** $x = 2$

(c) $y = 2$ **(d)** $x = -2$

111. The eccentricity of the ellipse $\dfrac{x^2}{25} + \dfrac{y^2}{16} = 1$ is

(a) $4/5$ **(b)** $3/4$

(c) $5/3$ **(d)** $3/5$

112. For a hyperbola, the length of the latus rectum is half the length of the transverse axis. Its eccentricity is

(a) $\sqrt{6}/2$ **(b)** $\sqrt{3}/2$

(c) $\sqrt{2}$ **(d)** $3/2$

113. The distance of the point $(1, 2, 3)$ from the plane $2x - y + 2z = 5$ is

(a) 1 **(b)** $1/3$

(c) $2/3$ **(d)** $5/3$

114. The angle between two lines with direction ratios $(1, 1, 0)$ and $(0, 1, 1)$ is

(a) 30° **(b)** 45°

(c) 60° **(d)** 90°

115. $\displaystyle\lim_{x \to 0} \frac{1 - \cos 2x}{x^2}$ equals

(a) 1 **(b)** $1/2$

(c) 4 **(d)** 2

116. $\displaystyle\lim_{x \to \infty} \left(1 + \frac{2}{x}\right)^x$ equals

(a) e **(b)** e^2

(c) $2e$ **(d)** 1

117. The number of points at which $f(x) = |x| + |x - 1|$ is not differentiable is

(a) 0 **(b)** 1

(c) 2 **(d)** 3

118. If $y = x^x$, then $\dfrac{dy}{dx}$ at $x = 1$ is

(a) 0 **(b)** e

(c) 2 **(d)** 1

119. If $x = a\cos^3\theta$ and $y = a\sin^3\theta$, then $\dfrac{dy}{dx}$ equals

(a) $\tan\theta$ **(b)** $-\cot\theta$

(c) $\cot\theta$ **(d)** $-\tan\theta$

120. The local maximum value of $f(x) = x^3 - 3x + 2$ is

(a) 0 **(b)** 2

(c) 4 **(d)** 6

121. The value of c in Rolle's theorem for $f(x) = x^2 - 4x + 3$ on $[1, 3]$ is

(a) $3/2$ **(b)** 2

(c) $5/2$ **(d)** 1

122. $\displaystyle\int \frac{dx}{x^2 + 4x + 13}$ equals

(a) $\tan^{-1}\dfrac{x+2}{3} + C$ **(b)** $\dfrac{1}{3}\tan^{-1}\dfrac{x+2}{3} + C$

(c) $\dfrac{1}{3}\tan^{-1}\dfrac{x-2}{3} + C$ **(d)** $\dfrac{1}{2}\ln(x^2 + 4x + 13) + C$

123. $\displaystyle\int_0^{\pi/2} \frac{\sin x}{\sin x + \cos x}\,dx$ equals

(a) $\pi/4$ **(b)** $\pi/2$

(c) π **(d)** 1

124. $\displaystyle\int_0^1 xe^x\,dx$ equals

(a) e **(b)** $e - 1$

(c) 1 **(d)** $e + 1$

125. The area of the region bounded by $y = x^2$ and $y = x$ is

(a) $1/3$ **(b)** $1/2$

(c) $1/6$ **(d)** $1/12$

126. The order and degree of the differential equation $\left(\dfrac{d^2y}{dx^2}\right)^3 + \left(\dfrac{dy}{dx}\right)^4 + y = 0$ are

(a) order 2, degree 3 **(b)** order 2, degree 4

(c) order 3, degree 2 **(d)** order 4, degree 2

127. The solution of $\dfrac{dy}{dx} + y = e^{-x}$ with $y(0) = 0$ is

(a) $y = e^{-x}$ **(b)** $y = xe^x$

(c) $y = (x+1)e^{-x}$ **(d)** $y = xe^{-x}$

128. Two fair coins are tossed. Given that at least one shows a head, the probability that both show heads is

(a) $1/4$ **(b)** $1/2$

(c) $2/3$ **(d)** $1/3$

129. If $|\vec{a}| = 2$ and $|\vec{b}| = 3$, then $|\vec{a} \times \vec{b}|^2 + (\vec{a} \cdot \vec{b})^2$ equals

(a) 6 **(b)** 13

(c) 36 **(d)** 25

130. The variance of the first 10 natural numbers is

(a) 8.25 **(b)** 7.25

(c) 5.5 **(d)** 10

Answer Key

1 (c)	**2** (a)	**3** (b)	**4** (a)	**5** (a)	**6** (d)	**7** (d)	**8** (c)	**9** (b)	**10** (c)
11 (d)	**12** (c)	**13** (a)	**14** (d)	**15** (b)	**16** (b)	**17** (a)	**18** (a)	**19** (d)	**20** (b)
21 (d)	**22** (b)	**23** (d)	**24** (a)	**25** (c)	**26** (d)	**27** (a)	**28** (b)	**29** (c)	**30** (b)
31 (b)	**32** (a)	**33** (c)	**34** (b)	**35** (c)	**36** (b)	**37** (d)	**38** (b)	**39** (d)	**40** (c)
41 (d)	**42** (b)	**43** (b)	**44** (a)	**45** (c)	**46** (b)	**47** (a)	**48** (d)	**49** (b)	**50** (a)
51 (c)	**52** (d)	**53** (a)	**54** (d)	**55** (b)	**56** (d)	**57** (c)	**58** (c)	**59** (d)	**60** (b)
61 (b)	**62** (a)	**63** (d)	**64** (d)	**65** (c)	**66** (b)	**67** (c)	**68** (a)	**69** (a)	**70** (b)
71 (a)	**72** (a)	**73** (d)	**74** (d)	**75** (a)	**76** (c)	**77** (d)	**78** (a)	**79** (a)	**80** (a)
81 (c)	**82** (c)	**83** (d)	**84** (b)	**85** (d)	**86** (c)	**87** (c)	**88** (b)	**89** (c)	**90** (c)
91 (a)	**92** (c)	**93** (b)	**94** (d)	**95** (a)	**96** (a)	**97** (b)	**98** (d)	**99** (b)	**100** (c)
101 (a)	**102** (d)	**103** (b)	**104** (c)	**105** (a)	**106** (c)	**107** (b)	**108** (a)	**109** (b)	**110** (c)
111 (d)	**112** (a)	**113** (b)	**114** (c)	**115** (d)	**116** (b)	**117** (c)	**118** (d)	**119** (d)	**120** (c)
121 (b)	**122** (b)	**123** (a)	**124** (c)	**125** (c)	**126** (a)	**127** (d)	**128** (d)	**129** (c)	**130** (a)

Score = 3 × (correct answers) − 1 × (wrong answers). Maximum 390.

Solutions

Part I: Physics

1. (c) $[h] = [E]/[\nu] = ML^2T^{-2} \cdot T = ML^2T^{-1}$, which is the dimension of angular momentum (mvr).

2. (a) $H = \dfrac{u^2 \sin^2\theta}{2g} = \dfrac{400 \times 1/4}{20} = 5$ m.

3. (b) To go straight across, the boat's velocity across the river is $\sqrt{5^2 - 3^2} = 4$ km/h, so $t = 1/4$ h $= 15$ min.

4. (a) $T = \dfrac{2m_1 m_2 g}{m_1 + m_2} = \dfrac{2 \times 3 \times 2 \times 10}{5} = 24$ N.

5. (a) $a = g(\sin\theta - \mu\cos\theta) = 10(0.6 - 0.5 \times 0.8) = 2$ m/s².

6. (d) Common velocity $v = \dfrac{2 \times 6}{3} = 4$ m/s. KE before $= 36$ J, after $= \frac{1}{2} \times 3 \times 16 = 24$ J, so loss $= 12$ J.

7. (d) $\frac{1}{2}kx^2 = \frac{1}{2}mv^2 \Rightarrow v = x\sqrt{k/m} = 0.1\sqrt{400} = 2$ m/s.

8. (c) $mgh = \frac{1}{2}mv^2\left(1 + \frac{k^2}{R^2}\right)$ with $k^2/R^2 = 2/5$, so $v^2 = \dfrac{2gh}{7/5} = \dfrac{10gh}{7}$.

9. (b) Parallel axes theorem: $I = \dfrac{ML^2}{12} + M\left(\dfrac{L}{4}\right)^2 = \dfrac{4ML^2 + 3ML^2}{48} = \dfrac{7ML^2}{48}$.

10. (c) 75% decayed means 25% $= (1/2)^2$ remains, i.e. two half-lives $= 40$ min.

11. (d) $v_e = \sqrt{2GM/R}$ with $M = \frac{4}{3}\pi R^3\rho$ gives $v_e = R\sqrt{8\pi G\rho/3} \propto R$. So $v = 2 \times 11.2 = 22.4$ km/s.

12. (c) By Kepler's third law $T \propto r^{3/2}$. The orbit radius goes from R to $2R$, so $T = 2^{3/2}T_0 = 2\sqrt{2}\,T_0$.

13. (a) $\Delta L = \dfrac{FL}{\pi r^2 Y}$. Doubling L doubles it and doubling r divides it by 4, so the extension is halved.

14. (d) Torricelli's theorem: $v = \sqrt{2gh} = \sqrt{100} = 10$ m/s.

15. (b) Each half has spring constant $2k$. Since $T = 2\pi\sqrt{m/k}$, the new period is $T/\sqrt{2}$.

16. (b) Open pipe: $v/2L = 300$ Hz. Closed pipe: $v/4L = 150$ Hz.

17. (a) $f' = f\dfrac{v}{v - v_s} = f\dfrac{v}{v - v/10} = \dfrac{10f}{9}$.

18. (a) $\eta = 1 - T_2/T_1 = 1 - 400/800 = 0.5 = 50\%$.

19. (d) $v_{rms} \propto \sqrt{T}$, so T becomes $4 \times 300 = 1200$ K $= 927$ °C.

20. (b) By Gauss's law the total flux is q/ε_0; by symmetry it divides equally among the 6 faces.

21. (d) $C' = \dfrac{\varepsilon_0 A}{d - t + t/K} = \dfrac{\varepsilon_0 A}{d/2 + d/8} = \dfrac{8}{5} \cdot \dfrac{\varepsilon_0 A}{d} = \dfrac{8C}{5}$.

22. (b) Volume stays constant, so the area becomes $A/3$. $R' = \rho(3L)/(A/3) = 9R$.

23. (d) With $A = B$, the output is $\overline{A \cdot A} = \overline{A}$, which is a NOT gate.

24. (a) $B = \dfrac{\mu_0 I}{2R} = \dfrac{4\pi \times 10^{-7} \times 5}{0.2} = \pi \times 10^{-5}$ T.

25. (c) $S = \dfrac{I_g G}{I - I_g} = \dfrac{0.01 \times 99}{0.99} = 1\ \Omega$.

26. (d) $\omega_0 = \dfrac{1}{\sqrt{LC}} = \dfrac{1}{\sqrt{10^{-2} \times 10^{-6}}} = 10^4$ rad/s.

27. (a) $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$ with $u=-30$, $f=20$: $\frac{1}{v}=\frac{1}{20}-\frac{1}{30}=\frac{1}{60}$, so $v=+60$ cm (real). $m=v/u=-2$: inverted and twice the size.

28. (b) $\beta=\frac{\lambda D}{d}=\frac{600\times10^{-9}\times1}{10^{-3}}=6\times10^{-4}$ m $=0.6$ mm.

29. (c) $E=1240/310=4.0$ eV, so $eV_0=4.0-2.5=1.5$ eV and $V_0=1.5$ V.

30. (b) $\frac{1}{\lambda}\propto\frac{1}{n_1^2}-\frac{1}{n_2^2}$. Balmer: $\frac{1}{4}-\frac{1}{9}=\frac{5}{36}$. Lyman: $1-\frac{1}{4}=\frac{3}{4}$. So $\frac{\lambda_B}{\lambda_L}=\frac{3/4}{5/36}=\frac{27}{5}$.

Part II: Chemistry

31. (b) Molar mass of $CO_2=44$ g/mol, so 4.4 g $=0.1$ mol $=6.022\times10^{22}$ molecules.

32. (a) Mole ratio C : H : O $=40/12:6.67/1:53.33/16=3.33:6.67:3.33=1:2:1$, i.e. CH_2O.

33. (c) Graham's law: $\frac{r_{H_2}}{r_{O_2}}=\sqrt{\frac{32}{2}}=4$, i.e. 4 : 1.

34. (b) $n=3, l=1$ is the 3p subshell: three orbitals, two electrons each, so 6.

35. (c) Xe has 4 bond pairs and 2 lone pairs (sp^3d^2 hybridisation). The lone pairs sit opposite each other, so the molecule is square planar.

36. (b) O_2^- has 17 electrons: 10 in bonding and 7 in antibonding molecular orbitals. Bond order $=(10-7)/2=1.5$.

37. (d) S has 4 bond pairs and 1 lone pair, i.e. 5 electron domains, so sp^3d (see-saw shape).

38. (b) $\Delta G=\Delta H-T\Delta S$. With both negative, $\Delta G<0$ only when T is small enough that $|\Delta H|>T|\Delta S|$.

39. (d) $CH_4+2O_2\rightarrow CO_2+2H_2O$. $\Delta_c H=-393.5+2(-285.8)-(-74.8)=-890.3$ kJ/mol.

40. (c) $K_p=K_c(RT)^{\Delta n_g}$ with $\Delta n_g=2-4=-2$.

41. (d) $[H^+]=2\times10^{-3}$ M, so pH $=3-\log 2=2.70$.

42. (b) Henderson equation: $\text{pH}=\text{p}K_a+\log\frac{[\text{salt}]}{[\text{acid}]}=4.74+1=5.74$.

43. (b) In fcc, atoms touch along the face diagonal: $4r=\sqrt{2}a$, so $r=\frac{a}{2\sqrt{2}}=\frac{400}{2.828}=141.4$ pm.

44. (a) $\Delta T_f=iK_fm$. Glucose does not dissociate ($i=1$), compared with $i=2,3,5$ for the others, so its freezing point is lowered least.

45. (c) $E^\circ_{cell}=0.34-(-0.76)=1.10$ V. $\Delta G^\circ=-nFE^\circ=-2\times96500\times1.10=-212\,300$ J $=-212.3$ kJ/mol.

46. (b) $Cu^{2+}+2e^-\rightarrow Cu$, so 0.5 F deposits 0.25 mol $=0.25\times63.5=15.875\approx15.9$ g.

47. (a) $t=\frac{2.303}{k}\log\frac{100}{0.1}$ with $k=0.693/10$ min^{-1}: $t=\frac{2.303\times3}{0.0693}\approx100$ min (about 10 half-lives).

48. (d) A 30 °C rise is three 10 °C steps: $2^3=8$.

49. (b) The very small Li^+ ion polarises the carbonate ion, so $Li_2CO_3\rightarrow Li_2O+CO_2$ on heating. The other alkali metal carbonates are thermally stable.

50. (a) Hypophosphorous acid, H_3PO_2, has only one P–OH group (the other two H atoms are bonded to P), so it is monobasic.

51. (c) $XeF_6+3H_2O\rightarrow XeO_3+6HF$. Partial hydrolysis gives $XeOF_4$ and XeO_2F_2.

52. (d) MnO_4^- + $8H^+$ + $5e^-$ → Mn^{2+} + $4H_2O$: Mn goes from +7 to +2.

53. (a) Charge balance: $3(+1) + x + 6(-1) = 0 \Rightarrow x = +3$. An anionic complex takes the suffix '-ate', with iron becoming 'ferrate'.

54. (d) Co^{3+} is d^6. F^- is a weak-field ligand, so the configuration is $t_{2g}^4 e_g^2$, which has 4 unpaired electrons.

55. (b) With peroxide, HBr adds by a free-radical (anti-Markovnikov) mechanism, so Br goes to the terminal carbon: $CH_3CH_2CH_2Br$.

56. (d) Each Cl withdraws electron density (–I effect) and stabilises the carboxylate ion. Three Cl atoms give the most stable anion, so trichloroacetic acid is the strongest.

57. (c) Ethanol is oxidised by NaOI to acetaldehyde (CH_3CHO), which has the $CH_3C{=}O$ group, so it forms CHI_3. The others cannot form a $CH_3CO–$ or $CH_3CH(OH)–$ group.

58. (c) In water, the balance of the +I effect, solvation (hydrogen bonding) and steric hindrance makes the order $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$.

59. (d) In sucrose, the glycosidic bond joins C1 of glucose to C2 of fructose, so neither unit has a free hemiacetal or hemiketal group. It does not reduce Tollens' or Fehling's reagent.

60. (b) Hexamethylenediamine and adipic acid each have 6 carbons, which gives the name nylon-6,6. Caprolactam gives nylon-6, the glycol and terephthalic acid give Terylene, and phenol with formaldehyde gives Bakelite.

Part III (a): English Proficiency

61. (b) Ephemeral means lasting for a very short time.

62. (a) Benevolent means well-meaning and kind. Its opposite is malevolent, meaning wishing harm to others.

63. (d) The correct spelling has a double c and a double m: accommodation.

64. (d) 'Since' is used with a point in time, and 'for' with a period of time, in the present perfect continuous.

65. (c) With 'neither … nor', the verb agrees with the nearer subject. 'Students' is plural, so the verb is 'were'.

66. (b) 'To burn the midnight oil' means to stay up late working or studying.

67. (c) The present perfect active (has approved) becomes present perfect passive: has been approved.

68. (a) A suggestion beginning with 'Let's' takes the tag 'shall we'.

69. (a) The passage moves from the benefits of mature trees to why young trees die, and ends with planners shifting their focus to survival. Only the statement about survival covers this whole argument.

70. (b) The passage says they die 'because they are planted in compacted soil and never watered after the first season'.

Part III (b): Logical Reasoning

71. (a) The terms are $n(n+1)$: 1×2, 2×3, 3×4, 4×5, 5×6, so the next is 6×7 = 42.

72. (a) Each term is (previous × 2) – 1: 33 × 2 – 1 = 65. (The differences 2, 4, 8, 16 also double, giving 32 next.)

73. (d) The first letter moves forward one step (A, B, C, D) and the second moves back one step (Z, Y, X, W).

74. (d) The series is the squares 1^2, 2^2, 3^2, …, so 24 should be 25.

75. (a) The relationship is a professional and the place where they work.

76. (c) The second number is the cube of the first: $3^3 = 27$, so $5^3 = 125$.

77. (d) Brass is an alloy (of copper and zinc). The others are elements.

78. (a) All except 21 (= 3 × 7) are prime numbers.

79. (a) Each letter moves one step forward: D→E, O→P, G→H.

80. (a) Each letter is replaced by its position in the alphabet: A = 1, P = 16, L = 12, E = 5.

81. (c) The only son of Riya's paternal grandfather is Riya's father. The son of her father is her brother.

82. (c) His net displacement is 4 km south and 3 km east, so the distance is $\sqrt{4^2 + 3^2} = 5$ km.

83. (d) Angle $= |30H - 5.5M| = |90 - 220| = 130^\circ$.

84. (b) From 1 January to 1 March is 31 + 28 = 59 days (2027 is not a leap year). 59 = 8 × 7 + 3, so it is 3 days after Friday: Monday.

85. (d) The flowers that fade quickly need not include any roses, so neither conclusion follows with certainty.

86. (c) The order is S > P > Q > R, so R is the shortest.

87. (c) Third column $= a^2 + b^2$: 4 + 9 = 13 and 16 + 25 = 41, so 9 + 36 = 45.

88. (b) Position from right $= 40 - 15 + 1 = 26$.

89. (c) After replacing the signs: 8 × 3 − 12 ÷ 4 + 2 = 24 − 3 + 2 = 23.

90. (c) Students who like at least one $= 30 + 25 - 10 = 45$, so $50 - 45 = 5$ like neither.

Part IV: Mathematics

91. (a) $z = \dfrac{(1+i)^2}{(1-i)(1+i)} = \dfrac{2i}{2} = i$, and $i^{100} = (i^4)^{25} = 1$.

92. (c) $1 + \omega = -\omega^2$, so $1 + \omega - \omega^2 = -2\omega^2$ and $(-2\omega^2)^3 = -8\omega^6 = -8$.

93. (b) $\alpha + \beta = 3$, $\alpha\beta = 1$. So $\alpha^2 + \beta^2 = 9 - 2 = 7$ and $\alpha^4 + \beta^4 = 49 - 2(1)^2 = 47$.

94. (d) The corner points of the feasible region are (0, 0), (3, 0), (3, 1) and (0, 4), giving Z = 0, 9, 11 and 8. The maximum is 11.

95. (a) $\sum_{n\geq 1} n r^{n-1} = \dfrac{1}{(1-r)^2}$ with $r = \frac{1}{2}$ gives 4.

96. (a) The scalar triple product $\begin{vmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & \lambda \end{vmatrix} = 2 - 2\lambda = 0$ gives $\lambda = 1$.

97. (b) $T_{r+1} = \binom{9}{r} x^{2(9-r)} x^{-r} = \binom{9}{r} x^{18-3r}$. Setting $18 - 3r = 0$ gives $r = 6$, and $\binom{9}{6} = 84$.

98. (d) 6 letters with A repeated 3 times and N twice: $\dfrac{6!}{3!\,2!} = 60$.

99. (b) $\binom{10}{2} - 10 = 45 - 10 = 35$.

100. (c) $|\operatorname{adj} A| = |A|^{n-1} = 4^2 = 16$ for $n = 3$.

101. (a) The determinant of the coefficients is $(k-1)^2(k+2)$. It is zero when $k = 1$ or $k = -2$.

102. (d) We need $\dfrac{5x - x^2}{4} \geq 1$, i.e. $x^2 - 5x + 4 \leq 0$, i.e. $1 \leq x \leq 4$. On this interval the log's argument is positive.

103. (b) Total functions $= 2^3 = 8$. Subtract the 2 constant functions, which are not onto: $8 - 2 = 6$.

104. (c) The contrapositive of $p \Rightarrow q$ is $\sim q \Rightarrow \sim p$.

105. (a) Using $\cos\theta\cos(60^\circ-\theta)\cos(60^\circ+\theta) = \frac{1}{4}\cos 3\theta$ with $\theta = 20^\circ$: $\frac{1}{4}\cos 60^\circ = \frac{1}{8}$.

106. (c) $\sin x = \sin\alpha \Rightarrow x = n\pi + (-1)^n\alpha$, with $\alpha = \pi/6$.

107. (b) $\tan^{-1}\dfrac{1/2+1/3}{1-1/6} = \tan^{-1}1 = \dfrac{\pi}{4}$.

108. (a) Write the second line as $3x + 4y = 12.5$. Distance $= \dfrac{|12.5-5|}{\sqrt{9+16}} = \dfrac{7.5}{5} = \dfrac{3}{2}$.

109. (b) $(x-2)^2 + (y+3)^2 = 12 + 4 + 9 = 25$, so the centre is $(2,-3)$ and the radius is 5.

110. (c) $x^2 = -4ay$ with $a = 2$ opens downward, with focus $(0,-2)$ and directrix $y = 2$.

111. (d) $e = \sqrt{1 - b^2/a^2} = \sqrt{1 - 16/25} = 3/5$.

112. (a) $\dfrac{2b^2}{a} = \dfrac{1}{2}(2a) \Rightarrow b^2 = \dfrac{a^2}{2}$. So $e = \sqrt{1 + b^2/a^2} = \sqrt{3/2} = \dfrac{\sqrt{6}}{2}$.

113. (b) $\dfrac{|2 - 2 + 6 - 5|}{\sqrt{4+1+4}} = \dfrac{1}{3}$.

114. (c) $\cos\theta = \dfrac{0+1+0}{\sqrt{2}\sqrt{2}} = \dfrac{1}{2}$, so $\theta = 60^\circ$.

115. (d) $1 - \cos 2x = 2\sin^2 x$, and $\dfrac{2\sin^2 x}{x^2} \to 2$.

116. (b) $\lim(1 + a/x)^x = e^a$ with $a = 2$.

117. (c) Each modulus term has a corner where its argument is zero, at $x = 0$ and $x = 1$. The slopes there change ($-2 \to 0$ and $0 \to 2$), so there are 2 such points.

118. (d) $\dfrac{dy}{dx} = x^x(1 + \ln x)$, which equals $1 \cdot (1 + 0) = 1$ at $x = 1$.

119. (d) $\dfrac{dy/d\theta}{dx/d\theta} = \dfrac{3a\sin^2\theta\cos\theta}{-3a\cos^2\theta\sin\theta} = -\tan\theta$.

120. (c) $f'(x) = 3x^2 - 3 = 0 \Rightarrow x = \pm 1$. Since $f''(-1) = -6 < 0$, the local maximum is $f(-1) = -1 + 3 + 2 = 4$.

121. (b) $f(1) = f(3) = 0$ and $f'(c) = 2c - 4 = 0$ give $c = 2$.

122. (b) $x^2 + 4x + 13 = (x+2)^2 + 3^2$, and $\displaystyle\int \frac{du}{u^2 + a^2} = \frac{1}{a}\tan^{-1}\frac{u}{a}$.

123. (a) Replacing x by $\pi/2 - x$ gives the integral with $\cos x$ on top. Adding the two forms gives $2I = \pi/2$, so $I = \pi/4$.

124. (c) By parts: $[xe^x - e^x]_0^1 = (e - e) - (0 - 1) = 1$.

125. (c) The curves meet at $x = 0$ and $x = 1$. Area $= \int_0^1 (x - x^2)\,dx = \dfrac{1}{2} - \dfrac{1}{3} = \dfrac{1}{6}$.

126. (a) The highest derivative is d^2y/dx^2 (order 2), and its power is 3 (degree 3).

127. (d) The integrating factor is e^x: $\dfrac{d}{dx}(ye^x) = 1$, so $ye^x = x + C$. Since $y(0) = 0$, $C = 0$ and $y = xe^{-x}$.

128. (d) The outcomes with at least one head are HH, HT, TH, and only HH has both heads, so the probability is $1/3$.

129. (c) $|\vec{a}\times\vec{b}|^2 + (\vec{a}\cdot\vec{b})^2 = |\vec{a}|^2|\vec{b}|^2(\sin^2\theta + \cos^2\theta) = 4 \times 9 = 36$.

130. (a) For the first n natural numbers, variance $= \dfrac{n^2 - 1}{12} = \dfrac{99}{12} = 8.25$.